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February 15, 2022

SENT VIA EMAIL (PachecoExpansion@valleywater.org)

Todd Sexauer
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118

RE: Comments on Pacheco Reservoir Expansion Project Draft Environmental Impact Report (State Clearinghouse # 2017082020)

Dear Mr. Sexauer:

These comments[1] on the Draft Environmental Impact Report ("DEIR") prepared by the Santa Clara Valley Water District ("Valley Water") for the Pacheco Reservoir Expansion Project ("project") are submitted on behalf of Stop Pacheco Dam coalition and Pacheco Land & Cattle Co., LLC. The coalition is working to protect ratepayers and the environment, as well as working ranchlands, from this wasteful and high-risk project. The coalition is concerned that the Pacheco Dam project would be extremely environmentally damaging and would not provide tangible water supply benefits.

Pacheco Land & Cattle Co. owns the 6,320-acre Lawler Ranch in southeastern Santa Clara County; the Lawler family has used the ranch for recreational, grazing and other conservation-compatible activities for nearly 60 years. A large portion of the ranch, including the historic O'Connor Ranch structures, would be completely destroyed by this wasteful dam project. The family is committed to conserving the rich historic, agricultural, biological and cultural resources of this unique and part of rural California. (A map showing the project's impact area in relation to protected lands and historic ranches in the region is included on the following page.)

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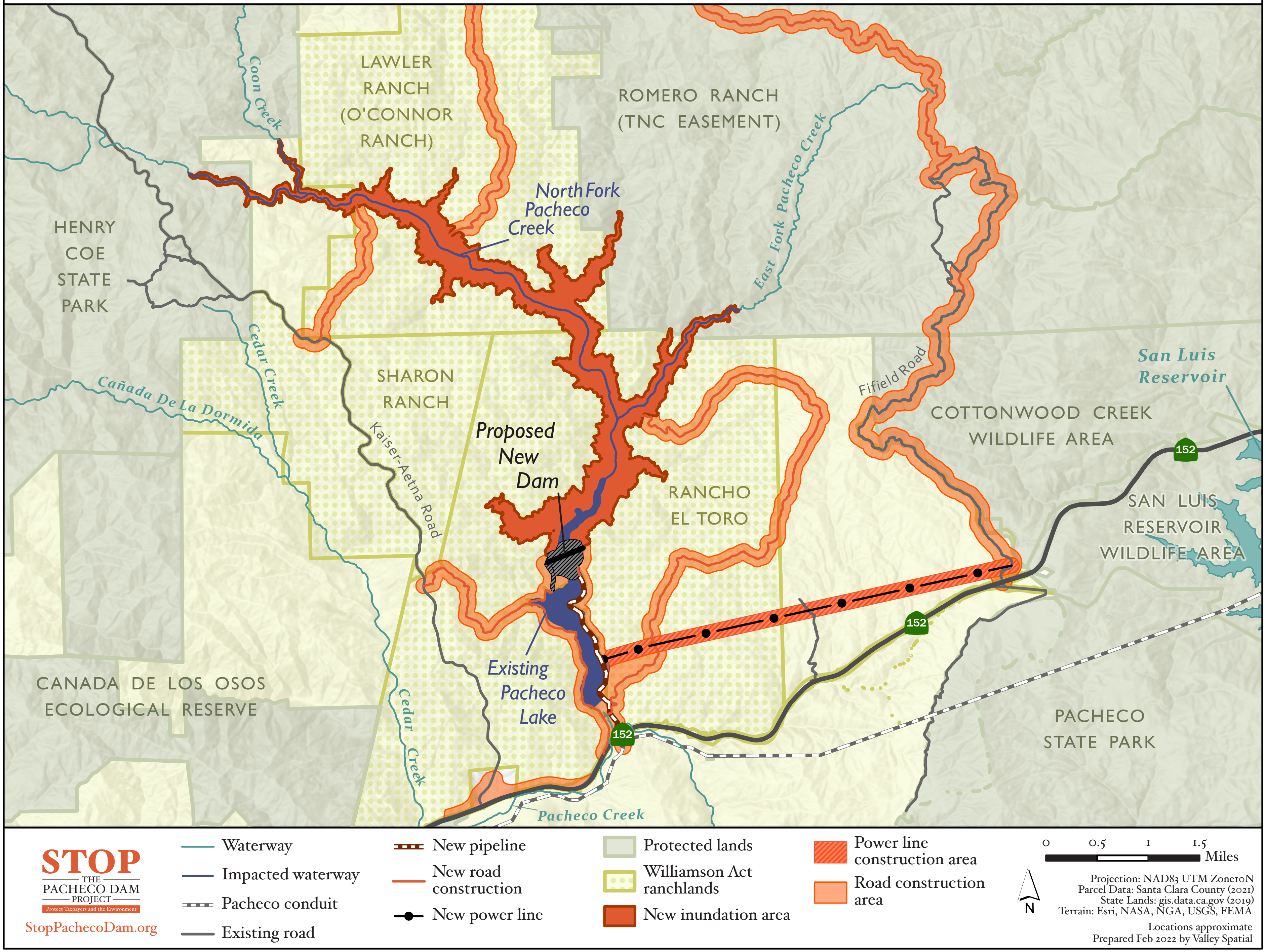
[1] With these comments, two reports prepared by experts in their respective fields are also being submitted that address flaws and omissions in the DEIR's analysis. (See Exhibit 1, Scott Cashen, M.S. - Independent Biological Resources Consultant, Comments on the Draft Environmental Impact Report for the Pacheco Reservoir Expansion Project, Chapter 3.5 (Biological Resources - Botanical/Wildlife), February 14, 2022, and Exhibit 2, Tom Cannon, Senior Aquatic Ecologist, Comments Draft EIR Pacheco Reservoir Expansion Project, Chapter 3.6 (Biological Resources - Fisheries), February 14, 2022.) Valley Water must also provide responses to comments to these expert reports.

@StopPachecoDamProject

PROPOSED PACHECO DAM IMPACT AREA

@StopPachecoDam



The DEIR for the new dam project fails to disclose, analyze and mitigate multiple admittedly significant impacts as required by the California Environmental Quality Act (Public Resources Code, § 21000 et seq. ["CEQA"]). The environmental review flaws discussed in this letter include, among other defects:

- The DEIR's project description mischaracterizes the project and provides an inaccurate depiction of project benefits.
- The baseline information regarding the project's setting is inaccurate.
- DEIR's mitigation strategy relies on unenforceable and ineffective BMPs and PAMMs.
- The significant impacts of the project are not disclosed, or are inadequately disclosed and mitigated in that:
    - The DEIR fails to discuss feasible mitigation measures for agricultural and forestry resources impacts.
    - The DEIR's air quality analysis relies on unenforceable and deferred mitigation.
    - The project's significant biological impacts are inadequately disclosed, improperly characterized, inadequately mitigated, or not mitigated at all. The DEIR fails to adequately characterize habitat and special status species resulting in a failure to properly analyze the project's impacts.
    - The DEIR provides an incomplete and misleading analysis of impacts on South Central Coast California Steelhead ("CCCS or steelhead"), and other native fisheries.
    - The DEIR fails to adequately analyze tribal, cultural and historical resources and fails to provide proper mitigation.
    - The DEIR fails to consider the components of CEQA Guidelines Appendix F in its energy resources analysis.
    - The blasting and erosion impacts are not adequately analyzed and geology impact mitigation measures lack performance measures.
    - The DEIR failed to quantify and analyze GHG emissions from reservoir off gassing and the DEIR's GHG emissions mitigation is both unenforceable and deferred.
    - The DEIR relies on inaccurate and generic data and omits discussion of the dam's public safety hazard.
    - Evaporation rates are not properly analyzed because the DEIR ignores climate change in its impact analysis. The DEIR's water supply benefits are misconstrued and out of context.
    - The decision to utilize a qualitative VMT analysis is not supported by evidence.

    - DEIR failed to discuss harmful algal blooms and other potential water quality problems.
- The cumulative impact analysis disregards several large related projects.
- The alternatives analysis does not include a reasonable range of project alternatives. In particular, the State of California has determined hardfill dams in this location are infeasible, yet, the DEIR includes hardfill dam projects.

In addition to the defects listed above, Valley Water has also failed to provide public access to the references relied upon for the conclusions in the DEIR. In order to prepare these comments, the references to DEIR sections 3.5 and 3.6 were requested from Valley Water, as those were not posted online with the DEIR. (See DEIR, pp. 5-7 to 5-17.) In response, Valley Water provided some of the 168 references listed for sections 3.5 and 3.6 of the DEIR. With respect to almost 50 references, however, Valley Water claims that they are "Exempt under GC 6254 (Federal Copyright Law)." It is presumed that Valley Water is referring to Government Code section 6254, subdivision (k); the withheld documents appear to be scientific references and no explanation of why federal copyright law would preclude their release has been provided.

Valley Water's refusal to make the references upon which the DEIR relies for its conclusions is improper and precludes full public review of the project. The administrative record, should a CEQA challenge be filed, would be based on the documents relied upon by Valley Water as the lead agency leading up to its determinations under CEQA regarding the project. (See Pub. Resources Code, § 21167.6, subd. (e) [explaining contents of CEQA records].) Should Valley Water wish to rely on the 50 or so references that it is currently refusing to disclose in the record (or any others that may be subsequently withheld), it must make those documents available to the public and include them in the project's administrative record.

I. DEIR'S PROJECT DESCRIPTION IS WOEFULLY INACCURATE AND UNSTABLE

"An accurate, stable and finite project description is the sine qua non of an informative and legally sufficient EIR." (*San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus* (1994) 27 Cal.App.4th 713, 730 (*San Joaquin Raptor*), quoting *County of Inyo v. City of Los Angeles* (1977) 71 Cal.App.3d 185, 193.) Furthermore, "[a]n accurate project description is necessary for an intelligent evaluation of the potential environmental effects of a proposed activity." (*Id.* at p. 730 [citation omitted].) "[D]ecision makers and [the] general public should not be forced to . . . ferret out the fundamental baseline assumptions that are being used for the purposes of environmental analysis." (*San Joaquin Raptor Rescue Center v. County of Merced* (2007) 149

Cal.App.4th 645, 659.) Thus, an inaccurate and incomplete project description renders the Draft EIR's analysis of potentially significant environmental impacts inherently unreliable.

A. The Proposed Project in the DEIR Is Infeasible

The DEIR fails to disclose the fact that the project described as the "Proposed Project" in the DEIR is not feasible and apparently can no longer be pursued by Valley Water. As the result of a Public Records Act request, this office learned that Division of Safety of Dams ("DSOD") denied Valley Water's feasibility request regarding construction of a "hardfill" dam. (DSOD Letter to Valley Water, November 1, 2021, attached as Exhibit 3.) Both the Proposed Project and Alternative C would be hardfill dams and are therefore facially infeasible. (DEIR, p. ES-5.) DSOD's November 1, 2021, letter stated, "DSOD has identified major issues that lead us to reject the hardfill dam concept." (Exhibit 3.) The letter goes on to state, "The upper dam site preferred by Valley Water remains a feasible site to construct a dam, such as an earthfill dam, but this site does have noted geologic issues that will need to be addressed for any dam type." (Exhibit 3.)

Subsequent to receiving the DSOD rejection letter, Valley Water failed to correct the DEIR to address DSOD's infeasibility determination for the Proposed Project and Alternative C, instead choosing to release an incorrect EIR to the public for review. Thus, the DEIR retains a hardfill dam for both the Proposed Project and Alternative C (DEIR, p. ES-5), and omits any mention of the DSOD November 2021 infeasibility determination.

Valley Water continues to impede public review by brushing over the significance of the DSOD's November 2021 infeasibility determination. On January 13, 2022, Valley Water held a public meeting regarding the DEIR. During that meeting commenters inquired about DSOD's letter and why a hardfill dam deemed infeasible is still referenced as the "Proposed Project" in the DEIR.[2] Valley Water staff stated that it is still working on a solution as to the design of this project in order to address DSOD's concerns. (January 13, 2022 Valley Water Meeting at 39:00.) Valley Water staff went on to assert that regardless of the type of dam, it would proceed with a variable flow schedule (as described in the "Proposed Project") in order to benefit steelhead. (January 13, 2022 Valley Water Meeting at 39:15.)

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[2] A recording of the meeting can be found at https://www.youtube.com/watch?v=jwK_t9eZfuc, visited January 20, 2022.

There are several inconsistencies with the content of the DEIR and the representations of Valley Water staff during the January 13, 2022 meeting. Despite the inclusion of the "Proposed Project" and "Alternative C" in the DEIR (both of which include hardfill dams), any new hardfill dam would require that Valley Water "appl[y] and obtain[] from [DSOD] written approval of plans and specifications." (Wat. Code, § 6200.) Due to the DSOD's denial of a hardfill dam design, the "Proposed Project" and "Alternative C" in the DEIR are both infeasible, and the DEIR's discussion of them as potentially feasible alternatives is incorrect and misleading.

As a result of the DSOD's feasibility determination, these comments generally focus on Alternative A in the DEIR, which is an earthfill dam in an upstream location, not the "Proposed Project" in the DEIR, which is infeasible. Where the difference is not important, the term "project" is used in this letter.

B. The Project Is Not an Expansion, It Is a New Reservoir

The DEIR's project description is inaccurate because it describes the project as a "reservoir expansion". The use of the word "expansion" denotes that the project is expanding on something already constructed. However, DEIR Figure 2-13 hints at what the DEIR's expansion language obscures: the so-called ""'Expanded Reservoir" has only a tiny overlap with the existing reservoir footprint, and the existing reservoir would be completely decommissioned. Therefore, the project is an expansion, not a new reservoir. As can be seen from the figure below, the overlap area between the existing reservoir's potential footprint and the new 140,000 acre-foot ("af") described in the proposed project and all of the alternatives is only about 20 acres. This project is not an expansion; it is a new dam and reservoir.

C. The Project Would Impede Steelhead Passage

Second, one of two primary objectives is to "Increase suitable habitat in Pacheco Creek for federally threatened SCCC steelhead through improved water temperature and flow conditions." (DEIR, p. 2-13.) However, in the same chapter, a project component is identified that appears to conflict with this objective.

> Under Alternative A, approximately 1.4 miles of North Fork Pacheco Creek would be restored between the spillway of the new dam (including the approximately 450-foot-long spillway return channel) to the downstream from scour pool of existing dam and spillway. Alternative A would focus on providing rearing habitat for SCCC steelhead. The approach to the design of the restoration channel and floodplain (e.g., alignment, hydraulics, composition) under Alternative A would be the same as described for the Proposed Project (see Section 2.3.1.3). **To keep adult SCCC steelhead from entering the restored channel and spawning during winter months when flows are subject to high variation, a physical barrier may be placed and operated on North Fork Pacheco Creek** near the confluence with South Fork Pacheco Creek.

(DEIR, p. 2-74 [bold added].) The need to block steelhead from the supposedly restored channel negates any potential benefit a restored channel may have, as well as poses a serious risk to trapping, injuring, and increasing predation on this protected species.

The DEIR also fails to address the lack of fish passage for the new proposed dam. (See, e.g., <u>Exhibit 1</u>, p. 10.) A project objective is to increase suitable habitat for steelhead (DEIR, p. 2-13), and the DEIR claims that the current Pacheco Reservoir would be restored for use by steelhead (DEIR, pp. 2-26 to 2-27). Yet there is no description of how fish would be able to pass the new project "physical barrier", the decommissioned existing dam, or move past the new proposed dam.

The DEIR acknowledges that:

> Section 5901 of the Fish and Game Code states that it is unlawful to construct or maintain any device in a stream that prevents, impedes, or tends to impede the passing of fish upstream and downstream. Fish and Game Code Section 5937 requires dam owners to allow sufficient water to pass to keep in any fish existing below the dam in good condition.

(DEIR, p. 3.6-16.) But there is no further discussion of the project's consistency with either the requirement not to impede passage of fish or to keep fish below existing dams in good condition. Moreover, there is no effort to harmonize the plan to place a physical barrier on North Fork Pacheco Creek near the confluence with South Fork Pacheco Creek to keep fish out of the reach of North Pacheco Creek under the current reservoir footprint.

Overall, the DEIR fails to clearly provide basic information regarding the project. "[D]ecision makers and [the] general public should not be forced to . . . ferret out the fundamental baseline assumptions that are being used for the purposes of environmental analysis." (*San Joaquin Raptor Rescue Center v. County of Merced* (2007) 149 Cal.App.4th 645, 659.) For example, the DEIR fails to provide the depth of the reservoir, dead pool depth or the procedure for filling the reservoir once constructed. This is all basic information that should be provided in the project description to ensure the public understands the project.

II. DEIR FAILS TO INCLUDE AN ACCURATE BASELINE

An accurate baseline must describe the physical environmental condition in the vicinity of the project as they "exist at the time the notice of preparation is published." (CEQA Guidelines, § 15125, subd. (a)(1).) The purpose of an accurate baseline is to ensure the EIR properly measures the changes in the environment that would result from implementation of the project. (CEQA Guidelines, § 15125.) The EIR "must delineate environmental conditions prevailing absent the project, defining a 'baseline' against which predicted effects can be described and quantified." (*Neighbors for Smart Rail v. Exposition Metro Line Constr. Auth.* (2013) 57 Cal.4th 439, 447.)

A. DEIR Incorrectly Uses 5,500 Acre-feet of Storage as Current Baseline for Reservoir Storage

The DEIR states, "The reservoir was designed with a storage reduction of approximately 650 af. Current operational capacity is estimated at 5,500 af, a reduction of approximately 650 af from the original design due to sediment deposition behind the dam." (DEIR, p. 2-5.) This leads the public to believe that the current reservoir normally contains 5,500 af of water.

According to the DEIR, however, "[s]ince 2017, the North Fork Dam has been under restricted operation criteria due to existing spillway deficiencies (e.g., damage to the spillway)." (DEIR, p. 2-69.) The Notice of Preparation ("NOP") for the DEIR was released on August 7, 2017. (DEIR, pp. ES-41, 1-2.) The DEIR should describe environmental conditions as they "exist at the time the notice of preparation is published." (CEQA Guidelines, § 15125.)

In 2018, DSOD sent a *Second Notice Regarding Necessary Repairs*. (SLLPIP EIS/EIR, p. 6-11, attached as Exhibit 4.) The San Luis Low Point Improvement Project ("SLLPIP") EIS/EIR[3] describes the content of this letter, stating:

> The North Fork Dam is currently being operated under the terms of a DWR Division of Safety of Dams order requiring that the upstream and downstream outlet controls be maintained in the fully open position to maximize releases and maintain the lowest possible surface elevation in Pacheco Reservoir given the current condition of its spillway (DWR 2018).

(Exhibit 4, p. 2-18.)

The SLLPIP EIS/EIR also states, "North Fork Dam is currently under restricted-operation criteria through an April 5, 2017 order of [DSOD] due to existing spillway deficiencies." (Exhibit 4, p. 3-16.) On December 20, 2021, DSOD sent a letter to Pacheco Pass Water District stating that Pacheco Pass Water District must continue to keep the outlet controls in the open position. (See DSOD Letter, December 20, 2021, attached as Exhibit 5.)

Therefore, currently and since at least 2017, the current reservoir was not permitted to hold 5,500 af of water, a point which has been repeated in the intervening years since issuance of the NOP. Further, the DEIR establishes that even during years the reservoir could hold water, many years it was drained. "Storage records available between 1975 to 2003 indicate the reservoir was drained in 17 of the 28 years, which is 60 percent of all years." (DEIR, p. 3.12-2.)

Using a storage volume inconsistent with conditions at the time of the NOP and current conditions as a baseline is inaccurate and deceptive. Due to its blatantly incorrect baseline, the DEIR violates CEQA because it is not a "good faith effort at full disclosure." (*Chaparral Greens v. City of Chula Vista* (1996) 50 Cal.App.4th 1134, 1145.) The inaccurate baseline renders the DEIR's analysis of potentially significant environmental impacts inherently unreliable.

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[3] Valley Water is the CEQA lead agency for the SLLPIP. As described in the discussion of flaws in the DEIR's cumulative impacts section, the DEIR for the project utterly fails to explain the relationship between the SLLPIP and the project described in the DEIR.

B. DEIR Fails to Establish an Accurate Environmental Setting for Biological Resources

As explained in detail in the Cashen Comments on Biological Resources – Botanical/Wildlife, the DEIR fails to provide baseline information necessary to analyze the biological impacts of the project. (See attached Exhibit 1, pp. 7, 14, 41, and 84.)

C. DEIR's Use of 2030 as a Future Condition Baseline Is Misleading

In addition to the year the NOP was released (2017) the DEIR includes analysis of a future condition (2030). Use of the year 2030 as a future baseline is misleading and has no informative value to decision-makers and the public.

The year 2030 cannot be a future with-project condition. According to the overly rosy timeline presented in the DEIR, construction would start in 2025 at the earliest, and would last at least 6.4 years. (DEIR, p. 2-77.) Assuming no delays and this schedule, the new reservoir would not be operational until at least 2032. Further, if water is available both from San Luis Reservoir and from the North Fork Pacheco Creek flows, it would take about nine years to fill the reservoir once constructed. Therefore, the earliest the new reservoir could possibly be full of water (if water is available) is 2042.

Thus, the year 2030 does not represent "future conditions"; to the extent the DEIR includes a "future conditions" date, it must be a date when the project could in concept be operational. By relying on a 2030 "future conditions" date, moreover, the DEIR fails to address potential impacts from climate change. This error creates inaccuracies in the hydrology, water quality, and biological resources impact analyses, among others.

III. THE DEIR'S APPROACH TO MITIGATION, INCLUDING BMPs AND PAMMs, ARE UNENFORCEABLE AND INEFFECTIVE MITIGATION

The DEIR also includes mitigation measures, which are actions taken by the lead agency to reduce impacts to the environment resulting from the original project design. Mitigation measures are identified by the lead agency after the project has undergone environmental review and are above-and-beyond existing laws, regulations, and requirements that would reduce environmental impacts.

Mitigation measures must be designed to avoid or substantially lessen project impacts. (Pub. Resources Code, § 21002.) Additionally, mitigation measures must be enforceable through conditions of approval, contracts or other means that are legally binding. (Pub. Resources Code, § 21081.6, subd. (b).) Mitigation must also be shown to be effective. (*Sierra Club v. County of San Diego* (2014) 231 Cal.App.4th 1152, 1168 [County relied on mitigation that was not likely to achieve GHG emissions reductions because the measures were not funded].) Specific examples of the inadequacies of the mitigation measures for Biological Resources – Botanical/Wildlife are described in Exhibit 1, at pages 84-97.

Rather than incorporate required actions into enforceable mitigation measures that meet CEQA requirements, the DEIR relies heavily on best management practices ("BMP") and project-specific avoidance minimization measures ("PAMM"). (DEIR, pp. ES-11 to ES-13.) The DEIR describes these measures as Design and Implementation Features in the Project Description. (DEIR, p. 2-37.) Such measures are referenced in CEQA Guidelines section 15064, subdivision (f)(2) and 15126.4, subdivision (a)(1)(A). Generally, these are not considered mitigation measures because they are part of the project that is undergoing environmental review. Nonetheless, in order to address an environmental impact, project design features that include impact avoidance and/or minimization measures must be described, and their effectiveness in reducing or avoiding potential impacts specifically analyzed, in the environmental document.

These actions (BMPs and PAMMs) lack performance standards and fail to provide enforcement mechanisms. Failure to evaluate the effect of these measures in the impact analysis violates the legal requirement to provide a logical argument, supported by substantial evidence, for each impact conclusion in an environmental document. (See *Lotus v. Dept. of Transportation* (2014) 223 Cal.App.4th 645, 656.) Therefore, concluding that an impact is less than significant without describing how avoidance and minimization measures of the project design prevent or minimize the impact, is not legally adequate. The DEIR also should, but does not, include the PAMMs that reduce environmental impacts in the mitigation monitoring and reporting program ("MMRP").

When reliant on a BMP or PAMM to reduce impacts, the DEIR must compare the significance of the impact before and after implementation of the measures. For instance, in *Mission Bay Alliance v. Office of Community Investment & Infrastructure* (2016) 6 Cal.App.5th 160, 185, the EIR contained analysis of the impact with and without implementation of a Muni Transit Service Plan ("TSP"). By pursuing the analysis in this manner, the court determined:

> By comparing the significance of the impact on local transit with and without the TSP, a reader learns that while implementation of the TSP will reduce impacts on Muni travel to a less than significant level, the impact

> without the TSP remains significant and unavoidable, even with alternative mitigation measures.

(*Ibid.*)

Here, the analysis of impacts simply relies on the BMPs and PAMMs without any explanation of effectiveness. In several instances the DEIR measures mitigation by including the BMPs and PAMMs. For instance, the mitigated emissions of criteria air pollutants measurements "reflect[] the application of BMP AQ-2 and PAMMs AQ-1 and AQ-2[.]" (DEIR, p. 3.4-40.) However, PAMMs AQ-1 and AQ-2 fail to provide any information regarding these PAMM's ability to impact criteria air pollutant emissions. (DEIR, pp. 2-41 to 2-42.) Therefore, the efficacy of these de facto mitigation measures is baseless. Additionally, enforceability is problematic, PAMM AQ-2 states, "The vehicle speeds on unpaved roads shall be limited to 15 miles per hour (mph) to reduce fugitive dust emissions." (DEIR, p. 2-42.) There is no information regarding when this measure is effective, who enforces the measures or the duration of the measure. Without any of this information it is impossible to determine the enforceability or efficacy of the mitigation. Therefore, this measure cannot be relied upon to lower impacts caused by the Project.

Specific examples of the extensive inadequacies of the PAMMs for Biological Resources – Botanical/Wildlife are described in <u>Exhibit 1</u>, at pages 77-84. As set forth more fully below, Valley Water must revise the DEIR to provide this required information and analyses.

IV. THE PROJECT'S ENVIRONMENTAL IMPACTS ARE NOT ADEQUATELY DISCLOSED, ANALYZED OR PROPERLY MITIGATED IN THE DEIR

The "fundamental purpose of an EIR is 'to provide public agencies and the public in general with detailed information about the effect which a proposed project is likely to have on the environment.'" (*Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 428, citing Pub. Resources Code, § 21061.) In order to serve this purpose, the EIR must "present information in such a manner that the foreseeable impacts of pursuing the project can actually be understood and weighed, and the public must be given an adequate opportunity to comment on that presentation before the decision to go forward is made." (*Id*. at 449-450.)

An EIR must identify significant effects the proposed project will have on the environment. (CEQA Guidelines, § 15126.2, subd. (a).) CEQA defines the "environment" as "the physical conditions that exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, or objects of historic or aesthetic significance." (Pub. Resources Code, § 21060.5.) "In preparing the EIR, the agency must determine whether any of the possible significant environmental impacts of the project will, in fact, be significant." (*Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1109.)

Sufficient analysis of recognized impacts does not excuse an EIR's failure to disclose others impacts. (See *Banning Ranch Conservancy v. City of Newport Beach* (2017) 2 Cal.5th 918, 941 ("however technically accurate the [biological impacts] analysis might be, it fell short by" not disclosing impacts to environmentally sensitive habitat); see also *Sierra Club v. County of Fresno* (2018) 6 Cal.5th 502, 517-522 [*Sierra Club*] (adequate analysis of project emissions did not reconcile failure to analyze the health impacts from those emissions).) "The ultimate inquiry . . . is whether the EIR includes enough detail to enable those who did not participate in its preparation to understand and to consider meaningfully the issues raised by the proposed project." (*Id*. at 516.) "A sufficient discussion of significant impacts in an [EIR] requires not merely a determination of whether an impact is significant, but some effort to explain the nature and magnitude of the impact." (*Id*. at 519.)

In general, the mitigation measures in the DEIR lack any explanation about their effectiveness, except a conclusion that they are effective. CEQA requires more.

Because the public must be able to understand, evaluate, and respond to conclusions in an EIR, the document must contain facts and analysis disclosing the analytical route the agency traveled from evidence to action, not just the agency's bare conclusions and opinions. (*Save Our Peninsula Committee v. Monterey County Bd. of Supervisors* (2001) 87 Cal.App.4th 99, 118.) Meaningful assessment of a proposed mitigation measure requires that the potential impact be clearly identified and quantified, if possible. The Draft EIR must then describe the mitigation measures and explain why the measures are expected to work. (*California Clean Energy Committee v. City of Woodland* (2014) 225 Cal.App.4th 173, 203.) Similarly, the DEIR should explain its conclusions that no mitigation is necessary, or that no mitigation is available.

A. Mitigation for the Project's Significant Agricultural Impacts Is Inadequate (Section 3.3)

CEQA Guidelines Appendix G provides significance thresholds for various potential impacts. Under agriculture and forestry resources one of the thresholds is whether the project would "conflict with existing zoning for agricultural use, or a Williamson Act contract?" (CEQA Guidelines, App. G.) Alternative A would impact more land under Williamson Act contracts than any other alternative, a total of 1,528 acres. (DEIR, p. 3.3-18.) The DEIR finds that this conversion would produce a significant and unavoidable impact to agricultural resources. (*Ibid*.) Rather than provide an analysis for potential mitigation measures the DEIR simply concludes there are no feasible mitigation measures available and therefore the impact remains significant and unavoidable. (*Ibid*.)

The DEIR concludes that there is no feasible mitigation to offset the impacts to land under Williamson Act contracts nor could the Project move to an area not under Williamson Act contracts. (DEIR, p. 3.3-18.) Other than a basic citation to *King & Gardiner Farms, LLC v. County of Kern* (2020) 45 Cal.App.5th 814 (*King & Gardiner*), there is no other mitigation analysis. The court in *King & Gardiner* found:

> Entering into a binding agricultural conservation easement does not create new agricultural land to replace the agricultural land being converted to other uses. Instead, an agricultural conservation easement merely prevents the future conversion of the agricultural land subject to the easement. Because the easement does not offset the loss of agricultural land (in whole or in part), the easement does not reduce a project's impact on agricultural land. The absence of any offset means a project's significant impact on agricultural land would remain significant after the implementation of the agricultural conservation easement.

(*King & Gardiner*, *supra*, 45 Cal.App.5th at 875.)

However, the holding of *King & Gardiner* does not allow Valley Water to conclude without analysis that there are no feasible mitigation measures. The *King & Gardiner* court did not analyze the CEQA Guidelines as amended in 2018. (*King & Gardiner*, *supra*, 45 Cal.App.5th at 876 ["Such measures '[c]ompensat[e] for the impact by replacing or providing substitute resources or environments."].) CEQA Guidelines section 15370, subdivision (e) now states that mitigation includes, "Compensating for the impact by replacing or providing substitute resources or environments, **including through permanent protection of such resources in the form of conservation easements**." (CEQA Guidelines, § 15370, subd. (e) [bold added].) Further, at the time of the amendment, the California Regulatory Notice Register specifically provided that, "This change is consistent with the recent court decision *Masonite Corporation v. County of Mendocino* (2013) 218 Cal.App.4th 230." (Cal. Reg. Notice Register 18, No. 4-Z, p. 133.)

As the current language of CEQA Guidelines section 15370, subdivision (e) suggests, *Masonite Corporation v. County of Mendocino* (2013) 218 Cal.App.4th 230 (*Masonite*) does not stand for the proposition that "Agricultural conservation easements are not considered CEQA mitigation for agricultural land conversions because they do not offset the conversion." (DEIR, p. 3.3-18.) Rather, the court in *Masonite* stated:

> We conclude that [Agricultural Conservation Easements] may appropriately mitigate the direct loss of farmland when a project converts agricultural land to a nonagricultural use, even though an ACE does not replace the onsite resources. Our conclusion is reinforced by the CEQA Guidelines, case law on offsite mitigation for loss of biological resources, case law on ACEs, prevailing practice, and the public policy of this state.

(*Masonite*, *supra*, 218 Cal.App.4th at 238.)

The DEIR fails to consider the language in the CEQA Guidelines, the legislative history and pertinent case law. By doing so, the DEIR has failed to properly consider and discuss feasible mitigation. (CEQA Guidelines, § 15126.4, subd. (a).) Failing to do so creates an informationally deficient DEIR.

B. The DEIR Relies on Deferred and Unenforceable Mitigation Measures for Air Quality Impacts (Section 3.4)

"An EIR shall describe feasible measures which could minimize significant adverse impacts[.]" (CEQA Guidelines, § 15126.4, subd. (a)(1).) Additionally, CEQA Guidelines requires that the "formulation of mitigation measures shall not be deferred until some future time." (CEQA Guidelines, § 15126.4, subd. (a)(1)(B).)

The DEIR determined that Alternative A would produce significant impacts for both Impacts AQ-1 and AQ-2. Those two impacts would remain significant and unavoidable after mitigation. (DEIR, pp. 3.4-36, 3.4-39.) The significance threshold for Impact AQ-1 is exceeded because construction emissions would exceed BAAQMD's thresholds of significance. (DEIR, p. 3.4-35.) Additionally, NO_x emissions would exceed SJVAPCD's thresholds for several years during construction. (*Ibid*.) The DEIR finds that MM-AQ-2 would lower these emissions to less than significant for SJVAB, however the emissions of criteria pollutants and ozone would still exceed BAAQMD's standards. (DEIR, p. 3.4-36.) The DEIR proposes to lessen these impacts through MM-AQ-1 and MM-AQ-2. (*Ibid*.)

The threshold of significance for Impact AQ-2 is whether there would be a cumulatively considerable net increase in criteria air pollutants in a non-attainment area under federal or state ambient air quality standards. (DEIR, p. 3.4-36.) Again, Alternative A would exceed ROG, NO_x, PM_{10} and $PM_{2.5}$ in many of the construction years. (DEIR, p. 3.4-37.) Similar to Impact AQ-1, AQ-2 relies on MM-AQ-1 and MM-AQ-2 to lessen the Project's impacts on air quality.

However, MM-AQ-2 is unenforceable and deferred mitigation. MM-AQ-2 would mitigate emissions from haul trucks by "engag[ing] in regional programs that serve to reduce air pollution in the San Joaquin Valley for the remaining emissions if such levels would exceed SJVAPCD's annual mass emissions thresholds of significance." (DEIR, p. 3.4-64.) No other aspects of the mitigation are discussed, other than the reductions must be quantifiable. (DEIR, p. 3.4-64.) There is no indication how or when these programs would be chosen. The mitigation measure does not indicate whether it is even possible to "engage" in enough programs to offset the emissions that would exceed SJVAPCD's annual emissions thresholds.

Additionally, CEQA imposes enforceability requirements for mitigation measures. "A public agency shall provide that measures to mitigate or avoid significant effects on the environment are fully enforceable through permit conditions, agreements, or other measures. (Pub. Resources Code, § 21081.6, subd. (b).) Similarly, CEQA Guidelines state: "Mitigation measures must be fully enforceable through permit conditions, agreements, or other legally-binding instruments." (CEQA Guidelines, § 15126.4, subd. (a)(2).) The purpose of these requirements is to ensure that mitigation measures are implemented. (*Federation of Hillside & Canyon Assn. v. City of L.A.* (2000) 83 Cal.App.4th 1252, 1261.)

MM-AQ-2 is unenforceable. In fact, it does not appear to have any enforcement mechanisms. Further, the mitigation measure is so vague it is unclear what it purports to accomplish. The DEIR provides one example of a "regional program" that Valley Water could use to mitigate haul truck emissions. (DEIR, p. 3.4-64.) The example states that there is a program that repairs vehicles in order to improve public health. (*Ibid*.) There is no other explanation for how these programs would be selected, how the mitigation would be quantified or who would oversee the process to ensure these emissions reductions are being accomplished through these programs. All these shortcomings result in an unenforceable mitigation measure.

MM-AQ-2 also provides an alternative avenue for mitigation. In the event one of the previously discussed "regional programs" is unavailable, Valley Water may enter into a voluntary emissions reductions agreement ("VERA") with SJVAPCD. (DEIR, p. 3.4-64.) First, it is unclear how a VERA operates. The DEIR explains that a VERA "is a mitigation measure by which the project proponent provides pound-for-pound mitigation of emissions increases through a process that funds and implements emission reduction projects." (DEIR, p. 3.4-17.) The DEIR fails to provide adequate information regarding the feasibility of VERAs. For example, there is no indication that VERAs are always available or that SJVAPCD has the ability to reduce emissions by the amounts Valley Water would require each year of the Project. The DEIR also fails to explain how this mitigation would be enforceable. There is no explanation regarding how "a pound-for-pound reduction in emissions" would be demonstrated or who would ensure those reductions are verified and accurate.

Overall, MM-AQ-2 fails as a mitigation measure for several reasons. It defers mitigation until an undefined later date and provides no trigger for when the mitigation measure must be commenced. Further, neither avenue of MM-AQ-2 provides any enforcement mechanisms. MM-AQ-2 is so vague that it is unclear whether its enforcement mechanisms are even feasible due to the opacity of the "programs" Valley Water may "engage" with to lower emissions.

C. Impacts to Biological Resources – Botanical and Wildlife are Not Disclosed (Section 3.5)

The DEIR ignores, downplays and distorts the numerous significant impacts the project would have on biological resources during construction and operation. Proposed to be located in a remote and largely wild region of the state, the project would displace wildlife that is already experiencing severe habitat loss and movement corridor obstruction.

The deficiencies in the DEIR Biological Resources section are catalogued in Senior Wildlife Biologist, Scott Cashen's comments on the DEIR, and are attached as Exhibit 1 (also referred to as "Cashen"). Cashen's report enumerates numerous and detailed concerns ranging from failure of the DEIR to adequately characterize the habitats and the special status species that use them; missing or inadequate information necessary to assess the environmental baseline and project impacts on these species and their sensitive or otherwise protected habitats; and in the limited instances where mitigation was defined, the adequacy of those measures to mitigate, let alone adequately mitigate, those impacts is questionable.

Individually, each of the identified defects would lead to significant harm to a given species and its habitat. Together, project impacts would fragment or destroy some of the most important habitat, including habitat owned by the state and conservation entities as a result of public investments, remaining in the State. In just one illustration, the project impact area along Pacheco Creek includes one of the most important of the 17 surviving stands of sycamore alluvial woodland in California. The project would directly (e.g., through removal or inundation) or indirectly (e.g., through operational flows) 90 percent of the sycamore alluvial woodlands in the Project study area. Yet the DEIR claims impacts on sycamore alluvial woodland would somehow be mitigated by “protection of existing habitat types” in the County. The project itself would damage most of those same sycamore oak woodlands, rendering mitigation completely ineffective and meaningless. The DEIR also fails to identify conflicts with the Santa Clara Valley Habitat Plan (“SCVHP”). (Exhibit 1, p. 68.) Contrary to what the DEIR mitigation measures suggest, purchasing credits at a mitigation or conservation bank is not a feasible option for mitigating many of the Project’s impacts.

The Cashen Report identifies direct and indirect project impacts to Sensitive Natural Communities that do not appear to be adequately characterized in terms of their classification and legal (or Agency) status. (Exhibit 1, p. 31.) A related mischaracterization associated with riparian wetland communities, appears to undercount the Waters of the U.S. and the State of California. (Exhibit 1, pp. 39-41.) That undercounting and misclassification results in failure to mitigate for project impacts to short-term restored/reclaimed, or temporary impacts to these waters, and provides limited or no ability to assess if the mitigation would offset the impacts.

The Cashen Report further identifies project direct and/or indirect impacts to 22 discrete species, ranging from the monarch butterfly to bald eagles. (Exhibit 1, p. 53.) Additional impacts to special status plants could not be analyzed, as the DEIR lacked substantive scientific information and deferred the potential field survey(s). (Exhibit 1, p. 41.)

An element of these impacts is related to the direct destruction of the unsurveyed habitat by the proposed dam inundation area, as well as the infrastructure to support the dam, such as powerlines. Those activities would fragment the habitat both during construction and during operation. That fragmentation then becomes complete loss in the inundation area, and created a significant barrier to many species that currently use this riparian valley as a migration corridor.

For example, habitat loss and fragmentation are primary threats to the mountain lion and American badger. (Exhibit 1, p. 60.) The proposed 200-foot buffer around the new reservoir would not mitigate these impacts. Powerlines have significant impacts on bird and bat migration, yet the DEIR inexplicably ignores these impacts. (Exhibit 1, pp. 93-94.) These undisclosed impacts do not simply include increase injury, mortality or "take" in the case of particular species, they can further have population-level impacts, such as isolating populations placing them at risk for genetic isolation and extirpation. (Exhibit 1, p. 70.) Because of these risks, the California Department of Fish and Wildlife has classified under the project impact area as an "Irreplaceable and Essential Corridor" for terrestrial connectivity. (Exhibit 1, p. 63.)

According to Cashen:

> [I]t is ridiculous for the DEIR to claim that the Project's impacts on wildlife movement corridors "may not differ significantly from the existing conditions." The proposed reservoir would have a surface area over seven times larger than the existing reservoir; it would create a movement barrier that extends approximately 5.2 miles (east-west) by 3.75 miles (north-south); and it would block an approximately 1.5-mile-wide pathway between two large conservation reserves (Romero Ranch and Henry Coe State Park). [citation] These impacts are vastly dissimilar from existing conditions, especially because they would occur within an area that has been identified as an "Irreplaceable and Essential Corridor" for terrestrial wildlife movement.

(Exhibit 1, p. 6.)

The DEIR also completely ignored potential impacts to Tule Elk. (Exhibit 1, pp. 15-16.) Tule Elk are mentioned twice in the DEIR, both instances are simply describing the project area historically. (DEIR, pp. 3.7-5, 3.7-9.) Further, Tule Elk are only mentioned once in the Biological Resources Appendix. However, the discussion is about mountain lion diets, not threats to the Tule Elk. (Biological Resources – Botanical/Wildlife, App., p. 3-16.)

In February 2020, the Santa Clara Valley Habitat Agency produced a study titled: *Wildlife Permeability and Hazards Across Highway 152 Pacheco Pass: Establishing a Baseline to Inform Infrastructure and Restoration*. (Exhibit 1, pp. 70, 103.) The study provides information regarding Tule Elk occurrences near the Project area. Further, as explained in the Cashen report, the Project area contains large swaths of Tule Elk habitat. (Exhibit 1, p. 16 [showing core habitat area for Tule Elk in project impact area].) By definition, core habitat areas provide a continuous area of suitable habitat large enough to sustain at least 50 individuals. (Exhibit 1, p. 15.) Indeed, Highway 152 includes elk crossing signs and elk are seen on this stretch of highway east of the project area.[4]

The DEIR ignored scientific information regarding the presence of Tule Elk and the impacts of the project on individual Elk as well as population-level impacts. Evidence shows that Tule Elk habitat is in and around the project impact area and that Tule Elk reside in the area. The DEIR's failure to describe potential impacts the project would have on Tule Elk makes the DEIR informationally deficient.

D. Biological Resources – Fisheries (Section 3.6)

Senior Aquatic Ecologist, Tom Cannon ("Cannon Report"), attached as Exhibit 2 (also referred to as "Cannon") identifies a series of failures of the DEIR related to the lack of adequate baseline information; absence of supporting field surveys; missing impact analyses; mischaracterizations of project impacts; and in the case of the steelhead, missing or inadequate information necessary to assess the environmental baseline and the purported benefits to the Steelhead and its Critical Habitat.

According to Mr. Cannon, the project is unlikely to support steelhead recovery. In large part, this is because "The DEIR fails to discuss or evaluate bottlenecks that would likely undermine any of the proposed project benefits. Without this analysis, there is no scientific basis for the DEIR's conclusion that the Project would facilitate recovery of the species in the Pajaro River system." (Exhibit 2, p. 2.) Other flaws in the DEIR's analysis of fisheries impacts identified by Cannon include:

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[4] See https://m.facebook.com/167018863327658/photos/a.2053511631345029/4359338134095689/?type=3&_rdr (2 comments noting Elk seen here).

- The DEIR fails to assess reasonable alternatives, and does not adequately assess benefits to steelhead from other activities in the Pajaro watershed. (Exhibit 2, pp. 2-3.)
- The DEIR fails to adequately discuss impacts on steelhead Critical Habitat that would be caused by the proposed dam both above and below the dam, or assess alternatives that would avoid, minimize, or mitigate for those impacts. (Exhibit 2, pp. 2-3, 24-25, 28-31.)
- The DEIR does not adequately represent project impacts associated with: "discharge of fine sediment, introduction of invasive species, and release of out-of-basin CVP water (which may affect imprinting and homing behavior)." (Exhibit 2, p. 9; see also 19, 28-31.)
- The DEIR does not provide adequate baseline information regarding ecological conditions, nor a considered analysis of project impacts on native roach and hitch populations. Existing watered sections or deeper pools of the upper NF may have native roach and hitch that would be wiped out by a new reservoir. (Exhibit 2, p. 7.)

  According to Cannon:

  > The Fish impacts listed number 1-4, 7-8, and 11 from all alternatives would be significant mainly because of the new reservoir (loss of designated critical stream habitat, reduction in winter storm flows, warm water summer releases), introduction of invasive predatory and competitive fish species, and water quality effects of the proposed reservoir []. Fish impact 12 would be significant as an additive to cumulative impacts to CV fishes, furthermore any increase in Delta exports should be considered a significant adverse impact. The DEIR fails to provide sufficient argument that the above-mentioned project impacts should be classified as not significant as defined in Section 3.6.3.2: The DEIR makes the conclusory statement that these impacts would not be significant without any supporting evidence.

(Exhibit 2, p. 24.) These defects in the DEIR related to the alternatives for the project action, the conflict in descriptions, the lack of adequate (or any) baseline, and what appear to be fatal flaws in the fisheries impacts analysis, are so numerous and significant that the document should be withdrawn.

E. Tribal Resources and Cultural Resources (Section 3.7)

The project impact area includes numerous cultural resources, some of which date back over 3,000 years. The area also includes important pieces of California's more recent history affiliated with Mexican Land grants and ranching operations, some of which were established prior to statehood. The DEIR fails to address the full extent of these tribal and cultural impacts, or to formulate all feasible mitigation to avoid or reduce them.

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CEQA provides that tribal cultural resources may include, "sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a Native American tribe[.]" (Pub. Resources Code, § 21074, subd. (a)(1).) The determining factor is whether the resources is eligible for inclusion in California's Register of Historic Resources or included in a local register of historic resources. (*Id*. at subds. (a)(1)(A), (a)(1)(B).) "A project with an effect that may cause a substantial adverse change in the significance of a tribal cultural resource is a project that may have a significant effect on the environment." (Pub. Resources Code, § 21084.2.)

CEQA Guidelines also requires specific mitigation measures be considered for impacts to historical resources. CEQA Guidelines state:

> Public agencies should, whenever feasible, seek to avoid damaging effects on any historical resource of an archaeological nature. The following factors shall be considered and discussed in an EIR for a project involving such an archeological site:
>
> (A) Preservation in place is the preferred manner of mitigating impacts to archaeological sites. Preservation in place maintains the relationship between artifacts and the archaeological context. Preservation may also avoid conflict with religious or cultural values of groups associated with the site.

> (B) Preservation in place may be accomplished by, but is not limited to, the following:
> 1. Planning construction to avoid archaeological sites;
> 2. Incorporation of sites within parks, greenspace, or other open space;
> 3. Covering the archaeological sites with a layer of chemically stable soil before building tennis courts, parking lots, or similar facilities on the site.
> 4. Deeding the site into a permanent conservation easement.
>
> (C) When data recovery through excavation is the only feasible mitigation, a data recovery plan, which makes provision for adequately recovering the scientifically consequential information from and about the historical resource, shall be prepared and adopted prior to any excavation being undertaken.

(CEQA Guidelines, § 15126.4, subd. (b)(3).)

Additionally, "When a project will impact an archaeological site, a lead agency shall first determine whether the site is an historical resources[.]" (CEQA Guidelines, § 15064.5, subd. (c)(1).) In *Madera Oversight Coalition, Inc. v. County of Madera* (2011) 199 Cal.App.4th 48, 81, the court held that the use of the words "shall" and "first" in section 15064.5 of the CEQA Guidelines requires the determination be made before the Final EIR is certified. As discussed below, the DEIR fails to adequately analyze impacts to tribal, cultural and historic resources, and also fails to provide proper mitigation for those impacts.

1. *The EIR's Cultural and Tribal Resources Section Fails to Comply with the Informational Requirements of CEQA*

The DEIR's cultural resources section suffers from substantive and procedural deficiencies. The cultural resources section provides a regulatory framework in Section 3.7.3 and identifies some relevant federal processes such as Section 106 of the National Historic Preservation Act ("NHPA"), but fails to describe what federal agencies would be required to authorize permits, actions, or funding qualifying as undertakings under the NHPA. (See CEQA Guidelines, § 15124, subd. (d); see also 36 C.F.R. § 800.16(y).) The U.S. Army Corps of Engineers would issue a fill permit under Section 404 of the Clean Water Act and the U.S. Bureau of Reclamation would have a role in authorizing or participating in the storage and conveyance of non-project water. (DEIR, p. 2-142.)

Both actions would qualify as undertakings within the meaning of Section 106. The cultural resources section then oddly uses the term "area of potential effects" synonymously with "project area" without describing any relevant consultation history with any federal agency or the State Historic Preservation Officer ("SHPO") as required by 36 C.F.R. section 800.4(a)(1) that would have resulted in the formal designation of the area of potential effects ("APE"). Determination of the APE is a formal process requiring consultation with relevant Native American tribes, the federal agency or agencies pursuing undertakings, the SHPO, and other consulting parties under section 106 of the NHPA, not CEQA. These details are conspicuously absent. The failure to fully integrate substantive and procedural requirements of Section 106 or explain previous actions taken to comply with these requirements creates an information gap and the risk that Valley Water will adopt substantive mitigation measures at odds with the requirements of federal cultural resources law. This is contrary to the direction that the CEQA document "to the fullest extent possible . . . integrate CEQA review with these related environmental review and consultation requirements." (CEQA Guidelines, § 15124, subd. (d)(1)(C).) The defects arising from this omission are more fully explained below.

In addition, the EIR also fails to substantiate:

- Why cultural resources are eligible for listing in the National Historic Register;
- Whether mitigation would be effective;
- What methods would be used to perform mitigation;
- Why tribal cultural resources are of value to the relevant Native American tribes; and
- What substantive input has been received from Native American tribes under CEQA regarding management preferences and mitigation approaches.

2. *The EIR Fails to Provide Adequate Information Regarding Archaeological Site Eligibility*

A lead agency's impact analysis must be supported by substantial evidence. (*Spring Valley Lake Ass'n v. City of Victorville* (2016) 248 Cal.App.4th 91, 103; *City of Maywood v. L.A. Unified School Dist.* (2012) 208 Cal.App4th 362, 391.) Substantial evidence is defined as ". . . facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts." (CEQA Guidelines, § 15384, subd. (b).) CEQA requires more than a bare outline of issues without any grounding in substantive discussion of either the actual qualities of resources or how mitigation will address those qualities. (CEQA Guidelines, § 15151 ["An EIR should be prepared with a sufficient degree of analysis to provide decision makers with information which enables them to make a decision which intelligently takes account of environmental consequences"].) For example, the California Register of Historical Resources allows an archaeological resource to be listed if it meets the criteria in Public Resources Code section 5024.1, subdivision (c)(4) because it has "*. . . yielded, or may be likely to yield, information important in prehistory or history*." (Italics added.) The DEIR fails to provide such information.

The DEIR fails to substantiate the basis for the stated eligibility of cultural resources and thus undermines the public's understanding of the impacts of the project and the putative efficacy of mitigation measures. In the cultural resources section the DEIR states:

> Archaeological testing and eligibility evaluations have been initiated at 22 of the 32 archaeological resources within the upstream region of the APE to determine the eligibility of each resource for listing in the NRHP and CRHR. The remaining ten resources were not formally evaluated due to a lack of legal access. Similarly, the two archaeological sites in the access/utility region of the APE have not been evaluated due to lack of legal access. Isolates are generally not considered eligible resources due to their limited information value and are not discussed further. The preliminary eligibility status of each evaluated site is listed in Table 3.7-8. Of the twenty-two evaluated sites, 13 appear eligible and five appear likely eligible, based on the current status of site analyses.

(DEIR, p. 3.7-24.) No facts are provided to substantiate the "preliminary eligibility" of these resources.

Additionally, the EIR provides mitigation for the significant and unavoidable cultural impacts, among other measures, "*Mitigation Measure Cul 2c– Avoid Historical Resources or Prepare and Implement a Data Recovery and Treatment Plan (Proposed Project, Alternatives A, B, C, and D)*." (DEIR, p. 3.7-88.) This measure states:

> A Data Recovery and Treatment Plan shall be prepared by a qualified archaeologist to address impacts to those archaeological historical resources that cannot be avoided by Project construction and operation. The Data Recovery and Treatment Plan will be consistent with requirements in Public Resources Code Section 21083.2 and Section 15126.4(b) of the CEQA Guidelines. The Data Recovery and Treatment Plan will include a research design to identify research questions as the focus data recovery

efforts, as well as detail the field and laboratory methods to address the questions.

(DEIR 3.7-88.)

The EIR relies on an as-yet unprepared data recovery plan to address impacts to resources they merely assert as eligible, while conceding impacts on these resources are significant and unavoidable. (DEIR, p. 3.7-91.) As stated above, CEQA requires findings for significant and unavoidable impacts, and requires that those finding be supported by facts. Specifically, CEQA requires that for significant and unavoidable impacts, the lead agency perform all *feasible* mitigation, or demonstrate why additional mitigation would be infeasible or is the duty of another entity. (CEQA Guidelines, § 15091.) Because the EIR offers no factual basis regarding the putative eligibility of resources, the efficacy or sufficiency of the proposed mitigation is inadequate. Even if Valley Water has stated why resources that may be affected are eligible, they still defer the substantive methods of their data recovery plan to a future date, beyond the field of public view.

The public and the decision makers deserve a better basis of facts for decision making and understanding the consequences of the proposed project. Given the absence of eligibility information, it is impossible for the public to understand whether the mitigation would "avoid or substantially lessen" the significant effects on these resources, consistent with CEQA Guidelines section 15091. Therefore, the efficacy of the proposed mitigation is meaningless. These deficiencies render the DEIR inadequate. At a minimum, Valley Water should recirculate the document with the following information:

- A concise and clear, factually supported eligibility analysis for archaeological resources. This should, at a minimum, state the age of the components at the affected resources, the constituents of the archaeological assemblages that may be affected, and the relevant research questions that these assemblages may be used to address important research questions in California history or prehistory within the meaning of the eligibility criteria in Public Resources Code section 5024.2, subdivision (c)(4) (the listing criteria for archaeological sites). In addition, the DEIR must substantiate the integrity of these resources, to support why they can speak to important research questions. Archaeological sites that are highly disturbed and mixed may lack the original spatial associations necessary to convey useful research information.
- A meaningful data recovery plan showing specific research methods and questions that can be answered by study of the affected resources, rather than an empty promise to prepare this document later.

3. *The EIR Fails to Disclose AB 52 Consultation Requirements under CEQA*

CEQA requires "a list of related environmental review and consultation requirements required by federal, state, or local laws, regulations, or policies" and "to the fullest extent possible . . . integrate CEQA review with these related environmental review and consultation requirements." (CEQA Guidelines, § 15124, subd. (d)(1)(C).)

While the EIR provides a thin "Regulatory Framework" in Section 3.7.3 for cultural resources, there is no mention of what federal undertakings under the NHPA would be required, what other state permits would be required or how these consultation and environmental review processes would work. Absent this information Valley Water fails to satisfy the requirements of CEQA Guidelines section 15124, and creates the risk of conflicting agency directives and decision-making as follows:

- Federal agencies must consult with stakeholders, including Native American tribes, under the NHPA, as described above. Because "Indian Tribes" within the meaning of Section 106 are different than the entities that Valley Water has contacted through the NAHC. (See 36 C.F.R. § 800.16(m).) As explained above, there is a risk of conflicting directives that have not been duly addressed or accounted for in the mitigation measures Valley Water proposes.
- Valley Water provides no record of what input Native American tribes have provided regarding tribal cultural resources. Other state agencies will have actions subject to CEQA (e.g., California Department of Fish and Wildlife would likely issue an incidental take permit under the California Endangered Species Act and a streambed alteration agreement under Section 1602 of the Fish & Game Code, both triggering CEQA). These agencies may pursue a more robust and independent environmental review process, including compliance with tribal consultation requirements. These processes may also lead to conflicting direction and mitigation approaches that the DEIR could have avoided by fully complying with CEQA Guidelines section 15124.
- The DEIR refers to an "area of potential effects" without disclosing the federal agency of SHPO role in determining this area, which is a term of art under Section 106.

4. *Valley Water Must Recirculate the EIR Because the DEIR Does Not Provide Transparent or Adequate Material to Fulfill the Informational Requirements of CEQA*

The CEQA Guidelines require a lead agency to recirculate a document when "the draft EIR was so fundamentally and basically inadequate and conclusory in nature that meaningful public review and comment were precluded." (CEQA Guidelines, § 15088.5, subd. (a)(4).) Here, Valley Water has deprived the public and its own decision makers of the following:

- Substantial evidence supporting why cultural resources are eligible for listing;
- Substantial evidence why tribal cultural resources are of value to affected Native American tribes;
- Real, tangible methods in their mitigation measures that would address the effects of the project; and;
- Consideration of parallel state and federal consultation and environmental review process, the absence of which creates a risk of conflicting decision making and consultation input based on the legally different standards of federal law as compared to CEQA.

Recirculation of a document with a significantly more robust description of these issues is the only appropriate remedy.

5. *Mitigation Measures to Comply with the Requirements of AB 52 May Create Conflicts with the Section 106 Process*

The EIR requires federal permits and authorizations that qualify as undertakings under Section 106 of the NHPA. Valley Water has conducted Native American consultation with tribes identified by the Native American Heritage Commission (NAHC). (DEIR, p. 3.7-29). Valley Water has also adopted mitigation measures to address the CEQA requirements governing tribal cultural resources such as *Mitigation Measure Cul 2c– Avoid Historical Resources or Prepare and Implement a Data Recovery and Treatment Plan* which requires that data recovery plans be prepared in consultation with Native American tribes, presumably those entities identified by the NAHC. (DEIR, p. 3.7-88.)

Independent of CEQA, Section 106 requires federal agencies to consult with Native American tribes (36 CFR § 800.3(f)(2)), defined as "Indian tribes" within the meaning of federal law (36 CFR § 800.16(m).) The list of relevant entities for purposes of Section 106 and other federal law is periodically updated by the U.S. Department of the Interior, with the latest list posted in *Federal Register*, Vol. 86, No. 18 / Friday, January 29, 2021[5].

The DEIR fails to indicate any attempt to reconcile the management process identified in these mitigation measures with the wishes of Native American tribes that may be identified by federal agencies consulting under Section 106. This is particularly egregious given that the legal meaning of "Indian tribes" under Section 106 are the tribes eligible for special programs of the *federal* government, identified in the *Federal Register* rather than the NAHC. In failing to anticipate this discrepancy, or coordinate with federal agency consultations, Valley Water has created a risk that Section 106 consultation will result in feedback and management indications from federally recognized tribes inconsistent with the feedback and management processes adopted to satisfy the requirements of CEQA and the tribes identified by the NAHC.

6. *The EIR Impermissibly Defers Mitigation for Tribal Cultural Resources Impacts*

The EIR contains the same error for archaeological resources and tribal cultural resources under CEQA. To support their assertion that they have identified tribal cultural resources the EIR states:

> . . . for the purposes of this Draft EIR, archaeological resources (i.e., archaeological resources and multi-component archaeological resources) within the downstream region of the APE identified in Table 3.7-4 have been preliminarily determined to be TCRs [tribal cultural resources].

(DEIR, p. 3.7-33.)

There is no meaningful discussion of the expressed indication of Native American community supporting why these resources are of cultural value to a Native American tribe within the meaning of Public Resources Code section 21074, subdivision (a).

The DEIR concedes there are significant and unavoidable impacts on tribal cultural resources. (DEIR, p. 3.7-91). However, the DEIR fails to provide a meaningful discussion of how mitigation could reduce these impacts, in a manner compliant with the Public Resources Code. The relevant section states:

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[5] See 2021-01606.pdf (govinfo.gov).

> If a project may have a significant impact on a tribal cultural resource, the lead agency's environmental document shall discuss both of the following:
> (1) Whether the proposed project has a significant impact on an identified tribal cultural resource.
> (2) Whether feasible alternatives or mitigation measures, including those measures that may be agreed to pursuant to subdivision (a), avoid or substantially lessen the impact on the identified tribal cultural resource.

(Pub. Resources Code, § 21082.3, subd. (b).)

Instead, the DEIR defers any meaningful discussion of what mitigation options or approaches tribes may prefer and relies on *Mitigation Measure TCR-1: Avoid Tribal Cultural Resources or Develop Treatment for Tribal Cultural Resources in Consultation with Tribes*. (DEIR, p. 3.7-89.) This measure indicates that Valley Water would avoid tribal cultural resources and work with tribes to "develop appropriate treatment" for these resources. This is contrary to the plain language of the Public Resources Code which states mitigation, including mitigation agreed upon by the relevant tribes, during consultation compliant with Public Resources Code section 21080.3.1, should be provided in the environmental document. Valley Water defers the preparation of meaningful content to an unknown time, outside the scope of public review. This decision deprives the public and the affected tribes of a record of how significant and unavoidable impacts would be addressed.

F. DEIR's Energy Impacts Analysis Is Deficient (Section 3.8)

The DEIR relies solely on "guidance from CEQA Guidelines Appendix G," for its two significance thresholds for energy impacts. (DEIR, p. 3.8-5.) However, the DEIR fails to consider the other energy specific factors provided in the CEQA Guidelines. This error makes the DEIR deficient as an informational document.

First, the energy analysis fails to analyze several considerations listed in the CEQA Guidelines. (CEQA Guidelines, § 15126.2, subd. (b) ["other relevant considerations may include, among others, the project's size, location, orientation, equipment use and any renewable energy features that could be incorporated into the project."].) Second, the DEIR fails to consider any of the elements included in Appendix F, which assist in determining whether a project's energy use is wasteful, inefficient, or unnecessary. (CEQA Guidelines, § 15126.2, subd. (b) ["Guidance on information that may be included in such an analysis is presented in Appendix F"].) Appendix F explains:

> The goal of conserving energy implies the wise and efficient use of energy. The means of achieving this goal include: [¶] (1) decreasing overall per capita energy consumption, [¶] (2) decreasing reliance on fossil fuels such as coal, natural gas and oil, and [¶] (3) increasing reliance on renewable energy sources.

(CEQA Guidelines, App. F, § I.)

The court in *California Clean Energy Committee v. City of Woodland* (2014) 225 Cal.App.4th 173, 213 (*CCEC*) relied on this Appendix F language when it invalidated an EIR that did "not indicate any investigation into renewable energy options that might be available or appropriate for the project." Similarly, here, the DEIR fails to describe how the Project would comply with any of the prescribed means to achieve energy conservation. This omission is especially concerning due to the large amount of fossil fuels being consumed during construction and operation. (DEIR, p. 3.8-12.)

The DEIR states, "Alternative A would require 10,911,073 gallons of diesel fuel for construction off-road equipment, 2,544,475 gallons of diesel for on-road hauling and 3,994,245 gallons of gasoline for worker commute trips." (DEIR, p. 3.8-12.) The project would also require nearly 36,000 gallons of jet A fuel per year. (*Ibid*.) Additionally, the production concrete would require over 38,750,000 kBtus (equivalent to 38.7 billion BTUs). This amount of energy consumption equals 11,357,000 kwh. (DEIR, p. 3.8-13.)

Rather than provide any analysis of whether these uses are inefficient or wasteful, the DEIR makes this conclusory statement: "Construction fuel consumption associated with Alternative A would not be any more inefficient, wasteful, or unnecessary than at other construction sites in the region." (DEIR, p. 3.8-13.) However, the significance standard is not whether a project would be more inefficient than others, but whether the project itself is wasteful, inefficient, or unnecessary. (CEQA Guidelines, § 15126.2, subd. (b).)

G. Geology Impacts are Not Analyzed (Section 3.9)

1. *Impact Analysis Fails to Analyze Potential Impacts of Blasting Operations During Construction*

An EIR must reflect a good faith effort at full disclosure, with "detail sufficient to enable those who did not participate in its preparation to understand and to consider meaningfully the issues raised by the proposed project." (*Laurel Heights Improvement Association v. Regents of University of California* (1988) 47 Cal.3d 376, 405; CEQA

Guidelines, § 15151.) An EIR must analyze every issue for which the record contains substantial evidence supporting a "fair argument" of significant impact. (*Visalia Retail, LP v. City of Visalia* (2018) 20 Cal.App.5th 1, 13; *Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1109.) The DEIR indicates that blasting and pile driving would occur at the project site, but fail to analyze impacts stemming from those operations.

The DEIR provides some information regarding impacts from landslides, surface erosion and vegetation removal. (DEIR, p. 3.9-43.) However, nowhere in this brief analysis regarding ground shaking, seismic-related ground failures and landslides, does the DEIR analyze impacts from blasting and pile driving operations. This information is not unknown. However, the information is housed in the Noise section. (See DEIR, pp. 3.14-5 to 3.14-6.) There, the DEIR indicates that detonation of explosives would break up or disrupt rock, while the remaining blast energy expands outward through ground vibrations or air overpressure. (DEIR, p. 3.14-5.) The Noise section also states, "pile driving and blasting are typical construction activities that generate the greatest levels of ground vibration. The project would require blasting and may involve operations of all pieces of equipment or similar types of equipment to those listed in Table 3.14-11." (DEIR, p. 3.14-20; see also DEIR, p. 3.14-23 [Alternative A would require similar activities].)

The failure of the DEIR is that these operations are only considered in the Noise section, which analyzes the impacts to sensitive receptors. The DEIR fails to analyze these same activities through a "ground shaking, seismic-related ground failures and landslides," analysis as the Geology section purports to complete. This failure results in an inadequate EIR.

2. *The DEIR Finds Impact Geo-1 Significant Without Adequate Analysis*

One significance criterion is whether the project would directly or indirectly cause adverse effects from strong seismic ground shaking. (DEIR, p. 3.9-29.) The DEIR finds this impact to be less than significant with mitigation. (DEIR, p. 3.9-30.) The impact analysis for Impact Geo-1 states that landslides due to seismic shaking have not been identified. (DEIR, p. 3.9-42.) However, the DEIR also states that an investigation was conducted to determine the age and stability of various landslide features at the project site. (DEIR, p. 3.9-43.) The investigation recommended additional studies be conducted near the dam site. There is no indication these additional studies were completed. Instead, the DEIR states, "Due to this uncertainty, this impact would be significant because substantial adverse effects could be caused by earthquake-induced landslides."

(DEIR, p. 3.9-43.) This bald conclusion violates CEQA. "[A]n EIR's designation of a particular adverse environmental effect as 'significant' does not excuse the EIR's failure to reasonably describe the nature and magnitude of the adverse effect." (*Cleveland Nat'l Forest Found. v. San Diego Association of Governments* (2017) 3 Cal.5th 497, 514; see also *Berkeley Keep Jets Over the Bay Com. v. Board of Port Comrs.* (2001) 91 Cal.App.4th 1344, 1371.)

3. *Mitigation Measure Geo-1 is Opaque and Lacks Performance Measures*

MM-Geo-1 fails to comply with CEQA mitigation requirements in at least two regards. First, rather than integrating Valley Water 2021 reports into a stand-alone mitigation measure, the DEIR takes excerpts from the reports and puts them in the DEIR. This makes it unclear whether other aspects of the reports would be implemented as mitigation or only the recommendations the DEIR contains. (DEIR, p. 3.9-85.) The mitigation measure contains two recommendations; however, Valley Water 2021b contains five recommendations. Therefore, it is unclear whether the mitigation measure includes the two recommendations specifically listed in the DEIR or all five listed in the report.

Second, the mitigation measure is impermissibly deferred and lacks performance standards. CEQA allows the formulation of mitigation be deferred when it is impractical or infeasible to include specific details during the project's environmental review. (CEQA Guidelines, § 15126.4, subd. (a)(1)(B).) However, CEQA also requires that the agency commit to the mitigation, adopt performance standards, identify potential actions to achieve the performance standard and incorporate the mitigation measure. (*Ibid*.)

MM-Geo-1 fails to meet these requirements. *MM-Geo-1 Application of Valley Water (2021a and 2021b) recommendations for soil erosion, liquefaction, and landslides* states:

> Valley Water will ensure that the recommendations outlined in the two Valley Water 2021 reports are implemented in conjunction with ongoing design efforts in order to avoid or minimize potential impacts to project facilities in the event of a seismic event.
>
> These recommendations are:
>
> Complete a subsurface exploration and mapping program. This program will include the presence or absence, geometry, source, and causes of

> landslides and potential landslides mapped within or adjacent to the proposed dam foundation. As part of the subsurface investigation, borings, test pits, and geophysical exploration will be evaluated to identify and assess the various inferred landslide deposits in the area downstream from the proposed dam. Geologic mapping conducted within and adjacent to the footprint of the proposed dam will be analyzed to assess the presence or absence of landslide deposits and potential unfavorable geologic conditions such as soil erosion, liquefaction, and slope mass movement.
>
> Slope stability analyses of interpreted landslides and existing slopes will be performed within the proposed dam footprint and reservoir rim areas. These analyses would help assess slope stability for dam construction and the stability of mapped landslides before and after reservoir filling. In addition, they will be used to inform the design team in the development of specific design requirements that will include measures necessary to stabilize these landslides or increase the stability of the proposed dam to a point that would reduce the risk of a seiche or other seismic induced hazard to a level acceptable to DOSD [sic].

(DEIR, p. 3.9-85.)

This mitigation measure refers to studies that should be performed before, not after, the DEIR was produced. The purpose of these studies is to determine whether landslides and soil erosion will create an infeasible dam location or design. The DEIR has put forth the proposed project and Alternatives A through D, all of which contain a dam site and dam design. Valley Water apparently hopes to use this deferred mitigation to circumvent mitigating the landslide and erosion hazards identified in the 2021 reports. (DEIR, p. 5-2, Valley Water 2021b, p. 17 [“Landslides along the north fork of Pacheco Creek and its tributaries are abundant, with landslides covering approximately 43 percent of the total area evaluated.”].)

H. The DEIR’s Analysis of GHG Emissions Is Flawed and GHG Mitigation Is Inadequate (Section 3.10)

1. *DEIR Fails to Consider Increased Emissions from the Reservoir*

CEQA requires a lead agency make a “good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of greenhouse gas emissions resulting from the project.” (CEQA Guidelines, § 15064.4, subd. (a).) The analysis should consider evolving scientific knowledge and consider the increase in GHG emissions as compared to the existing environmental setting. (CEQA Guidelines, § 15064.4, subd. (b).)

The DEIR states:

> [M]ethane and other GHGs off-gassed from the reservoir surface is another possible source of emissions . . . . However, terrestrial carbon stored in sediments, transported by inland waters, results in the burial of organic carbon (i.e., sequestration) within the reservoirs, thus, increased reservoir capacity as a result of the Project could result in an increased potential for additional carbon sequestration within the expanded reservoir, potentially counteracting the loss of sequestration from vegetation loss and/or the increased emissions from off-gassing.

(DEIR, p. 3.10-8.) Thus, without actual analysis, the DEIR concludes that the stored carbon from the expanded reservoir would cancel out any increase in emissions from off-gassing. This analysis could easily be accomplished, and was not likely completed because of the significant methane emissions associated with wetting and drying features and the exceptional climate change potential of methane (Greenhouse Gas equivalents [GHGe]) that would show the project would be a major emitter of methane and thus obviate any carbon sequestration benefits. This is not supported by substantial evidence. (CEQA Guidelines, § 15384.)

The DEIR goes on to conclude that no quantitative analysis could be completed for the reservoir's off-gassing emissions due to lack of available science. (DEIR, p. 3.10-8.) Therefore, the DEIR omits these emissions from its analysis. The DEIR, however, cites to a study that explains GHG emissions from water surfaces, Deemer et al. 2016. In fact, the Deemer study provides a table to help calculate the potential emissions from different types of reservoirs. (Deemer et al., p. 950 [Table 1].) By omitting the potentially large source of CO_{2e} emissions from reservoir off-gassing, the DEIR fails to adequately analyze the GHG impacts of the project. This failure also leads to an inaccurate determination that the impact could be mitigated to less than significant. These deficiencies result in a deficient DEIR that requires recirculation.

2. *Mitigation Measure GHG-2 Is Unenforceable and Impermissibly Deferred*

CEQA Guidelines require GHG emission mitigation measures to avoid, lessen, or rectify the impacts they are intended to mitigate. (CEQA Guidelines, § 15370.) Though CEQA Guidelines allow off-site mitigation of GHG emissions those measures must be subject to monitoring or reporting. (CEQA Guidelines, § 15126.4.) Therefore, "Mitigating conditions are not mere expressions of hope," and "must be fully enforceable through permit conditions, agreements, or other legally-binding instruments." (*Sierra Club v. County of San Diego* (2014) 231 Cal.App.4th 1152, 1167; CEQA Guidelines, § 15126.4, subd. (a)(2).)

The DEIR's mitigation of GHG emissions is inadequate for several reasons. First, the DEIR provides an estimated number of offsets that Valley Water would be required to purchase. (DEIR, p. 3.10-27.) However, in the next paragraph the DEIR states that these levels could be lowered if "participation in local/regional offset programs, or through the use of new GHG-efficient technologies or operational practices that may be available in the future." (*Ibid*.) This language allows Valley Water to disregard its analysis and reconfigure the emissions numbers outside of the public's view. Thus, allowing Valley Water to spend less on offsets once it has revised estimates from a "qualified GHG specialist retained by Valley Water and based on substantial evidence." (*Ibid*.) This loophole creates unenforceable mitigation.

Second, the DEIR provides a geographical preference for purchasing carbon offsets. The list begins with Santa Clara County and ends with "other states with offset validity laws at least as strict as California's." (DEIR, p. 3.10-27.) MM-GHG-2 also requires offsets to be "real, permanent, quantifiable, verifiable, enforceable, and additional," as defined by California Code of Regulations, title 17, ("17 CCR") section 95802. Further, the DEIR requires offset protocol be consistent with CARB requirements under 17 CCR section 95972. (DEIR, p. 3.10-27.) However, there is no indication of how these "requirements" would be enforced. The regulations this mitigation relies on cover "covered entities", the Project does not fall under a "covered entity." (Cal. Code Regs., tit. 17, § 95801 [purpose of this article is to provide compliance instruments for covered entities].) The regulations that MM-GHG-2 are required to be "consistent" with are implemented by CARB in a manner that is compliant with CARB's cap-and-trade program. Being consistent with a CARB implemented program is not the same as compliance under the cap-and-trade program. (See *Golden Door Properties, LLC v. County of San Diego* (2020) 50 Cal.App.5th 467 (*Golden Door*).) In *Golden Door*, the court described why the GHG mitigation in that case was not equivalent to CARB's cap-and-trade program.

> The County contends that M-GHG-1 is "substantially similar" to the offset program authorized under cap-and-trade. Specifically, the County asserts that like offsets under cap-and-trade, M-GHG-1 requires offsets "be purchased from a registry approved by [C]ARB or one that meets section 38562[, subdivision (d)(1)]." The County argues that this is a "sufficient

> safeguard[ ]" to "ensure credits purchased pursuant to M-GHG-1 are real, permanent, verifiable, and enforceable." [¶] However, M-GHG-1 is materially different from Assem. Bill No. 32 compliant cap-and-trade offsets in several key respects.

(*Golden Door, supra*, 50 Cal.App.5th at 511.)

The DEIR also requires, "All carbon offsets must meet these requirements and be purchased from programs verified by a major third-party registry; examples include, but are not limited to, Climate Action Reserve (CAR), American Carbon Registry, and Verra (formally the Verified Carbon Standard)." (DEIR, p. 3.10-27.) Nearly identical language is used in *Golden Door*. Addressing the efficacy of the voluntary offset registries the court states the following:

> Indeed, CARB has stated that offset protocols developed by CARB-approved registries (including registries named in M-GHG-1) do *not by that fact alone* meet the offset criteria in Assem. Bill No. 32:
>
> "Voluntary offset programs such as the American Carbon Registry, Climate Action Reserve, Verified Carbon Standard, and others may submit protocols to [C]ARB for review. However, regardless of how the voluntary protocols are developed, [C]ARB staff must determine whether the voluntary protocol should be developed for use in the Cap-and-Trade Program and if so, to conduct its own rulemaking process under the Administrative Procedure Act . . . *This process ensures that any voluntary protocol . . . demonstrates the resulting reductions meet the offset criteria in [Assem. Bill No. 32] . . .*
>
> "Protocols developed by the voluntary programs are not Compliance Offset Protocols as they are not developed through a rulemaking process, *may not meet the [Assem. Bill No. 32] and Cap-and-Trade Regulation criteria*, and were not approved by [CARB]."

(*Golden Door, supra*, 50 Cal.App.5th at 512, italics in original.)

Additionally, MM-GHG-2 has other similar pitfalls as the mitigation in *Golden Door, supra*, 50 Cal.App.5th at page 562. The *Golden Door* court determined GHG mitigation violated CEQA because: "(1) it would allow a project applicant to offset 100 percent of its GHG emissions through offset projects originating outside of California; and (2) it allows a County official to determine whether any particular offset program is feasible and otherwise appropriate, with no objective criteria to guide the exercise of the discretion." (*Ibid*.) Here, the DEIR would allow the entire GHG emissions from the project be offset with offsets originating outside California. (DEIR, p. 3.10-27.) Perhaps more inappropriate than *Golden Door*, the DEIR fails to describe who would make the determinations regarding the offset program's feasibility. Therefore, MM-GHG-2 lacks performance standards to ensure the mitigation would be achieved in an enforceable manner. (CEQA Guidelines, § 15126.4, subd. (a)(1)(B).)

Overall, MM-GHG-2 contains many of the same shortcomings contained in the *Golden Door* case. Therefore, Valley Water should revise the DEIR to rectify this deficient mitigation measure.

I. The DEIR Fails to Consider Several Hazards (Section 3.11)

1. *DEIR Fails to Analyze Risks to Public from Proposed Project in Light of DSOD's Determination That a Hardfill Dam Would Create a Hazard to Public Safety*

On November 1, 2021, DSOD responded to Valley Water's design concept submittals for the Proposed Project's hardfill dam. (Exhibit 3.) The letter states, "DSOD cannot agree with Valley Water and its consultants that hardfill dams have proven adequate performance based on the lack of documented negative performance." (Exhibit 3, p. 1.) DSOD goes on to state that it identified major issues, including issues relating to the degradation of hardfill over time, that led it to reject the hardfill dam concept. (*Ibid*.)

2. *The DEIR's Hazard Analysis Relies on Inaccurate and Generic Data*

The DEIR's analysis of existing hazards in the project area is incomplete and misleading. The DEIR states "Data from this report includes hazardous materials use, spills, and cleanup reports for listed properties within a 1-mile radius of the Project study area. This database report is provided in the Hazards and Hazardous Materials Appendix." (DEIR, pp. 3.11-2, 3.11-10.)

The referenced search documents, the Hazards and Hazardous Materials Appendix, Attachment B Environmental Risk Information Services Database Report, relied on user settings that were incomplete or incorrect, creating narrow buffers of distances from the project *footprint perimeter*. The use of a perimeter for analysis of a large project footprint, such as a reservoir, is incorrect as it does not include the interior areas. For example, the search includes 44 database searches within a ¼ mile or less of each side of that project perimeter (in only 11 cases were searches completed up to 1 mile). Therefore, the analysis was limited in the vast majority of datasets to areas less than 1/4 of a mile edge of the project footprint perimeter, not "within a 1-mile radius of the Project study area,"

This analysis of the project perimeter, and at distances far less than a mile is even incomplete within the context of the incorrect approach as identified further on DEIR page 3.11-12: "Records requests could not be sent for portions of the project study area that only had assessor parcel numbers. Therefore, records requests were only sent for provided physical addresses associated with the Project study area." and, "As noted in Table 3.11-4, some of the parcel physical addresses correlate poorly with the Project study area." (DEIR p. 3.11-13.) Therefore, the DEIR failed to follow its own stated approach, that approach is inadequate on its face, and even that approach was incomplete as it failed to cover all impacted parcels, and even those with addresses were not "correlated".

J. The Project's Hydrology and Water Management Impacts are Not Addressed (Section 3.12)

The DEIR's discussion of water supply benefits is misleading. The DEIR fails to describe climate changes impacts on the evaporation rate and fails to provide adequate information regarding future evaporation rates. Though the project would theoretically provide increased storage, that storage does not equate to similar amounts of water distributed to customers. The project appears to a place for Valley Water to store water and allow it to evaporate until the Board of Directors determines there is an "emergency" and the water can be used. Overall, it is a costly project that contains little to no benefit to municipal and industrial ("M&I") and agricultural users in Santa Clara County.

1. *DEIR Fails to Consider Increased Evaporation Rates Due to Climate Change*

The DEIR states, "evaporation would be continuous based on volumes in storage." (DEIR, p. 3.12-30.) Alternative A's existing conditions calculate long-term average evaporation would be 5,353 af per year. (DEIR, p. 3.12-154 [Table 3.12-53].) Alternative A's future conditions calculate long-term average evaporation would be lowered to 5,043 acre feet per year. (DEIR, p. 3.12-155 [Table 3.12-54].) In Section 3.12.3.1, the DEIR states several times that climate change was included in the modeling and acknowledges that evaporation rates vary based on temperature. (DEIR, p. 3.12-18 to 23.) However, it is unclear how the DEIR concludes the amount lost to evaporation would decrease as temperatures increase.

The DEIR's modeling indicates that the future temperature would rise on average by 2.3 degrees Fahrenheit, and in some months as much as 3.5 degrees. (DEIR Water Resources and Fisheries Numerical Modeling Appendix, p. 4-2.) The report prepared by Pascolini-Campbell et al. (2021) (attached as Exhibit 6), shows that global land evapotranspiration increased by 10 ± 2 per cent between 2003 and 2019, and that land precipitation is increasingly partitioned into evapotranspiration rather than runoff. Increased evapotranspiration rates on land may also correlate to increased evaporation rates from open water bodies. The DEIR provides no basis for its determination that less water would evaporate as temperatures increase in the future.

DEIR Appendix "Water Resources and Fisheries Numerical Modeling" chapter 4 describes how climate change projections were applied to the simulations and projections of future conditions. Essentially, 20 climate change project models were combined into an ensemble scenario of "change factors" to historical hydrology. In other words, the past hydrological record was modified to include the increased variability in conditions expected by various climate change models and projected emissions.

Effects such as increased evaporative loss, as already shown by Pascolini-Campbell et al. (2021) and others, are accounted for through the modified hydrologic inputs. The reservoir management modeling was calibrated to local rainfall and runoff data, so it would account for conditions changing over the past few decades, and they ran 2030 future conditions by adjusting the last 100-year period by climate change impacts factors.

The DEIR's future evaporation estimates of are not supported by substantial evidence.

2. *The DEIR's Discussion of Water Supply Benefits Is Misleading*

The entire project teeters on the idea that "Valley Water and [San Benito County Water District ("SBCWD")] are unable to take advantage of **a portion** of higher wet year allocations **in some years** due to insufficient local storage." (DEIR, p. 2-13, bold added.) This statement summarizes the non-existent need for the project. The project is apparently being built to store a little more water during some wet years. This is not an adequate basis for a $2.5+ billion reservoir that would decimate the region's environment.

The purported water supply benefits of the project have shrunk over time. In the Initial Study, the new reservoir was touted as providing reliable M&I water supplies, "including during drought period and emergencies." (Initial Study, p. 1-1.) Since the

Initial Study, it appears the "during drought period and emergencies" is now a main focus rather than an added benefit. Further, the size of the proposed reservoir creates a misleading idea of the benefits it would create. Depending on the alternative selected, the project would include a new reservoir with either 96,000 or 140,000k af capacity. (DEIR, p. ES-5.) However, the net increase in water delivered to customers may be as low as just 2,600 to 3,595 af per year. (DEIR, p. ES-15 [Table ES-4].) The DEIR fails to explain how such a large increase in storage capacity results in such low quantities of deliverable water. (Compare DEIR, p. ES-15 "Emergency Response" quantities with DEIR, p. ES-15 "Water Supply" quantities.)

The DEIR describes emergency response water as "water supplies to meet unmet demands during Delta catastrophic events (e.g., flood or earthquake, Delta levee failures, or if seawater intruded into the Delta to an extent that would make it too saline for human consumption), periods of extended drought, supply shortages triggered by regulatory and environmental restrictions, or other emergencies." (DEIR, p. 2-61.) The list does not disclose when and how Valley Water may utilize the stored water for "emergencies."

The idea that more storage capacity will provide water supply reliability is unsupported. Valley Water's February 2022 Water Tracker newsletter shows all Valley Water reservoirs are at 26% capacity.[6] Even omitting data from Anderson, all reservoirs are only at 53%. Thus, Valley Water is currently using roughly half its storage capacity, during the current rainy season. This is yet another indication of the lack of evidence provided for the need of this project, which is not worth the massive cost and impacts.

All these factors result in an unclear and misleading reasoning for the need of such a large reservoir. This misrepresentation is exacerbated by Valley Water's decision not to pursue other storage related projects, discussed in more detail in the Alternatives section below.

K. The DEIR Improperly Relied on a Qualitative VMT Analysis (Section 3.18)

An EIR must evaluate a project's transportation impacts, generally VMT is the most appropriate measure for determining significance. (CEQA Guidelines, § 15064.3, subd. (a).) CEQA Guidelines section 15064.3, subdivision (b)(3) allows qualitative analysis, "If existing models or methods are not available to estimate the vehicle miles traveled for the particular project being considered[.]" The DEIR asserts:

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[6] https://www.valleywater.org/sites/default/files/2022-02/Water%20Tracker%20February%202022.pdf, last visited February 15, 2022.

> VMT is a function of the number and length of trips to/from construction personnel residences, to/from waste disposal facilities, and to/from other sources of construction materials during the temporary construction period…As such, the Project does not lend itself neatly to a VMT analysis that seeks to analyze long-term travel patterns. For these types of projects, where quantification is not as straightforward, a qualitative approach is acceptable and is performed by comparing Project-related trips to those on SR 152[.]

(DEIR, p. 3.18-8.)

First, this cursory explanation is not adequate to support the use of a qualitative analysis. Second, the DEIR provides several instances of quantitative VMT analysis. The DEIR determines that construction workers would be required to travel at least 30 miles and construction equipment at least 80 miles. (DEIR, p. 3.18-13 – 14.) The DEIR also states, "Alternative A would temporarily increase construction related VMT by approximately 2.2 percent over existing VMT[.]" (DEIR, p. 3.18-20.) Therefore, it appears the DEIR decided not to use a quantitative approach in order to avoid a possible significance determination.

Additionally, the DEIR's VMT analysis relies on an improbable assumption. PAMM TR-2 states, "This PAMM will require a Ridesharing Program to reduce the number of single occupancy vehicle trips by the workers traveling to and from the Project site with at least 90 percent of all worker vehicle trips being shared by at least two workers." (DEIR, p. 3.18-9.) Additionally, the DEIR assumes that 22.5 percent of these trips will contain at least 5 construction workers per vehicle. (DEIR, p. 2-59.) Based on these assumptions, the DEIR further assumes that there would be a maximum of 594 construction worker trips per day for Alternative A. (DEIR, p. 3.18-14 [Table 3.18.3].) This assumes that there are 297 one-way trips made on a given day. (DEIR Transportation Appendix, Attachment C.)

However, the DEIR fails to describe how it determined these assumptions. The only statement made in the Transportation Appendix is that "Majority of the workers are expected to be vanpooling or carpooling," the table then states that 25% would vanpool (5 persons per vehicle), 65% would carpool (2 persons per vehicle) and only 10% would be in single occupancy vehicles. (DEIR Transportation Appendix, Attachment C.) Nowhere in the DEIR or appendices is there an explanation for these assumptions. Therefore, these assumptions are not supported by substantial evidence and cannot be relied upon in the VMT analysis.

L. DEIR Fails to Discuss Harmful Algal Blooms as a Water Quality Impact (Section 3.20)

Algal blooms, which can lead to HABs, "are a prime agent of water quality deterioration, including foul odors and tastes, deoxygenation of bottom waters (hypoxia and anoxia), toxicity, fish kills, and food web alterations." (Exhibit 7, *Harmful Freshwater Algal Blooms, With an Emphasis on Cyanobacteria*, p. 76.)

There are five main drivers that create harmful algal blooms ("HAB").

1. Water temperature
2. Water column irradiance and water clarity
3. Stratified water column coupled with long residence times
4. Availability of nitrogen : phosphorus ratios as a driver for HABs
5. Salinity regime

(Exhibit 8, *Factors Affecting the Growth of Cyanobacteria with Special Emphasis on the Sacramento-San Joaquin Delta*, pp. ii, 21[Figure 3.1 depicting algal bloom process].)

Currently Valley Water and SBCWD experience water quality issues in San Luis Reservoir due to algal blooms. (Exhibit 4, pp. 4-10 - 11.) This deterioration of water quality results in treatability issues for M&I and agricultural irrigation. (*Ibid*.)

One of the DEIR's water quality significance thresholds is whether the project would "otherwise substantially degrade surface water quality in Pacheco Creek or its tributaries." (DEIR, p. 3.20-25.) The DEIR does not discuss algal blooms as a separate water quality issue, but alludes to HABs under the dissolved oxygen subheading describing water quality conditions. (DEIR, p. 3.20-10.) The DEIR finds that dissolved oxygen would not cause a significant impact by degrading surface water in Pacheco Creek. (DEIR, p. 3.20-62.) However, this determination conflicts with other evidence in the DEIR.

There is no indication in the DEIR that dissolved oxygen at the new reservoir would not result in algal blooms, yet the DEIR has very little discussion about this potential impact. This is peculiar, given the existing problems with water quality and HABs from the San Luis low point, which the DEIR does mention. "Water quality in the San Luis reservoir deteriorates due to a combination of warmer temperatures, wind-induced nutrient mixing, and algal blooms near the reservoir surface." (DEIR, p. 3.20-15.) The SLLPIP EIS/EIR states that once San Luis Reservoir water levels reach an elevation of 369 feet the water quality becomes so bad that that it cannot be withdrawn for M&I purposes. (Exhibit 4, p. ES-2.)

San Luis Reservoir's mean temperature for July and August is generally 72 degrees Fahrenheit. (DEIR, p. 3.20-15.) Water temperature modeling for the expanded reservoir shows that multiple months across several water year types would increase to 72 degrees Fahrenheit. (DEIR Water Resources and Fisheries Numerical Modeling App., p. 5-9.)

With regard to the current Pacheco Reservoir, the DEIR states:

> Anecdotal observations suggest when Pacheco Reservoir storage is low in the fall, cyanobacteria (i.e., blue-green algae) may form a harmful algal bloom, depleting dissolved oxygen in the reservoir and diminishing water quality. Releases from the reservoir during these times are toxic to fish and livestock that use Pacheco Creek as a water source downstream.

(DEIR, p. 3.20-10.) Further, the DEIR also notes that pumping water from San Luis Reservoir may introduce total dissolved solids and nitrates, as well as, warmer water that would lead to warming in the Pacheco Reservoir. (DEIR, p. 3.20-61.)

Taking into account the project's flow requirements, the increased temperatures from climate change, the evaporation rates and similar location as San Luis Reservoir, the DEIR must analyze whether similar algal blooms would occur in the expanded reservoir. It did not. Therefore, the conclusion that operations would not degrade water quality is not supported by substantial evidence.

V. CUMULATIVE IMPACTS OF THE PROJECT IN COMBINATION WITH OTHER RELATED PROJECTS ARE IGNORED

An EIR's cumulative impacts analysis may rely on a list of past, present and probable future project producing related environmental impacts. (CEQA Guidelines, § 15130, subd. (b)(1)(A).) Cumulative impacts are those which, "when considered together, are considerable or which compound or increase environmental impacts." (CEQA Guidelines, § 15355.) These impacts may result from "minor but collectively significant projects taking place over a period of time." (*Id*. at subd. (b).)

The DEIR limits its list of relevant projects to those that contain similar environmental impacts and geographic location. (DEIR, p. 3.1-6.) Similar environmental impacts are those similar to the impacts analyzed in the DEIR. (*Ibid*.) The geographic location varies depending on the resource being analyzed. (*Ibid*.) The DEIR appears to break down cumulative impacts into three categories. Construction related, which would occur in the next five to eight years. Cumulative short-term impacts, which would occur within three to five years after construction. Long-term impacts, which would occur after construction, after the reservoir is full and the reservoir is operational. (DEIR, p. 3.1-8.)

A. Water Transfers are a Cumulative Project

The DEIR's cumulative projects list fails to include water transfers and therefore omits analysis of those cumulative impacts. (See DEIR, pp. 3.1-9 to 3.1-12.) Water transfers involve temporary and long-term exchange of water. Generally, water rights holders in the north sell water to buyers south of the Delta. The water is then conveyed through the State Water Project or Central Valley Project to the buyers' facilities. In 2021 alone, Valley Water was part of nine different transfers.[7] These transfers totaled 15,500 af of transferred water and 431,780 af of exchange water. (*Ibid*. [not all af were delivered to Valley Water alone].) Because the project would provide 25 times more storage capacity than the current Pacheco Reservoir, it is reasonable to believe that Valley Water would place water from water transfers in the new reservoir.

By omitting water transfers as a cumulative project, the DEIR overlooks and minimizes the significance of several impacts. These impacts include: biological resources (both terrestrial and aquatic), GHG emissions, hydrology and water management, and water quality. Water transfers exacerbate these impacts because additional water is exported from the Delta, which has far reaching impacts to ecosystems and water quality. Additionally, the energy and GHG emissions associated with exporting transferred water to the new reservoir proposed by the project is omitted in the DEIR's cumulative analysis.

B. The SLLPIP, Also Being Pursued By Valley Water, Is a Cumulative Project

The DEIR summarily states that the Cumulative impacts analysis does not consider SLLPIP because it is similar to Alternative D. (DEIR, p. 3.1-14.) Yet the DEIR fails to disclose the similarities and differences between Alternative D and the SLLPIP. In any case, as discussed previously, the most likely alternative to be adopted by Valley Water would be Alternative A, not Alternative D. Thus, the DEIR should be revised to explain the relationship between implementation of an earthfill dam (such as Alternative A) and the SLLPIP.

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7 See https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2021transfertable.pdf

In addition, the DEIR overlooks the fact that the SLLPIP would ameliorate water quality conditions for Valley Water's San Luis intake by extending it to a deeper part of the reservoir with better water quality. (Exhibit 4, p. ES-4.) The DEIR for the project fails to explain the impacts of the project, if implemented, in combination with the SLLPIP. Moreover, should Valley Water proceed with the SLLPIP, the need for the new reservoir at Pacheco Pass may be lessened due to improved access to good quality water at San Luis Reservoir. By excluding any discussion of the SLLPIP, the DEIR fails to inform the public about the relationship between the project and SLLPIP. This is especially egregious, given that Valley Water is also the lead CEQA agency for the SLLPIP EIS/EIR.

VI. DEIR FAILS TO PROVIDE A RANGE OF REASONABLE ALTERNATIVES AND FAILS TO DISCUSS WATER SUPPLY ALTERNATIVES THAT DO NOT CONSIDER NEW DAM CONSTRUCTION

An EIR must provide "a range of reasonable alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project." (CEQA Guidelines, § 15126.6, subd. (a).) The DEIR fails to meet this basic requirement.

The purpose of identifying reasonable alternatives is to discuss ways to change the project or its location to less or avoid significant impacts. (CEQA Guidelines, § 15126.6, subd. (b).) A reasonable range of alternatives should include alternatives that could feasibly accomplish most of the basic objectives and avoid or lessen at least one of the significant effects. (CEQA Guidelines, § 15126.6, subd. (c).) The DEIR's list of alternatives are essentially the same as the Proposed Project: tear down the existing dam and construct a new dam roughly a mile upstream. (DEIR, p. ES-5 [Table ES-1].)

Relying on these very narrow alternatives is not supported by substantial evidence. For example, the Proposed Project would create an increase in M&I deliveries by 3,600 acre-feet a year. (DEIR, p. ES-15.) Therefore, Valley Water would like to completely destroy over 1,500 acres of habitat and ranchland to construct a 140,000 af reservoir in order to obtain an additional 3,600 af of water. There are several alternatives that could meet this additional amount of water without construction of a new 140,000 acre-foot reservoir.

Therefore, any alternative that could yield 3,600 af of water would meet the project needs, and in all likelihood would have vastly lower environmental impacts. The statement of need is inappropriately defined such that there are essentially no alternatives, and the DEIR further fails to provide a range of reasonable alternatives. Even within that inadequate list of alternatives, the DEIR fails to include obvious alternatives that would achieve the same purpose with significantly less environmental impacts.

For illustration, either dam location or dam construction method could, and should, include a fish ladder to secure access to steelhead and other native species to the watershed above the proposed dam. The obvious alternative to this massive dam project's ecological impacts should have been evaluated, yet it is not considered.

In addition to failing to provide reasonable alternatives, the DEIR's selected alternatives fall short of meeting the primary objectives.

The DEIR contains two primary objectives:

- Increase water supply reliability and system operational flexibility to help meet M&I and agricultural water demands in Santa Clara and San Benito Counties during drought periods and emergencies, or to address shortages due to regulatory and environmental restrictions.
- Increase suitable habitat in Pacheco Creek for federally threatened SCCC steelhead through improved water temperature and flow conditions.

The DEIR fails to assess the myriad of alternative water supplies that Valley Water has previously identified and ranked.[8] In addition, Cannon identifies that not only does the DEIR fail to adequately assess the project impacts on suitable habitat for steelhead in general, but "without more detailed analysis it is unclear if even the purported project benefits exceed impacts, and if this location would have any beneficial impact on the population at all." The alternatives analysis should also assess if suitable habitat benefits be achieved elsewhere on Pacheco creek or nearby streams. (DEIR, p. ES-13.)

An EIR must examine a range of "alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project." (CEQA Guidelines, § 15126.6, subd. (a).) CEQA defines "feasible" as "capable of being

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[8] See, e.g., Attachment 3 of Valley Water's October 22, 2021 Meeting Agenda Item 2.1, available at: https://scvwd.legistar.com/LegislationDetail.aspx?ID=5186615&GUID=416421D9-406F-4949-9CD2-AEC50CA2C916&Options=&Search= (discussing water supply projects to include in the 2040 Master Plan).

accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors." (Pub. Resources Code, § 21061.1.) A project alternative is considered infeasible if there is legal uncertainty about the agency's ability to accomplish a specific alternative. (*Marin Mun. Water Dist. v. KG Land California Corp*. (1991) 235 Cal.App.3d 1652, 1666.) As explained above, both alternatives with a hardfill dam (Proposed Project and Alternative C) have already been rejected by DSOD for safety reasons. (See Exhibit3.)

VII. CONCLUSION

The DEIR is an inadequate document under CEQA, riddled with informational deficiencies and lacking in supporting evidence. The DEIR overlooks, dismisses, or downplays the project's many significant impacts and fails to provide mitigation to reduce those impacts to the extent feasible. A project-level review of the numerous significant impacts associated with this project is not contained in the DEIR.

As Valley Water considers preparing and recirculating a legally adequate EIR, it should also reconsider the water supply reliability value of this project, weighed against other options. The project costs are sure to continue rising, as will the technological challenges associated with placing a dam in this high-risk location. In addition, the project would destroy and degrade increasingly imperiled agricultural, historical and cultural resources within the County. Valley Water's 2040 Water Supply Master Plan includes better investment and policy options that would better ensure affordable water security for future generations than this outdated and risky new dam project.

Thank you for considering these comments. Please feel free to contact my office with any questions about these comments.

Very truly yours,

SOLURI MESERVE
A Law Corporation

By:

Osha R. Meserve

Attachments available via Dropbox at:
https://www.dropbox.com/sh/gqwp41454s6cvbc/AACWtz14sEH6rAxhnvGs1Ek8a?dl=0

Exhibit 1	Scott Cashen, M.S., Independent Biological Resources Consultant, Comments on the Draft Environmental Impact Report for the Pacheco Reservoir Expansion Project, Chapter 3.5 (Biological Resources – Botanical/Wildlife), February 14, 2022
Exhibit 2	Tom Cannon, Aquatic Ecologist, Comments on the Draft EIR Pacheco Reservoir Expansion Project, Chapter 3.6 (Biological Resources – Fisheries), February 14, 2022
Exhibit 3	November 1, 2021, Division of Safety of Dams Letter to Santa Clara Valley Water District re: Feasibility of Hardfill Dam Construction at Pacheco Reservoir
Exhibit 4	San Luis Low Point Improvement Project EIS/EIR
Exhibit 5	December 20, 2021, Division of Safety of Dams Letter to Pacheco Pass Water District re: Spillway at North Fork Dam
Exhibit 6	Pascolini-Campbell et al. (2021). "A 10 per cent increase in global land evapotranspiration from 2003 to 2019." Nature 593, 543–547. https://doi.org/10.1038/s41586-021-03503-5.
Exhibit 7	*Harmful Freshwater Algal Blooms*, *With an Emphasis on Cyanobacteria*
Exhibit 8	*Factors Affecting the Growth of Cyanobacteria with Special Emphasis on the Sacramento-San Joaquin Delta*

EXHIBIT 1

February 14, 2022

Ms. Osha Merserve
Soluri Meserve
510 8th Street
Sacramento, CA 95814

Subject: Comments on the Draft Environmental Impact Report for the Pacheco Reservoir Expansion Project

Dear Ms. Meserve:

This letter contains my comments on the Draft Environmental Impact Report ("DEIR") prepared by Valley Water for the Pacheco Reservoir Expansion Project ("Project"). The Project would include: (a) decommissioning of the existing North Fork Dam; and (b) construction and operation of a new dam and expanded reservoir, water conveyance facilities, and related miscellaneous infrastructure (e.g., access improvements and roads, electrical transmission lines) in the southeastern portion of Santa Clara County.

I am an environmental biologist with 28 years of professional experience in wildlife biology and natural resources management. I have served as a biological resources expert for over 150 projects in California. My experience and scope of work in this regard has included assisting various clients with evaluations of biological resource issues, reviewing environmental compliance documents prepared pursuant to the California Environmental Quality Act ("CEQA") and the National Environmental Policy Act ("NEPA"), and submitting written comments in response to CEQA and NEPA documents. My work has included the preparation of written and oral testimony for the California Energy Commission, California Public Utilities Commission, and Federal courts. My educational background includes a B.S. in Resource Management from the University of California at Berkeley, and a M.S. in Wildlife and Fisheries Science from the Pennsylvania State University. A copy of my current curriculum vitae is attached hereto.

The comments herein are based on my review of the environmental documents prepared for the Project, a review of scientific literature pertaining to biological resources known to occur in the Project area, consultations with other biological resource experts, two site visits to the "upstream" portion of the Project area, and the knowledge and experience I have acquired during my 28-year career in the field of natural resources management. The literatures cited herein has been provided separately for inclusion in the administrative record.

Contents

EXECUTIVE SUMMARY

The Project represents an experimental attempt to benefit one special-status species, the South-Central California Coast steelhead. Numerous sensitive resources would be sacrificed to conduct this experiment. Many of these resources are as imperiled, or more imperiled than the steelhead. Some of the Project's impacts would be especially severe, and likely are not mitigable. For example, the Project would eliminate one of the last stands of sycamore alluvial woodland remaining in the entire State of California.

My CEQA comments fall into three interrelated categories: (1) the DEIR fails to provide an accurate description of the environmental setting; (2) the DEIR lacks a proper assessment of the Project's environmental impacts; and (3) the mitigation incorporated into the DEIR is inadequate and does not ensure the Project's significant impacts are reduced to less-than-significant levels.

First, the DEIR's description of the environmental setting is replete with inconsistent, misleading, and erroneous information. For example, there is no scientific explanation for why the Project study area would contain 6,000 acres of grassland habitat for the American badger,[1] but only 1,354 acres of grassland habitat for raptors.[2] In many instances, the DEIR's provision of erroneous information appears to be due to the DEIR's failure to understand the habitat(s) associated with each species that occurs (or potentially occurs) in the Project study area. For example, the DEIR's statement that the Project study area contains approximately 4,000 acres of woodland and scrub habitats that provide suitable nesting habitat for the bald eagle is false because bald eagles do not nest in scrub habitats (they nest in large trees).[3] Similarly, western mastiff bats do not roost in trees (as suggested in the DEIR); they roost in exfoliating rock slabs, or in crevices in large boulders and buildings. The DEIR's provision of inconsistent, misleading, and erroneous information pertaining to the Project's environmental setting is compounded by the omission of field surveys needed to determine presence of special-status animals and other sensitive resources. Contrary to what the DEIR would like the reader to believe, "desktop analysis" is not a valid method for establishing the Project's environmental setting and impacts.

Second, the DEIR does not disclose the true effects of the Project on the environment because much of the environmental analysis therein is based on flawed data and reasoning. A critical flaw with the DEIR is that it fails to provide the information the public needs to validate the DEIR's impact assessments. For example, although the DEIR indicates the Project would impact 20 acres of dispersal habitat for the foothill yellow-legged frog, it does not identify where those 20 acres are located, which Project activity would cause the impacts, *or even what the DEIR considers to be "dispersal habitat."* In some instances, it is clear that the impact values provided in the DEIR are incorrect. For example, the Project involves removal of Pacheco Reservoir, which provides 187 acres of foraging habitat for bald eagles. However, according to the DEIR, the Project would impact only 98 acres of bald eagle foraging habitat.[4] Upon reviewing the DEIR's Aquatic Resources Delineation, I discovered that much of the existing reservoir was not delineated as "reservoir" or any other aquatic resource type.

[1] DEIR, p. 3.5-40.
[2] DEIR, p. 3.5-38.
[3] DEIR, p. 3.5-38.
[4] DEIR, Table 3.5-9.

The DEIR's impact analysis lacks scientific merit and credibility. For example, the DEIR claims that the Project would dramatically improve habitat for steelhead in Pacheco Creek, but habitat for all other aquatic organisms would remain unchanged. It is ridiculous for the DEIR to claim that conversion of an intermittent stream into a perennial one would have no beneficial effects on invasive species, including the American bullfrog (a species that is dependent on permanent sources of water to complete its life cycle). Similarly, it is ridiculous for the DEIR to claim that the Project's impacts on wildlife movement corridors "may not differ significantly from the existing conditions." The proposed reservoir would have a surface area over seven times larger than the existing reservoir; it would create a movement barrier that extends approximately 5.2 miles (east-west) by 3.75 miles (north-south); and it would block an approximately 1.5-mile-wide pathway between two large conservation reserves (Romero Ranch and Henry Coe State Park).[5] These impacts are vastly dissimilar from existing conditions, especially because they would occur within an area that has been identified as an "Irreplaceable and Essential Corridor" for terrestrial wildlife movement.

Third, the DEIR provides no assurances that the proposed mitigation measures would reduce the Project's impacts to less-than-significant levels. The DEIR's core strategy for mitigating the Project's most significant impacts is the pledge to formulate various mitigation "plans" after termination of the CEQA review period. The pledge to formulate a "plan" of unknown quality and scientific rigor is not mitigation, especially in absence of performance standards, and monitoring and reporting requirements, for the mitigation. This is especially true for Mitigation Measure BI-8b, which would supposedly mitigate the Project's significant impacts on 1,043 acres of oak woodlands and various other habitat types. Indeed, the DEIR claims Mitigation Measure BI-8b would mitigate impacts to habitats for over 20 special-status animals, even though the compensatory mitigation requirement under Mitigation Measure BI-8b pertains solely to the California tiger salamander and California red-legged frog. The DEIR's deferral of mitigation plans is exacerbated by its failure to demonstrate feasible mitigation options exists. For example, based on my independent analysis, there may not be feasible options for mitigating the Project's extremely significant impacts on sycamore alluvial woodlands.

In conclusion, there is insufficient information to support the findings in the DEIR. To the contrary, there is abundant evidence that directly contradicts those finding. The Project would have significant impacts that were not properly analyzed, and that were not disclosed to the public. The mitigation proposed in the DEIR is vague, deferred, and does not ensure the Project's significant impacts would be reduced to less-than-significant levels. As a result, the DEIR needs to be revised and recirculated for public review.

PROJECT DESCRIPTION

The Aesthetics chapter of the DEIR suggests a switchyard would be constructed near Fifield Road, approximately 500 feet north of SR 152.[6] Figure 3.2-1 in the DEIR depicts the switchyard ("transmission interconnection") on the east side of Fifield Road, which is in the Cottonwood Creek Wildlife Area. The Project Description chapter of the DEIR does not discuss or map the

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[5] See DEIR, Figure 3.5-2. Conservation Easements in Project Study Area.
[6] DEIR, pp. 3.2-9 and -10.

switchyard, nor does the Biological Resources chapter identify the resources that would be impacted in the Cottonwood Creek Wildlife Area. This omission precludes informed public review.

ENVIRONMENTAL SETTING

Accurate information on the baseline setting is critical to understanding the magnitude and extent of Project impacts, and to formulating effective mitigation.

Tables 2-2 and 2-3 in the DEIR's Biological Resources–Botanical/Wildlife Appendix (hereafter "Biology Appendix") provide an (unidentified) author's determination on the potential for a given special-status species to occur in the Project study area. One of the criteria used to determine the potential for a given species to occur in the study area was whether the California Natural Diversity Database ("CNDDB") contains records of the species occurring within five miles of the study area.[7] This approach is misleading because the CNDDB is a positive siting database. Thus, occurrence records in the CNDDB are dependent on: (a) survey effort within a given area, and (b) whether the observer submitted an occurrence record to the CNDDB. Most of the land within the study area and surrounding five miles consists of large, private properties that have not been surveyed for biological resources. Therefore, even if a given species is abundant on those properties, there are unlikely to be CNDDB occurrence records.

Project Surveys

<u>Animals</u>

No protocol or focused wildlife surveys were conducted for the Project, except for eagles. Habitat is defined by presence of the organism. It is simply not possible to provide accurate information on the environmental setting and Project impacts without focused surveys to determine the distribution, abundance, and seasonal use patterns of the target species. Similarly, it is not possible to formulate effective mitigation without this information. These sentiments are reflected in the various guidelines issued by the California Department of Fish and Wildlife ("CDFW") and U.S. Fish and Wildlife Service ("USFWS").

Despite what is suggested in the DEIR, the surveys that were conducted for the California red-legged frog ("CRLF") and California tiger salamander ("CTS") site assessments are not a substitute for protocol-level surveys, nor can those site assessments be used for the purposes of impact analyses under CEQA. Instead, the site assessments serve as the foundation for determining where potential habitat is located, and thus, where protocol-level surveys should be conducted. Because protocol-level surveys were not conducted for the Project, the DEIR Valley Water does not incorporate the data needed for an accurate impact assessment.

The need for protocol-level surveys is especially important for this Project because: (1) the site supports or potentially supports numerous special-status species, some of which are as imperiled or more imperiled than the South-Central California Coast steelhead (see Table 1, below); (2) the Project would impact a large block of relatively undisturbed habitat; (3) the Project would impact

[7] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, p. 2-4.

three conservation reserves (i.e., Henry Coe State Park, the Nature Conservancy's Romero Ranch, and CDFW's Cottonwood Creek Wildlife Area); and (4) the Project would have widespread, irreversible impacts on ecosystem processes, biodiversity, and the ecological health of the Pacheco Creek watershed.[8]

Table 1. Imperiled and Critically Imperiled species that would be impacted by the Proposed Project.[9]

	NatureServe Rank[10]		
Species	State Rank	Global Rank	Habitat Impacts[11]
South-Central California Coast steelhead	S2	G5TQ	Potentially positive, negative, or neutral
California floater mussel	S2?	G3Q	Unknown (not quantified in the DEIR)
Western bumble bee	S1	G2G3	1,731 acres (1,487 acres permanently lost)[12]
Crotch bumble bee	S1S2	G3G4	1,731 acres (1,487 acres permanently lost)[13]
Giant gartersnake	S2	G2	Unknown (no surveys conducted)[14]
San Joaquin coachwhip	S2?	G5T2T3	1,700 acres (1,490 acres permanently lost).[15]
San Joaquin kit fox	S2	G4T2	131 acres (86 acres permanently lost)[16,17]
Townsend's big-eared bat	S2	G4	1,154 acres of potential roosting habitat.[18]

[8] *See* Grossinger RM, Beller EE, Salomon MN, Whipple AA, Askevold RA, Striplen CJ, Brewster E, Leidy RA. 2008. South Santa Clara Valley Historical Ecology Study, including Soap Lake, the Upper Pajaro River, and Llagas, Uvas-Carnadero, and Pacheco Creeks. Prepared for the Santa Clara Valley Water District and The Nature Conservancy. A Report of SFEI's Historical Ecology Program, SFEI Publication #558, San Francisco Estuary Institute, Oakland, CA.
[9] California Natural Diversity Database. 2021 Oct. Special Animals List. Available at: <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109406&inline>. (Accessed 24 Nov 2021). *See also* California Natural Diversity Database. 2021 Oct. Special Vascular Plants, Bryophytes, and Lichens List. Available at: <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109383&inline>. (Accessed 24 Nov 2021).
[10] Ranks provided in the California Natural Diversity Database. *See* DEIR, Biological Resources - Botanical/Wildlife Appendix, Attachment A, Exhibit A (CNDDB results, p. 8).
[11] Impact values are for the Proposed Project. Alternative A would have greater impacts.
[12] DEIR, p. 3.5-84.
[13] *Ibid*.
[14] DEIR, p. 3.5-25. Potential habitat occurs in the Project's access and utility area, which has not been surveyed.
[15] DEIR, p. 3.5-95.
[16] DEIR, p. 3.5-108.
[17] This value is not substantiated and appears erroneous. According to the DEIR (Appendix A, Attachment A, Exhibit E, Table 4-1), there are 520 acres of suitable dispersal habitat and 868 acres of "low or unsuitable" dispersal habitat for the San Joaquin kit fox in the study area, which does not include the Project's access and utility area.
[18] DEIR, p. 3.5-110.

Table 2. Continued.

	NatureServe Rank[a]		
Species	State Rank	Global Rank	Habitat Impacts
Hall's bush-mallow	S2	G2	5 populations[19]
Most beautiful jewelflower	S2	G2T2	3 populations[20]
Arburua Ranch jewelflower	S2	G3G4T2	Potentially "substantial portions of populations"[21]
Sycamore alluvial woodland	S1	G1	Approximately 158.7 acres.

Letter codes

S = Imperilment status in California.

G = Imperilment status throughout the global range of the species.

T = Reflects the global status of just the subspecies.

Q = Questionable taxonomy that may reduce conservation priority.

Rank

1 = *Critically Imperiled* (at very high risk of extirpation or extinction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors).

2 = *Imperiled* (at high risk of extirpation or extinction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors).

3 = *Vulnerable* (at moderate risk of extirpation or extinction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors).

4 = *Apparently Secure* (at a fairly low risk of extirpation or extinction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors).

5 = *Secure* (at very low risk of extinction due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats).

Uncertainty about the status of an element is expressed in two major ways:

I) By expressing that ranks as a range of values. For example, S1S2 means the status in California is somewhere between Critically Imperiled and Imperiled.

II) By adding a "?" to the rank. For example, S2? represents more certainty than S2S3, but less certainty than S2.

Plants

The DEIR states that special-status plant surveys and mapping of vegetation in the field were confined to portions of the study area that were "accessible."[22] However, the DEIR does not provide a map that depicts the specific areas that were surveyed, nor does it identify which

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[19] DEIR, Table 3.5-10.
[20] *Ibid*.
[21] DEIR, p. 3.5-82. Potential habitat occurs in the Project's access and utility area, which has not been surveyed.
[22] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit B, p. 2-3, and Attachment B, p. 2-3.

portions of the study area were "accessible." As a result, it is impossible to understand how much of the study area remains un-surveyed, and thus, how accurately the DEIR portrays the Project's environmental setting.

A map that depicts the specific areas that were surveyed for special-status plants during each of the three survey passes referenced in the DEIR must be provided to allow for public review of the Project and its impacts on sensitive botanical resources.

The DEIR states: "[d]esktop information was solely used for the evaluation of the access and utility area portion of the Project study area given the area was inaccessible for field investigations at the time of Draft EIR preparation."[23] However, according to the DEIR: "[l]ands within the access and utility area includes…the Upper Cottonwood Creek Wildlife Area managed by the California Department of Fish and Wildlife (CDFW), and the San Luis Reservoir managed by the California Department of Water Resources."[24] In addition, Valley Water's consultants apparently had access to the Romero Ranch, which would contain one of the Project's permanent access roads.[25] Therefore, it appears that substantial portions of the lands within the access and utility area were indeed accessible for field investigations. This is important because it is not possible to accurately describe the environmental setting (e.g., habitat conditions and vegetation alliances) solely through the use of "desktop information" (e.g., aerial photographs).

According to the DEIR, the "desktop analysis" included a review of "natural resource agency databases, literature, and other relevant sources."[26] The DEIR provides no mention of an attempt to solicit information from The Nature Conservancy ("TNC"), thus it appears the desktop analysis did not incorporate data on special-status species occurrences within the Romero Ranch. This is important because: (a) the Romero Ranch is a large conservation reserve that would be impacted by the Project; (b) TNC maintains data on special-status species occurrences within its properties; and (c) these data are generally not in the CNDDB (or other natural resource agency databases).[27]

Project Study Area

The DEIR and appendices provide inconsistent information on what the Project "study area" is. For example:

- According to the Biological Resources chapter of the DEIR, the Project study area encompasses <u>9,425 acres.</u>[28]
- According to DEIR Table 3.5-1, the Project study area encompasses <u>9,374 acres.</u>

[23] DEIR, p. 3.5-7.
[24] DEIR, p. 3.5-6.
[25] *See* DEIR, Figure 3.5-2.
[26] DEIR, Appendix Biological Resources – Botanical/Wildlife, Attachment A, p. 2-3.
[27] There are only two CNDDB occurrence records within the boundaries of the Romero Ranch, one of which predates TNC's acquisition of the property.
[28] DEIR, p. 3.5-1.

- According to Attachment A to the Biological Resources Appendix, the Project study area encompasses 6,835 acres.[29]
- According to Attachments B and C to the Biological Resources Appendix, the Project study area encompasses 6,765 acres."[30]

This issue is compounded by inconsistencies between DEIR Table 3.5-1 (*Land Cover Types*) and DEIR Table 3.5-2 (*Aquatic Resources*). For example, Table 3.5-1 indicates 32.4 acres of ponds and 267.9 acres of reservoir within the study area. However, Table 3.5-2 indicates 38.1 acres of ponds and 174.2 acres of reservoirs within the study area. These are just a few of the inconsistencies I found during my review of the DEIR and Biology Appendix.

The "study area" described in the Biology Appendix did not include land within the access and utility area. However, in many instances the DEIR applies the term "study area" to the entire Project area. In other instances, it appears that the DEIR is applying the term to areas that were subject to field surveys. The numerous inconsistencies in application of the term "study area" make it impossible to understand which portions of the overall Project area have been accounted for in the DEIR's description of the Project's environmental setting and impacts.

Wetlands and Other Jurisdictional Waters

According to the aquatic resources delineation that was conducted for the Project, the current footprint of Pacheco Reservoir is approximately 98.13 acres. This value was apparently used to calculate the Project's impacts on species that use Pacheco Reservoir as habitat (e.g., bald eagle and western pond turtle, among others).[31] However, according to the Fisheries chapter of the DEIR, Pacheco Reservoir is 187 acres.[32] I examined the maps in the aquatic resources delineation report in an attempt to determine the reason for the discrepancy between the value reported in the aquatic resources delineation (98 acres) and the value reported in the Fisheries chapter of the DEIR (187 acres). The maps reveal that only a portion of Pacheco Reservoir was delineated as "reservoir." As illustrated in Figure 1 below, areas that contained open water were not delineated as "reservoir" or any other aquatic resource type. I was unable to determine whether the error was replicated in the delineation of other jurisdictional resources; however, it is clear that the DEIR does not provide an accurate assessment of existing conditions and the Project's impacts to aquatic resources.

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[29] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, p. 2-1.
[30] *Ibid*, Attachment B, p. 2-1 and Attachment C, p. 2-1.
[31] For example, DEIR p. 3.5-105 states the Proposed Project would impact "up to about 98 acres of potential foraging habitat for bald eagle."
[32] DEIR, p. 3.6-30, -59, -87, -115, and -143.

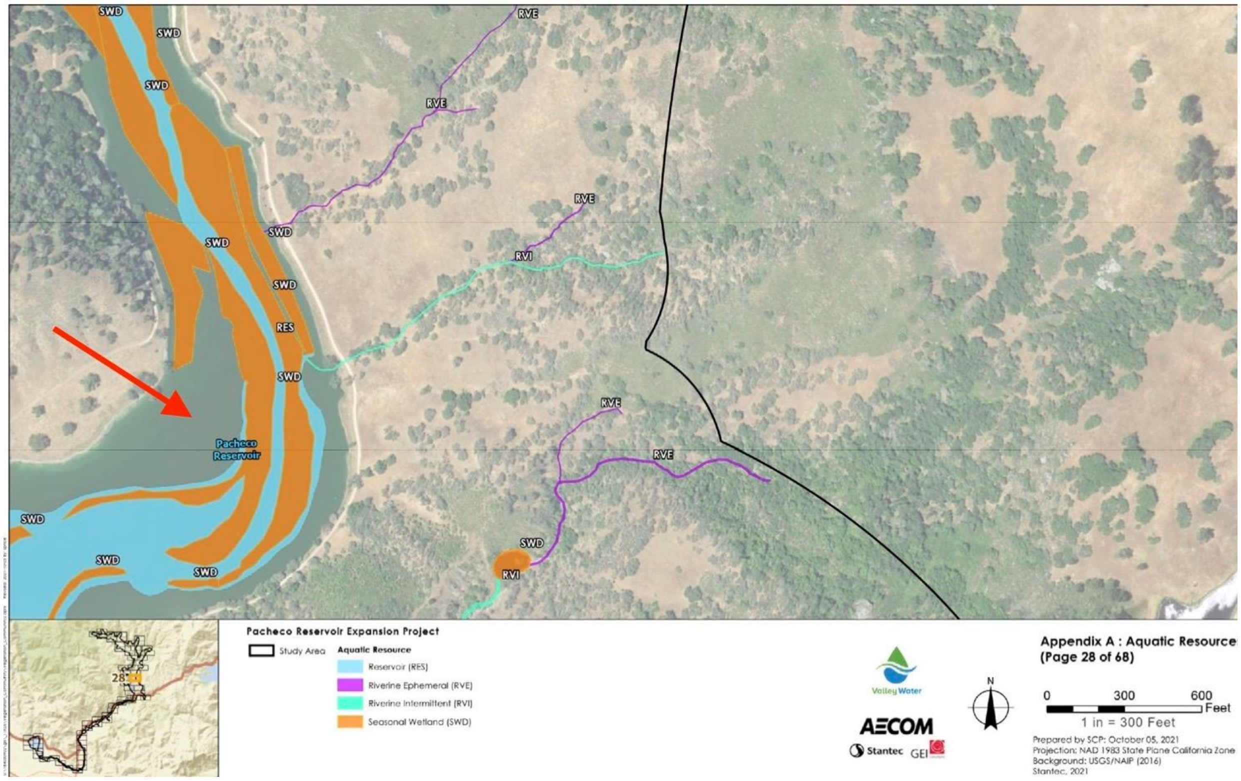

Figure 1. Map provided in the Aquatic Resources Delineation. Red arrow points to a portion of the reservoir that was not delineated as an aquatic resource.

California Condor

The DEIR makes the following statements about the California condor:

1. "The study area is located within the range of the species and limited cliff habitat is present in the study area. Pacheco Creek downstream of the existing North Fork Dam is within the species range (i.e., the species range does not extend into the areas around Pacheco Reservoir). No CNDDB occurrences are within 5 miles of the study area."[33]
2. "Given the lack of nesting habitat for California condor and lack of documented occurrences in and near the Project study area, this species has a low potential to occur."[34]

These statements are largely incorrect. Telemetry data collected by the USFWS and U.S. Geological Survey between 2017 and March 2019 reveal presence of several California condors in the Project study area.[35] Three of the birds tracked in the study traveled along North Fork Pacheco Creek in the immediate vicinity of the existing reservoir (Figure 2, below).

[33] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Table 2-3.
[34] DEIR, p. 3.5-39.
[35] California Department of Parks and Recreation. 2019. Draft Environmental Impact Report for the Gonzaga Ridge Wind Repowering Project. Figure 3.2-4.

California condors have relatively heavy wing-loading (mass per wing area) and have a difficult time becoming and remaining airborne over flat terrain. Consequently, they generally occur in hilly terrain and use roosting sites on ridgelines, rocky outcrops, steep canyons, and in tall trees or snags near foraging grounds.[36] These terrain conditions occur throughout most of the Project study area.

Whereas nesting habitat for California condors is usually rock or cliff escarpments within steep mountainous or canyon terrain, condors tend to travel long distances to forage in open foothill grasslands and oak savanna foothills that support populations of deer, elk, and cattle.[37] Both of these habitat types (i.e., nesting and foraging) are essential to persistence and recovery of the species. Most of the Project study area (including areas around Pacheco Reservoir) is comprised of hilly terrain with grasslands, oak savannas, and rocky outcrops. In addition, the Project study area supports populations of deer, elk, and cattle. Therefore, the Project study area not only provides foraging (and roosting) habitat for the California condor, but there is direct evidence that condors use the study area.

The Project would directly, indirectly, and cumulatively impact foraging habitat for the California condor. As a result, the DEIR's conclusions regarding the California Condor are erroneous and must be corrected.

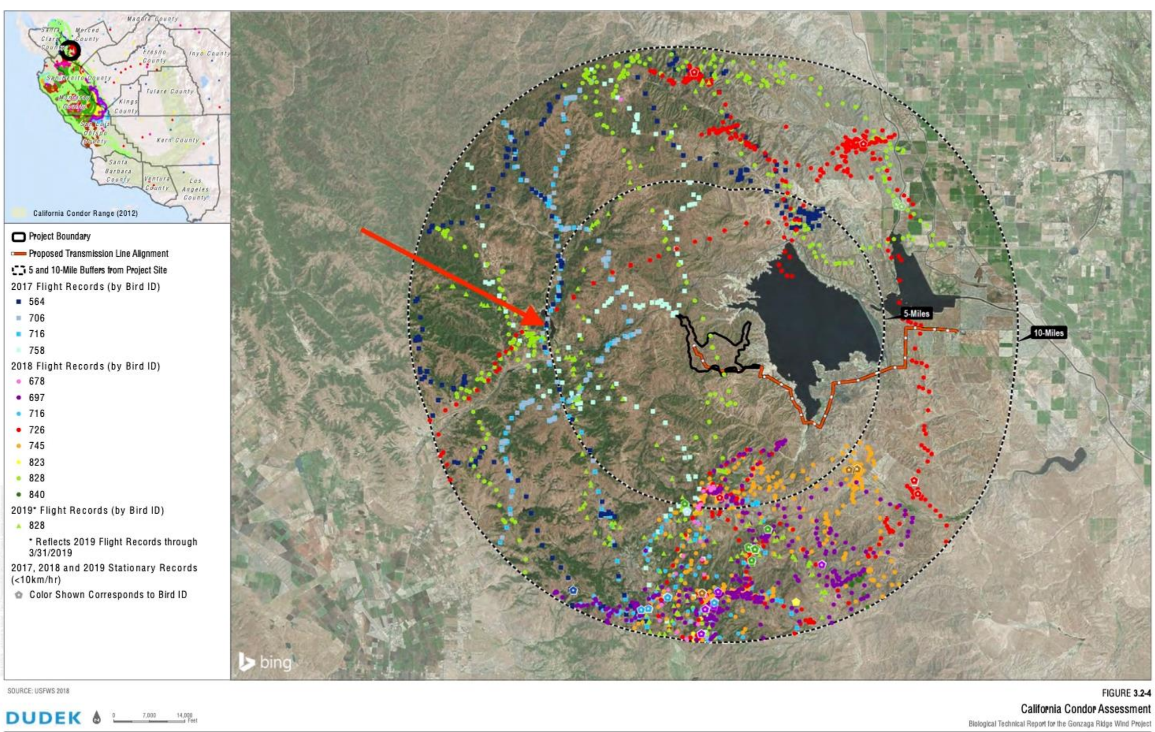

Figure 2. Flight paths of California condors between 2017 and early 2019. Red arrow points to Pacheco Reservoir.

[36] U.S. Fish and Wildlife Service. 2013. California Condor (*Gymnogyps californianus*), 5-Year Review: Summary and Evaluation.
[37] *Ibid*.

Burrowing Owl

No surveys were conducted to determine presence, abundance, distribution, and seasonal use patterns of burrowing owls in the study area. However, according to the DEIR: "[a]pproximately 1,354 acres of grasslands or livestock pasture habitats within the upstream and downstream areas provide potential nesting habitat for burrowing owl."[38] "Potential habitat" is not the same as habitat. Burrowing owls have high site fidelity and rarely colonize "new" habitat areas. There are thousands of acres of potential habitat that are not occupied by burrowing owls, and thus, have no current value in conservation of the species. As a result, surveys are essential to evaluating the Project's actual impacts on burrowing owls.

Burrowing owls are nearly extirpated from the entire Bay Area.[39] Santa Clara County contains one of the last breeding colonies.[40] That colony contained an estimated 101 pairs in 2000 and 2003.[41] In 2020, there were only 16 successful pairs remaining.[42] Therefore, a breeding colony of burrowing owls at the Project site would have tremendous conservation value, and any impacts to that colony could be extremely significant given the precipitous decline elsewhere in the County. Consequently, protocol-level survey data on burrowing owl use of the Project study area are essential to understanding the severity of the Project's impacts and the ability to mitigate the impacts through the measures proposed in the DEIR. These data must be disclosed to the public during the Project's CEQA review—*not* when Project impacts are imminent as proposed in Mitigation Measure BI-13b.

The need to establish the baseline population of burrowing owls on a site prior to assessing impacts and formulating mitigation measures is emphasized in CDFW's Staff Report on Burrowing Owl Mitigation, which states:

> "The following three progressive steps are effective in evaluating whether projects will result in impacts to burrowing owls. The information gained from these steps will inform any subsequent avoidance, minimization and mitigation measures. The steps for project impact evaluations are: 1) habitat assessment, 2) surveys, and 3) impact assessment. ….Adequate information about burrowing owls present in and adjacent to an area that will be disturbed by a project or activity will enable the Department, reviewing agencies and the public to effectively assess potential impacts and will guide the development of avoidance, minimization, and mitigation measures…Detailed information, such as approximate home ranges of each individual or of family units, as well as foraging areas as related to the proposed project, will be important to document

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[38] DEIR, p. 3.5-38.
[39] Townsend SE, Lenihan C. 2003. Burrowing Owl Status in the Greater San Francisco Bay Area. Proceedings of the California Burrowing Owl Symposium. Bird Populations Monographs No. 1:60-70.
[40] *Ibid.*
[41] *Ibid.*
[42] Burrowing Owl Expert Team. 2020 Dec. Santa Clara Valley Habitat Plan, 2020 Burrowing Owl Breeding Season Survey Report. Report prepared for the Santa Clara Valley Habitat Agency, Morgan Hill, CA.

> for evaluating impacts, planning avoidance measure implementation and for mitigation measure performance monitoring."[43]

Similarly, California Burrowing Owl Consortium mitigation guidelines state:

> "There is often inadequate information about the presence of owls on a project site until ground disturbance is imminent. When this occurs there is usually insufficient time to evaluate impacts to owls and their habitat. The absence of standardized field survey methods *impairs adequate and consistent impact assessment during regulatory review processes, which in turn reduces the possibility of effective mitigation*."[44]

It is not possible to effectively assess Project impacts until protocol surveys that adhere to CDFW guidelines have been conducted. As a result, detection surveys described in CDFW's Staff Report must be conducted, and the results of those surveys must be released in a revised CEQA document so that they can be thoroughly vetted by the public, resource agencies, and scientific community during the CEQA review process.

Tule Elk

The DEIR provides no mention of the tule elk, except that it is a prey species of the mountain lion. The tule elk is identified as a "Species of Greatest Conservation Need" ("SGCN") in the California State Wildlife Action Plan.[45] Through the California State Wildlife Action Plan, CDFW seeks to continue to prioritize protection of key habitat linkages, sensitive habitats, and specialized habitats for SGCN.[46]

The Project site coincides with a potential core habitat area for the tule elk (Figure 3, below).[47] This means it provides a continuous area of suitable habitat large enough to sustain at least 50 individuals.[48] The Project inundation area would directly impact the core habitat, and it would eliminate one of only two linkages between habitat in the southern portion of the core and habitat in the northern portion of the core. As a result, the DEIR must disclose and analyze direct, indirect, and cumulative impacts to tule elk habitat and movement corridors.

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[43] California Department of Fish and Game. 2012. Staff Report on Burrowing Owl Mitigation, pp. 5, 6 and 29.

[44] *See p. i in:* The California Burrowing Owl Consortium. 1993. Burrowing Owl Survey Protocol and Mitigation Guidelines. [emphasis added].

[45] The SGCN list consists of species deemed to be most rare, imperiled, and/or in need of conservation. *See* California Department of Fish and Wildlife (CDFW). 2015. California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians. Edited by Gonzales AG, Hoshi J. Prepared with assistance from Ascent Environmental, Inc., Sacramento, CA. Table C-8 and p. 1-12.

[46] *Ibid*, p. 2.

[47] Science and Collaboration for Connected Wildlands. 2014. Tule Elk Connectivity Modeling for the California Bay Area Linkage Network [ds868]. Calif. Dept. of Fish and Wildlife. Biogeographic Information and Observation System (BIOS). Retrieved 25 Jan 2022 from: <https://apps.wildlife.ca.gov/bios/>.

[48] *Ibid.*

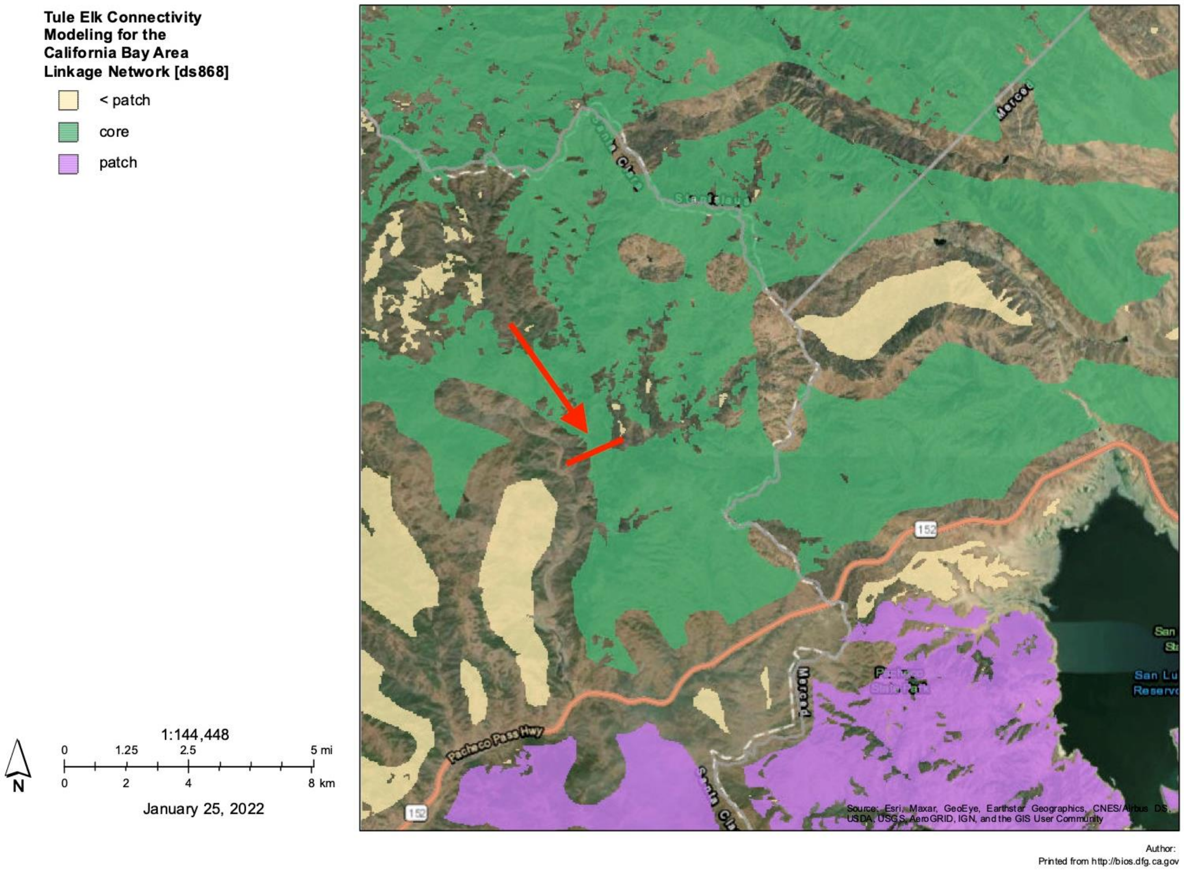

Figure 3. Potential core habitat area for tule elk (in green). Red line depicts movement corridor that would be blocked by the proposed inundation area.

Western Spadefoot

According to the DEIR, a species was determined to be absent from the study area if: "[f]ocused surveys determined the species is absent from the study area, the species is acknowledged to be extirpated locally or the study area is located outside of the species range, or potential habitat to support the species is not present in the study area."[49] The eastern portion of the Project impact area overlaps with the existing (extant) range of the western spadefoot.[50] Although the study area contains potential habitat for the western spadefoot,[51] no surveys for the species were conducted. As a result, the DEIR's determination that the species is absent is not supported by evidence. Project activities within the eastern portion of the Project area have the potential to cause significant impacts on the western spadefoot. Therefore, the DEIR must disclose and analyze the Project's impacts on the western spadefoot.

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[49] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, p. 2-4.
[50] *Ibid*, Table 2-3.
[51] *Ibid.*

California Tiger Salamander

The DEIR states:

> "the Project study area contains approximately 6,082 acres of suitable aquatic, upland, and dispersal habitat for California tiger salamander, which includes both the upstream and downstream areas. Aquatic features consisting of ponds of varying sizes (from less-than 0.01 acre to San Felipe Lake [approximately 74 acres]) and have sufficient water depths and emergent vegetation to provide potential breeding habitat for this species."[52]

This information is insufficient. The DEIR must provide a breakdown of the amount of each habitat type (i.e., aquatic, upland, dispersal) in the Project study area. In addition, to enable understanding of how the Project would affect metapopulation dynamics of the California tiger salamander ("CTS"), the DEIR must map or otherwise identify the locations of each habitat type in relation to the Project's impact areas.

The DEIR provides conflicting information on CTS breeding habitat within the access and utility area. Page 3.5-33 of the DEIR states: "[w]ithin the access and utility area, no breeding habitat was identified; however, there is approximately 2,607 acres of aquatic, upland and dispersal habitat based on the desktop analysis." This statement conflicts with the CTS Site Assessment, which depicts CTS breeding habitat within the access and utility area.[53] It also conflicts with DEIR page 3.5-86, which states: "[w]ithin the upstream area, downstream area, *and access and utility area*, there is suitable aquatic breeding habitat (i.e., ponds) and suitable dispersal/upland habitat consisting of grassland, woodlands, scrub, and chaparral vegetation communities for both California tiger salamander and California red-legged frog."[54]

According to the Biology Appendix: "[t]he site assessment was conducted in accordance with the United States Fish and Wildlife Service (USFWS) Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander (USFWS 2003)."[55] This statement is misleading for three reasons. First, the site assessment failed to encompass the entire Project site[56] (and areas within 1.24 miles of the project boundaries) in accordance with the USFWS guidelines.[57] Instead, the site assessment was confined to areas within 1.24 miles of the dam footprint, inundation area, and borrow sites, entirely omitting some of the areas what would be impacted by the proposed transmission line and access roads.[58]

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[52] DEIR, p. 3.5-33.
[53] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit D, Figure 4-2.
[54] [emphasis added].
[55] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit D, p. 2-1.
[56] In this case, the "project site" includes the access road, transmission line, and other project facilities within the access and utility area.
[57] U.S. Fish and Wildlife Service. 2003. Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander. October 2003. U.S. Fish and Wildlife Service, Sacramento Office. p. 3.
[58] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit D, Figure 2-1. *See also*, Exhibits 16 through 20 in DEIR Appendix – Alternatives Development and Project Description.

Second, a critical component of the site assessment is mapping of suitable upland habitat, including locations of underground refugia, with a focus on areas where small mammal burrows are located or are most dense.[59] This information is needed to understand how the Project would impact: (a) migration and dispersal corridors, and (b) areas where CTS are likely concentrated (due to density of underground refugia). None of the maps provided in the DEIR (and associated CTS Site Assessment) identify locations of underground refugia, or even where suitable upland habitat is located in relation to the Project's impact areas. This precludes the ability to understand how the Project would affect metapopulation dynamics, which are essential to persistence of the CTS.[60]

Third, the objective of the CTS site assessment is to determine presence of potential habitat—*not to delineate actual habitat for the purpose of impact assessments*. According to the USFWS (2003): "[b]ased on the information provided from the site assessment, the Service and Department will provide recommendations as to the appropriateness of field surveys…**Biological field surveys should be conducted for all sites with potential CTS habitat**."[61] Although the site assessment revealed presence of potential CTS habitat, the biologists did not conduct field surveys for CTS (i.e., to document CTS presence, distribution, and habitat use within the Project area). Instead, the biologists made unsupported conclusions regarding which aquatic features provided CTS breeding habitat, and which ones did not. These conclusions are the sole basis for the DEIR's impact analyses.

According to the CTS Site Assessment, the biologists eliminated 47 aquatic features from consideration as potential breeding habitat because the features "lack sufficient hydroperiod and vegetation to support breeding and larval development."[62] Vegetation, however, is not a primary constituent element ("PCE") of CTS breeding habitat.[63] CTS lay their eggs on both submerged and emergent vegetation *and on submerged debris* in shallow water.[64] Because the biologists eliminated aquatic features lacking vegetation (but containing submerged debris and an adequate hydroperiod), they underreported the distribution and abundance of potential breeding habitat for CTS.[65]

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[59] U.S. Fish and Wildlife Service. 2003. Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander. October 2003. U.S. Fish and Wildlife Service, Sacramento Office. p. 3.
[60] *See* U.S. Fish and Wildlife Service. 2014. California Tiger Salamander Central California Distinct Population Segment (*Ambystoma californiense*). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. p. 11. *See also* U.S. Fish and Wildlife Service. 2017. Recovery Plan for the Central California Distinct Population Segment of the California Tiger Salamander (*Ambystoma californiense*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. v + 69pp.
[61] U.S. Fish and Wildlife Service. 2003. Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander. October 2003. U.S. Fish and Wildlife Service, Sacramento Office. p. 4. [emphasis added].
[62] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit D, Table 4-2 and p. 4-5.
[63] "Primary constituent elements" are the physical and biological features of a landscape that a species needs to survive and reproduce.
[64] California Department of Fish and Wildlife. California Interagency Wildlife Task Group. 2005. CWHR version 9.0 personal computer program. Sacramento, CA. Life history account for California Tiger Salamander. Available at: <https://wildlife.ca.gov/Data/CWHR/Life-History-and-Range>. (Accessed 26 Jan 2022).
[65] *For example, see* DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit D, Subexhibit A, photos 3 and 4.

The PCE of CTS breeding habitat is:

> "Standing bodies of fresh water (including natural and manmade (e.g., stock)) ponds, vernal pools, and other ephemeral or permanent water bodies which typically support inundation during winter rains and hold water for a minimum of 12 weeks in a year of average rainfall."[66]

To evaluate this PCE, the Project biologists visually surveyed 25 of the 232 aquatic features within the assessment area. The survey was conducted during a drought year and was limited to a single site visit. To evaluate the hydroperiod of the remaining 207 aquatic features, "aerial images from multiple years and seasons were reviewed in Google Earth." To assess the validity of this method, I reviewed Google Earth imagery of ponds in the study area. Table 2 (below) provides the dates of imagery available from Google Earth and identifies whether aquatic features P-21 and P-225 contained water on those dates. The biologists classified both of those ponds as non-breeding habitat for CTS. To conclude a particular feature did not provide potential breeding habitat (i.e., hold water for at least 12 weeks), the biologists would have needed one image of the feature when it first filled with water, and another image of the feature showing absence of water sometime within the subsequent 12 weeks. As evident in Table 2, Google Earth does not contain the imagery needed to determine whether aquatic features in the assessment area hold water for a minimum of 12 weeks in a year of average rainfall. There is only one year (2012) between 2011 and 2020 with multiple (two) images in spring when an ephemeral feature would be expected to hold water. However, for that year the absence of water in a feature on 16 April, 5 May, or both would not be sufficient evidence because it would not be possible to rule out the possibility that the feature held water in the 12 weeks preceding the 16 April image (nor is there evidence that 2012 was a year of average rainfall).

Table 2. Presence of water in ponds P-21 and P-225, by Google Earth imagery date.

Year	Date	Water in P-21	Water in P-225
2020	8/26, 9/25	No, No	Yes, Yes
2019	None	-	-
2018	3/31, 9/20	Yes, No	Yes, Yes
2017	3/13	Yes	Yes
2016	None	-	-
2015	4/12	Yes	Yes
2014	None	-	-
2013	3/20	Yes	Yes
2012	4/16, 5/5	Yes, Yes	Yes, Yes
2011	5/20	Yes	Yes

[66] U.S. Fish and Wildlife Service. 2005. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the California Tiger Salamander, Central Population; Final Rule. Federal Register 70(162):49380-49458.

The DEIR also fails to explain inconsistencies between the determinations in the CTS Site Assessment, and those in the California Red-legged Frog ("CRLF") Site Assessment. The PCE for CRLF breeding habitat is:

> "Standing bodies of fresh water (with salinities less than 7.0 ppt), including: natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years."[67]

Therefore, if an aquatic feature (e.g., pond) provides potential breeding habitat for the CRLF, it also provides potential breeding habitat for the CTS. However, this is not reflected in the site assessments, which classified several ponds as potential breeding habitat for the CRLF, but not for the CTS.[68]

Due to the errors described above, the DEIR fails to provide accurate information on the amount of potential CTS breeding habitat in the Project area. This undermines the DEIR's assessment of impacts to CTS breeding habitat. It also undermines the accuracy of the DEIR's assessment of impacts to upland and dispersal habitat, because impacts to these two habitat types are dependent on the spatial configuration of breeding habitat.

California Red-legged Frog

The DEIR's description of the environmental setting for the California red-legged frog ("CRLF") suffers the same flaws as those described above for the California tiger salamander.

A proper impact assessment requires a site assessment *and field surveys*; however, no field surveys for CRLF were conducted. The USFWS guidance states:

> "Similar to the 1997 Guidance, two procedures are recommended in the new Guidance **to accurately assess the likelihood of CRF** presence in the vicinity of a project site: (1) an assessment of CRF locality records and potential CRF habitat in and around the project area and, (2) focused field surveys of breeding pools and other associated habitat to determine whether CRF are likely to be present…**If the following Guidance is followed in its entirety**, the results of the site assessments and surveys will be considered valid by the Service for two (2) years, unless determined otherwise on a case-by-case basis by the appropriate Service Fish and Wildlife Office…**Based on the information provided in the site assessment**

[67] U.S. Fish and Wildlife Service. 2010. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the California Red-legged Frog; Final Rule. Federal Register 75(51):12816-12959.

[68] Features P-16, P-18, P-21, P-226, P-33, P-7, and P-9 were classified as potential breeding habitat for CRLF but not CTS. *See* Subexhibit B to Exhibits C and D, DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A.

> **report and the survey results**, the Service will provide guidance on how CRF issues should be addressed through the section 7 or section 10 processes."[69]

Not only did the Project biologists fail to conduct the surveys recommended by the USFWS, but they did not even visit most of the aquatic habitats before concluding absence of potential breeding habitat. I found no evidence that it would be possible to use Google Earth imagery to determine whether a particular aquatic feature provided potential breeding habitat (i.e., held water for a minimum of 20 weeks; *see* Table 2 above.) Furthermore, there is no explanation for why feature O-1 was classified as "non-habitat" because the associated data sheet indicates the biologists potentially detected CRLF at that feature.

The DEIR states: "[w]ithin the access and utility area no breeding habitat was identified; however, there is approximately 2,607 acres of aquatic, upland and dispersal habitat based on desktop analysis."[70] The DEIR fails to explain why the 10.2 acres of ponds in the access and utility area do not provide potential breeding habitat.[71] Moreover, Figure 2-1 in the CRLF Site Assessment clearly shows that the assessment and associated "desktop analysis" did not encompass the entire access and utility area. Therefore, it is unclear whether the information in the DEIR accounts for the entire access and utility area, or only the portion that was included in the CRLF Site Assessment. If the information in the DEIR is supposed to account for habitat throughout the entire Project area, where is the analysis that was used to derive the determinations that the access and utility has "no breeding habitat" but "2,607 acres of aquatic, upland and dispersal habitat"?

Foothill Yellow-legged Frog

The DEIR provides the following description of the environmental setting for the foothill yellow-legged frog ("FYLF"):

> "Based on the results from the reconnaissance-level habitat assessment surveys along with terrestrial vegetation mapping and the aquatic resources delineation, the Project study area contains approximately 86 acres of aquatic breeding habitat, 254 acres of aquatic non-breeding habitat, and 174 acres of dispersal habitat for foothill yellow-legged frog. The suitable aquatic breeding habitat occurs primarily on North Fork Pacheco Creek upstream from North Fork Dam and along the South Fork Pacheco Creek. There is one historical CNDDB occurrence record from 1950 for this species located along Pacheco Creek, downstream from North Fork Dam (CDFW 2021e). Suitable dispersal and foraging habitat for this species is also present in Pacheco Creek downstream from North Fork Dam in the form of cobble and sand bank, rock outcrops, and deeper pools; however, this portion of the creek lacks breeding habitat due to flow regimes that negatively affect breeding. In addition, no foothill yellow-legged frogs were observed during pedestrian surveys (SCVHA 2020). According to the Santa Clara Valley Habitat

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[69] U.S. Fish and Wildlife Service. 2005. Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog. Available at: <https://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/crf_survey_guidance_aug2005.pdf >. [emphasis added].

[70] DEIR, p. 3.5-34.

[71] *See* DEIR, Table 3.5-1 in comparison to Table 3-1 in Attachment B of the Biology Appendix.

> Agency's (SCVHA) report (2020) foothill yellow-legged frog are absent within Pacheco Creek below North Fork Dam based on regulated discharges and on SCVHA surveys conducted in April and July 2019 as part of a separate study. Within the access and utility area, no suitable aquatic habitat for this species was identified. Based on this information and the presence of potentially suitable habitat within the Project study area, foothill yellow-legged frog has a moderate potential to occur in the portion of the Project study area above North Fork Dam and Pacheco Reservoir."[72]

The DEIR fails to identify where the various habitats (i.e., breeding, non-breeding, and dispersal) for the FYLF are located in the study area. This issue is compounded by the DEIR's failure to identify the specific aquatic resource types (e.g., as classified in DEIR Table 3.5-2) that provide habitat for the FYLF.

Focused surveys were not conducted to determine FYLF presence and habitat use in the study area. Although dams can have negative effects on FYLF, there is no evidence that the existing flow regime has eliminated all FYLF breeding habitat from Pacheco Creek below North Fork Dam. FYLF breed at the margins of relatively wide and shallow streams with cobble, boulder, and gravel substrates.[73] These habitat conditions are present in at least portions of Pacheco Creek.

Contrary to what the DEIR claims, the SCVHA (2020) report did not state FYLF are absent from Pacheco Creek below North Fork Dam. The report states: "[g]iven the lack of any detections during H.T. Harvey's April and July surveys, and the lack of any recent observations in the PCW, it is our opinion that foothill yellow-legged frogs are currently absent from the study area."[74] In this case, H.T. Harvey's study area was limited to an approximately two-mile segment of Pacheco Creek within the Pacheco Creek Reserve, Bureau of Reclamation property, and the Ciraulo property. The apparent absence of FYLF within a two-mile segment of Pacheco Creek is not evidence that FYLF are absent throughout the entire 17-mile segment of Pacheco Creek below North Fork Dam. As a result, the DEIR's description of the environmental setting is erroneous and must be corrected.

Western Pond Turtle

The DEIR states:

> "Based on the results from the reconnaissance-level habitat assessment surveys along with terrestrial vegetation mapping and the aquatic resources delineation, there is approximately 681 acres of aquatic habitat for western pond turtle within the upstream and downstream areas in the form of ponds, Pacheco Reservoir, and Pacheco Creek. This includes approximately 476 acres in the downstream area and approximately 206 acres in the upstream area. Numerous areas of basking

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[72] DEIR, p. 3.5-35.

[73] Thomson RC, Wright AN, Shaffer HB. 2016. California Amphibian and Reptile Species of Special Concern. California Department of Fish and Wildlife. University of California Press, Oakland, California.

[74] Santa Clara Valley Habitat Agency. 2020. Pacheco Creek Restoration Project Final Feasibility Study. Prepared by H.T. Harvey & Associates. p. 53.

> habitat were also observed within the upstream and downstream areas, including rock outcrops, logs, gravel, and sandy banks. Approximately 804 acres of nesting habitat occurs in downstream area and 923 acres in the upstream area in the form of grassland. Within the access and utility area less than 1 acre of aquatic habitat and approximately 2,600 acres of dispersal and upland habitat was identified."[75]

The DEIR does not describe the criteria that were used to classify pond turtle habitat, nor does it explain how the acreage values provided in the DEIR were calculated. Based on the information provided in the DEIR, there are 1,727 acres of grassland nesting habitat in the upstream and downstream areas, and an additional 2,600 acres of dispersal and upland habitat in the access and utility area. The DEIR fails to identify: (a) the amount of dispersal and upland habitat in the upstream and downstream areas, and (b) the amount nesting habitat in the access and utility area.

There are 10.2 acres of ponds in the access and utility area.[76] The DEIR fails to explain why 9.2 acres of the ponds do not provide aquatic habitat for pond turtles. Furthermore, pond turtle nesting habitat is not limited to grasslands. Pond turtles exhibit ecological plasticity in habitat use and will nest in various habitat types containing sparse vegetation and significant solar exposure.[77] Because the DEIR only accounts for grassland nesting habitat, it does not accurately report the total amount of pond turtle nesting habitat in the Project area, and thus, the total amount of pond turtle nesting habitat that would be impacted by the Project is not accurately defined.

Special-status and Protected Raptor Species

The DEIR states: "[n]o cliff habitats with potential to support American peregrine falcon or California condor nesting were observed in the Project study area; however, the area provides potential grassland foraging habitat, as described above for the species."[78] This statement is inconsistent with the DEIR's Biology Appendix (Attachment A, Table 2-3), which indicates cliff habitat is present in the study area (albeit limited). It also is inconsistent with my observations of potential nest substrates (large rock outcrops) during site visits in 2021 (Plate 1, below). In addition, at least one peregrine falcon was detected during the Project's eagle surveys, which strongly suggests the bird was nesting in a nearby area.

The DEIR includes wildly varying estimates of grassland habitat in the study area:

a) "Approximately 1,354 acres of grasslands or livestock pasture habitats within the upstream and downstream areas provide potential nesting habitat for burrowing owl, and foraging habitat for most of the special-status raptor species."[79]

[75] DEIR, p. 3.5-35.
[76] Pond acreage in the access and utility area was derived by comparing the values provided in DEIR, Table 3.5-1, and Table 3-1 in Attachment B of the Botanical/Wildlife Appendix.
[77] Rathbun GB, Scott NJ Jr, Murphey TJ. 2002. Terrestrial Habitat Use by Pacific Pond Turtles in a Mediterranean Climate. Southwestern Naturalist 47(2):225-235. *See also* Davidson KA, Alvarez JA. 2020. A Review and Synopsis of Nest Site Selection and Site Characteristics of Western Pond Turtles. Western Wildlife 7:42-49.
[78] DEIR, p. 3.5-38.
[79] DEIR, p. 3.5-38.

b) "Approximately 804 acres of [pond turtle] nesting habitat occurs in downstream area and 923 acres in the upstream area in the form of grassland."[80]

c) "Within the upstream and downstream areas, there are approximately 130 acres of [American badger] dispersal habitat (i.e., riparian forest and woodland) and approximately 6,000 acres of potential denning habitat (i.e., grasslands) which could also be used for dispersal."[81]

There is no scientific explanation for why there are 6,000 acres of grassland habitat for the American badger, 1,727 acres of grassland habitat for nesting pond turtles, but only 1,354 acres of grassland habitat for burrowing owls and other raptors that forage in grasslands.

Plate 1. Rock outcrops in the upstream portion of the Project study area. Red arrow points to outcrop that provides potential nest substrates for the American peregrine falcon and other raptors.

Eagles

The Diablo Range of west-central California is hypothesized to support one of the densest known breeding populations of golden eagles in North America.[82] Due to the high abundance of golden eagle nesting territories in the Central Coast Ranges, and the productivity (i.e., reproductive success) of those territories, the Central Coast Ranges serve as the stronghold for eagle conservation in California.[83] The golden eagle population cannot withstand any additive

[80] DEIR, p. 3.5-35.
[81] DEIR, p. 3.5-40.
[82] Wiens JD, Kolar PS, Fuller MR, Hunt WG, Hunt T. 2015. Estimation of Occupancy, Breeding Success, and Abundance of Golden Eagles (*Aquila chrysaetos*) in the Diablo Range, California, 2014. U.S. Geological Survey Open-File Report 2015-1039.
[83] Thelander CG, California Department of Fish and Game. 1974. Nesting territory utilization by golden eagles (Aquila chrysaetos) in California during 1974. Wildlife Management Branch Administrative Report No. 74-7 (November 1974). 22 pp. *See also* US Fish and Wildlife Service, Division of Migratory Bird Management. 2009. Final Environmental Assessment, Proposal to Permit Take. Provided Under the Bald and Golden Eagle Protection Act. Washington: Dept. of Interior. Table C.4.

mortality.[84] Therefore, the loss of even one golden eagle would constitute a significant impact (as reflected in the USFWS's no-net-loss standard).

The DEIR does not provide reliable information on the number of eagle territories in the study area. For example, the DEIR states the following regarding bald eagles: "[a]lthough no nests were observed within the upstream area of the Project study area, potentially suitable habitat for this species does occur upstream."[85] In fact, there is a bald eagle nest in the "upstream area." The nest lies within the proposed inundation area, is near an unimproved road, and is very conspicuous from all vantage points (Plates 2 and 3, below). According to the property owner, bald eagles have nested at this location for many consecutive years, including in 2020 when the Project biologists conducted eagle surveys. The map in the eagle survey report (Biology Appendix, Attachment D) suggests survey station #14 was located in close proximity to the nest. The fact that the biologists either failed to detect the nest, or incorrectly classified it as "inactive," is evidence that the surveys were insufficient and failed to provide adequate data on eagle territories that would be affected by the Project.

According to the eagle survey report: "[t]he survey efforts consisted of three ground-based and three aerial-based surveys as described in the *Draft Workplan for Nesting Bald and Golden Eagles Surveys* (Draft Workplan)…The Draft Workplan provided in Exhibit B, provides further details regarding the rationale and placement of the survey points."[86] The Draft Workplan was omitted from the DEIR, and despite requests, Valley Water refused to provide me with a copy of the Draft Workplan. As a result, I was unable to evaluate the rationale that was used to select the survey points. This is important because the eagle survey report provides no evidence that the ground-based survey stations were located in areas that provided a broad panorama of the surrounding habitat, thereby maximizing detection of eagles.

The eagle survey report states: "[t]he survey area consists of a 1-mile buffer around the existing Pacheco Reservoir and upstream areas (i.e., generally north of the existing North Fork Dam) surrounding the reservoir up to the expanded reservoir boundary plus an approximately 500-foot buffer, and approximately 17 miles of Pacheco Creek along the 100-year floodplain from the North Fork Dam downstream to San Felipe Lake (see Exhibit A, Figure 2)."[87]

No surveys were conducted throughout the entire access and utility area. This is important because transmission lines (especially distribution lines) are a leading cause of eagle fatalities.[88] The relative threat of a particular transmission line is a function of its proximity to eagle concentration areas, foraging areas, or nesting areas. For example, the closer a transmission line is installed to an eagle nest, the more likely it is that eagles will encounter (e.g., strike) that line as they fly to and from the nest. The failure to conduct eagle surveys throughout the entire

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[84] U.S. Fish and Wildlife Service. 2016. Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. Division of Migratory Bird Management, Washington D.C., USA.
[85] DEIR, p. 3.5-106.
[86] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment D, pp. 2-1 and -2.
[87] *Ibid*.
[88] U.S. Fish and Wildlife Service, Division of Migratory Bird Management. 2009. Final Environmental Assessment, Proposal to Permit Take. Provided Under the Bald and Golden Eagle Protection Act. Washington: Dept. of Interior. pp. 61 and 62.

access and utility area precludes the ability to assess the likelihood that the Project's proposed transmission line would cause "take" of eagles.

The Project's eagle survey report states: "[t]otal numbers of eagle observations are not indicative of population size, but location, frequency, and behaviors observed during eagle observations can indicate what habitats eagles are utilizing and in what capacity."[89] This statement is misleading. Studies by Wiens et al. (2015, 2018) described how eagle survey data could be used to estimate population parameters, such as the proportion of sites that are occupied, the proportion of sites with successful reproduction, and the abundance of eagles.[90] According to the eagle survey report, the biologists reviewed Wiens et al. 2015, and they adhered to the survey methods described in Wiens et al. 2018.[91] Nonetheless, the survey report admits the survey data "can indicate what habitats eagles are utilizing and in what capacity." This information pertaining to eagle use of various habitats in the Project study area was not provided anywhere in the DEIR, and it apparently was not considered in the DEIR's impact assessments. Thus, the DEIR's conclusions regarding eagles are unsupported.

[89] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment D, p. 4-1.
[90] Wiens JD, Kolar PS, Fuller MR, Hunt WG, Hunt T. 2015. Estimation of Occupancy, Breeding Success, and Abundance of Golden Eagles (*Aquila chrysaetos*) in the Diablo Range, California, 2014. U.S. Geological Survey Open-File Report 2015-1039. *See also* Wiens JD, Kolar PS, Fuller MR, Hunt WG, Hunt T, Bell DA. 2018. Spatial Patterns in Occupancy and Reproduction of Golden Eagles During Drought: Prospects for Conservation in Changing Environments. The Condor: Ornithological Applications 120:106-124.
[91] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment D, p. 2-1.

Plate 2. Bald eagle nest (in red circle) near North Fork Pacheco Creek. The nest tree lies within the middle of the proposed inundation area.

Plate 3. Bald eagle (red circle) perched near nest site (red arrow) on 5 February 2022.

PROJECT IMPACTS

The DEIR fails to provides the information needed to accurately understand the Project's impacts. The Project Description chapter does not quantify impacts for all of the Project's facilities and ground disturbance activities, and there are no maps of the Project footprint (disturbance areas) in relation to existing vegetation communities or habitat types. Consequently, there is no ability to verify whether the DEIR accounts for all of the Project's impacts. This issue is compounded by the DEIR's failure to identify how the impact values provided in the DEIR were derived. For example, although the DEIR indicates the Project would impact 20 acres of dispersal habitat for the FYLF, it does not identify where those 20 acres are located, which Project activity would cause the impacts, *or even what the DEIR considers to be "dispersal habitat."* Because all the impacts are lumped into generic categories (e.g., "construction impacts" vs. "operations impacts"), and because there are no maps of the Project footprint in relation to habitat types, it is impossible to even speculate how the impact values provided in the DEIR were derived.

The DEIR quantifies the Project's impacts to sensitive natural communities and riparian habitats in the "Proposed Project Inundation or Construction Area;" however, the DEIR does not quantify impacts to "non-sensitive communities," many of which provide habitat for sensitive animals. This issue is exacerbated by the DEIR's failure to identify which vegetation communities (or alliances) were considered "habitat" for one or more of the special-status species analyzed in the DEIR.

The biological resource impact values provided in the DEIR appear arbitrary and erroneous. For example, the DEIR states that the Project would impact 574 acres of foraging habitat for the golden eagle, 1,858 acres of habitat for the American badger, and 1,700 acres of habitat for the San Joaquin coachwhip. This makes absolutely no sense because all three species are associated with the same types of habitat (e.g., grassland and open scrub communities).

It is unclear whether the impact acreages provided in the DEIR's various tables include the access and utility area. For example, the title of Table 3.5-6 is: "*Impacts on Sensitive Natural Communities and Riparian Habitats in the Proposed Project Inundation or Construction Area*." In the Biology Appendix, the "construction area" refers to the construction area for the proposed dam and reservoir, not the construction area for the transmission line and land owner access roads.[92]

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"Desktop analysis" was used to assess impacts to hundreds of acres in the access and utility area (i.e., no field surveys were conducted). This is not a valid approach, as alluded to in the various mitigation measures that require field surveys to assess habitat potential in the access and utility area prior to construction.[93] Project impacts to sensitive species and habitats in the access and utility area are not trivial: they include over 37 miles of new access roads that would fragment the landscape and degrade the surrounding habitats.

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[92] For example, *see* DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, p. 2-1.
[93] *For example*, Mitigation Measures BI-1b, -2a, -4a, 5a, -7, -8a, -13b, and -14a.

All of these deficiencies preclude the public, scientific community, and natural resource agencies from having an accurate understanding of the Project's impacts, and thus, the sufficiency and feasibility of mitigation proposed in the DEIR. As a result, the DEIR must be revised and recirculated for public review after the DEIR's material defects have been corrected.

Impact Characterization

The DEIR's description of the impact classification scheme is confusing and unsupported.[94] According to the DEIR:

> "A temporary impact typically would occur only during construction. For the purposes of this resource section, impacts considered temporary consist of construction easements for components such as access routes, dam, electrical transmission substation, etc. Ground disturbing activities (e.g., grading) would not be required in these areas and use would be limited to activities such as vehicle staging and ingress/egress."

It remains unclear what activities would cause temporary impacts and whether the term "temporary" applies to the resources (e.g., organisms) that would be impacted or the overall construction timeline. According to DEIR Table 3.5-15, which appears to be the most comprehensive account of impacts to habitat, Project Alternative A would cause 43.2 acres of temporary impacts. This value appears too large to be only impacts that do not involve ground disturbing activities. Staging areas presumably would require grading, as would access roads. Even if the DEIR is correct that no grading would be required, ingress and egress of construction equipment and vehicles would cause substantial ground disturbance (e.g., soil compaction), resulting in more than a temporary impact from an ecological perspective.

The DEIR states:

> "A short-term impact could occur during construction and could last from the time construction ceases to within three to five years after construction. For the purposes of this resource section, impacts considered short-term include staging areas, where they may be used for a short while following construction. Areas subjected to short-term impacts would be restored once the activities in the area have been completed."

This description of short-term impacts appears inconsistent with the description of temporary impacts. What is the rationale for classifying some staging areas as "temporary impacts" but others as "short-term" impacts? Construction activities would last approximately 6 to 7 years, which encompasses many reproductive cycles or even the entire lifespan of some wildlife species. Even if restoration activities begin immediately after construction ceases, it can take vegetation communities (e.g., mature oak woodlands) decades or centuries to return to pre-disturbance levels. By scientific standards, an impact that would occur for a minimum of six years is not "short-term." The Biological Opinion for the Santa Clara Valley Habitat Plan ("SCVHP") states the following: "[f]or the purposes of the Plan, all impacts associated with Covered Activities **that have a duration exceeding one year or that take more than one year**

[94] *See* DEIR, p. 3.5-47.

to restore immediately following construction will be considered permanent." This same standard must be applied to Proposed Project and Project Alternatives, especially because none of the mitigation measures proposed in the DEIR require restoration of "short-term" impact areas. Even if Valley Water is committed to restoring impact areas, there are no mechanisms (e.g., performance standards or monitoring and reporting requirements) that would ensure restoration activities are successful. Many vegetation communities (e.g., oak or sycamore woodlands) are notoriously difficult to restore, thus rendering the impacts permanent despite implementation of dedicated restoration efforts.

Impact Bio-1: Sensitive Natural Communities and Riparian Habitat

Direct Impacts

According to the DEIR:

> "Of the total 169 acres of impacts on sensitive natural communities, approximately three acres of impacts would occur on vegetation that qualifies as riparian habitat regulated under FGC Section 1602. Specially, this riparian vegetation consists of the Goodding's willow – red willow vegetation alliance. Impacts on riparian vegetation not comprised of CDFW-designated sensitive natural communities include approximately two acres of long-term impacts on mulefat thickets subject to inundation within the expanded reservoir."[95]

These impact values do not appear to be correct. CDFW's jurisdiction under FGC Section 1602 is not limited to "riparian vegetation;" it applies to any activity that may:

a) Substantially divert or obstruct the natural flow of any river, stream, or lake;
b) Substantially change or use any material from the bed, channel, or bank of any river, stream, or lake; or
c) Deposit or dispose of debris, waste, or other materials containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.[96]

Furthermore, CDFW cautions:

> "Vegetation maps produced under the state standards do not imply regulatory jurisdictional determinations under…Section 1600 of the California Fish and Game Code (Lake and Streambed Alteration Program)…or the lack thereof. Such determinations usually require a site visit to assess the current conditions on the ground and to map boundaries at a finer scale than the state vegetation map standard. Similarly, terms such as "riparian" and "wetland" in the vegetation keys and type descriptions may inform but do not imply or assert regulatory jurisdiction or the lack thereof."[97]

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[95] DEIR, p. 3.5-59.
[96] *See* <https://wildlife.ca.gov/Conservation/Environmental-Review/LSA/Q-and-A#2195910-when-is-notification-required>.
[97] *See* <https://wildlife.ca.gov/Data/VegCAMP/Natural-Communities>

The DEIR does not provide the information needed to validate the accuracy of the DEIR's impact assessment. As a result, the DEIR must be revised to include maps that depict the impact areas of the Proposed Project and Alternatives A through D in relation to:

a. Vegetation alliances and associations;
b. Resources under the jurisdiction of the U.S. Army Corps of Engineers;
c. Resources under the jurisdiction of the State Water Resources Control Board;
d. Resources under the jurisdiction of the CDFW.

These maps could easily be produced by overlaying the footprint of the Proposed Project (and various Project Alternatives) onto the maps provided in Attachments B, C, and E of the Biology Appendix.

Indirect Impacts

The DEIR identifies the introduction or spread of *Phytophthora* and other pathogens, and the introduction or spread of non-native and invasive plants ("NNIP"), as potentially significant indirect impacts caused by the Project.[98] The DEIR states these indirect impacts would be avoided through implementation of the DIFs (design and implementation features) described in the DEIR.[99]

Based on their investigation of *Phytophthora* along Pacheco Creek, Swiecki and Bernhardt (2021) concluded:

> "Because *Phytophthora* reproduction, spread, and infection are favored by soil saturation and inundation, changes to the hydroperiod of Pacheco Creek due to longer or more frequent periods of water release have the potential to increase the activity of *Phytophthora* species. *Phytophthora* species that are commonly detected in surface waters, such as clade 6 species, and those that are transitory in water due to runoff from rainfall events, such as *P. cambivora*, could become more uniformly distributed along the creek channel if the hydroperiod is increased. Increased periods of soil saturation could also increase opportunities for establishment of *Phytophthora* species moved by flowing creek water or inadvertently transported to the site in contaminated soil or plant material on vehicles, equipment, and the like…Furthermore, as discussed above, changes in the hydroperiod and distribution of surface water along the creek has the potential to increase *Phytophthora* distribution and activity, which could adversely impact native vegetation in affected areas. This potential impact should be taken into consideration for its potential to affect both habitat restoration and the sustainability of existing vegetation."[100]

The DEIR provides no analysis of the Project's potential to introduce or spread *Phytophthora* species (or other pathogens) due to changes in the hydroperiod and distribution of surface water

[98] DEIR, p. 3.5-61.
[99] *Ibid.*
[100] Swiecki TJ, Bernhardt E (Phytosphere Research). 2021. *Phytophthora* sampling of sycamores along Pacheco Creek. Technical Report prepared for the Santa Clara Valley Water District. pp. 9 and 11.

along Pacheco Creek. In addition, the DEIR provides no discussion or analysis of the Project's potential to introduce or spread NNIPs due to: (a) use of imported water (from San Luis Reservoir and the Sacramento-San Joaquin Delta), and (b) changes in the hydroperiod and distribution of surface water along Pacheco Creek. The DIFs described in the DEIR do not address or mitigate potentially significant impacts associated with the introduction or spread of *Phytophthora* species and NNIPs due to Project operations.

Impact Bio-2: Sycamore Alluvial Woodlands

Sycamore alluvial woodland is an extremely rare and threatened habitat type that supports numerous special-status species.[101] By 1996, there were only 17 significant stands of sycamore alluvial woodland (totaling approximately 2,000 acres) remaining in the state.[102] A statewide assessment by Keeler-Wolf et al. (1997) found the sycamore alluvial woodland along Pacheco Creek to be one of the most important of the 17 surviving stands.[103]

The project would directly (e.g., through removal or inundation) or indirectly (e.g., through operational flows) impact 92% (158.7 acres) of the sycamore alluvial woodlands in the Project study area, which encompasses the stand of statewide significance along Pacheco Creek.[104] This impact would be extremely significant and may not be mitigatable due to the difficulty in finding unhybridized seed sources;[105] the limited number of sites that potentially could be acquired for compensatory mitigation; conflicts with the Santa Clara Valley Habitat Plan;[106] and competition with the California High-Speed Rail Authority to acquire sycamore alluvial woodland compensation sites.[107]

The DEIR claims:

> "Within the region surrounding the Project study area (San Benito, Merced, Stanislaus, and Alameda Counties), there are approximately 600 acres of large, intact stands of sycamore alluvial woodlands on private lands that are not

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[101] San Francisco Estuary Institute-Aquatic Science Center and H.T. Harvey & Associates. 2017. Sycamore Alluvial Woodland: Habitat Mapping and Regeneration Study. Prepared for the California Department of Fish and Wildlife Local Assistance Grant Program. A Report of SFEI-ASC's Resilient Landscapes Program and H.T. Harvey & Associates, Publication # 816, San Francisco Estuary Institute, Richmond, CA.
[102] *Ibid.* Significant stand was defined as an occurrence covering at least 10 acres.
[103] Grossinger RM, Beller EE, Salomon MN, Whipple AA, Askevold RA, Striplen CJ, Brewster E, Leidy RA. 2008. South Santa Clara Valley Historical Ecology Study, including Soap Lake, the Upper Pajaro River, and Llagas, Uvas-Carnadero, and Pacheco Creeks. Prepared for the Santa Clara Valley Water District and The Nature Conservancy. A Report of SFEI's Historical Ecology Program, SFEI Publication #558, San Francisco Estuary Institute, Oakland, CA. p. 83.
[104] DEIR, Tables 3.5-1 and 3.5-7, pp. 3.5-68 and -69, and Biological Resources - Botanical/Wildlife Appendix, Attachment B, Table 3-1.
[105] California Department of Fish and Wildlife. 2019 Oct 2. Comments on the San Luis Low Point Improvement Project Draft Environmental Impact Statement/Environmental Impact Report. Available at: <https://ceqanet.opr.ca.gov/2002082020/3>. (Accessed 23 Nov 2021).
[106] DEIR, p. 3.5-114.
[107] The San Jose to Merced Project Section of the high-speed rail project requires 50.4 acres of compensatory mitigation for impacts to sycamore alluvial woodlands. *See* California High-Speed Rail Authority. 2020 Apr. Draft Environmental Impact Report / Environmental Impact Statement: San Jose to Merced Section. pp. 3.7-165 and -183. I was unable to determine whether additional mitigation is required for any of the other high-speed rail segments.

> currently protected by conservation easements with additional areas within and adjacent to these stands that provide sycamore alluvial woodland restoration and establishment opportunities (Keeler-Wolf, et al. 1997, GreenInfo Network 2021). Within Santa Clara County, specifically along South Fork Pacheco Creek and Pacheco Creek (which is within the Project study area), there are approximately 120 acres of privately owned sycamore alluvial woodlands not protected by conservation easements (approximately 16 acres of sycamore alluvial woodlands along Pacheco Creek are owned by SCVHA)."[108]

These claims conflict with information provided by the CNDDB and the two sources cited in the DEIR (i.e., Keeler-Wolf et al. 1997, GreenInfo Network 2021). For example, according to the CNDDB, there are six occurrences of sycamore alluvial woodland in Merced, Stanislaus, and Alameda Counties (none in San Benito County). However, only three of the occurrences are on private land.

The statement that there are "additional areas within and adjacent to these stands that provide sycamore alluvial woodland restoration and establishment opportunities" is not supported by scientific evidence. Keeler-Wolf et al. (1997) concluded: "given the current understanding, the complexity of conditions necessary in order for [sycamore alluvial woodland] to persist, expand, or be restored is prohibitive."[109] Based on my review of the scientific literature, there have not been significant improvements in the ability to restore or establish sycamore alluvial woodlands since the 1997 Keeler-Wolf et al. report.

The DEIR suggests there are 120 acres of privately-owned sycamore alluvial woodlands along South Fork Pacheco Creek and Pacheco Creek that could be protected by conservation easements. However, most of the sycamore alluvial woodlands are located along Pacheco Creek, and almost all of those woodlands would be indirectly impacted by perennial flows created by the Project to the point that ***they are likely to be eliminated***.[110] Furthermore, some of the sycamore alluvial woodlands along Pacheco Creek are located on conservation properties owned by the Santa Clara Valley Habitat Authority (e.g., the 142-acre Pacheco Creek Habitat Preserve

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108 DEIR, p. 3.5-67.

109 Keeler-Wolf T, Lewis K, Roye C. 1997. The Definition and Location of Central California Sycamore Alluvial Woodland. Prepared by Natural Heritage Division, Bay-Delta and Special Water Projects Division, California Department of Fish and Game. p. 108.

110 DEIR, Biological Resources - Botanical/Wildlife Appendix, p. 3.5-68 ("[o]ver time, the sycamore alluvial woodlands in these areas could further transition to mixed riparian communities that do not include California sycamore as a dominant species."). *See also* Grossinger RM, Beller EE, Salomon MN, Whipple AA, Askevold RA, Striplen CJ, Brewster E, Leidy RA. 2008. South Santa Clara Valley Historical Ecology Study, including Soap Lake, the Upper Pajaro River, and Llagas, Uvas-Carnadero, and Pacheco Creeks. Prepared for the Santa Clara Valley Water District and The Nature Conservancy. A Report of SFEI's Historical Ecology Program, SFEI Publication #558, San Francisco Estuary Institute, Oakland, CA. *See also* Spencer WD, Barry SJ, and six others (Independent Science Advisors). 2006. Report of Independent Science Advisors for Santa Clara Valley Habitat Conservation Plan / Natural Community Conservation Plan (HCP/NCCP). Available at: <https://scv-habitatagency.org/DocumentCenter/View/93/Report-of-the-Independent-Science-Advisors-for-the-Santa-Clara-Valley-HCP-NCCP?bidId=>. (Accessed 1 Dec 2021).

and 102-acre Ciraulo parcel).[111] Thus, the sycamore alluvial woodlands along Pacheco Creek would not serve as viable mitigation sites.

The DEIR states: "the Proposed Project's consistent summer baseflows would provide higher groundwater levels during the summer months relative to baseline conditions, potentially benefiting established sycamores." This statement appears to conflict with scientific evidence. According to Grossinger et al. (2008):

> "Large mid- and late-summer reservoir releases are likely to cause negative effects on the Pacheco Creek sycamores, as the species prefers gradual drawdown of the water table through the summer and roots can be injured by a higher water summer table (Keeler-Wolf et al. 1996). Presently, North Fork Pacheco Reservoir is operated to release water at these times to recharge groundwater for use by downstream farmers, which has probably contributed to the changes observed in recent decades."[112]

The Project's perennial flows would facilitate invasion of sycamore alluvial woodlands by more hydrophilic species (e.g., willows), while the Project's new dam would attenuate the winter flood flows necessary for reproduction of sycamores.[113] These negative effects would far exceed any potential benefits that the proposed flows would have on groundwater availability for established sycamores. Even if the Project would somehow benefit established sycamores, there would be no recruitment of new sycamore trees and the community would eventually disappear.

The DEIR's analysis of operational impacts concludes with the following statements:

> "Within the portion of Pacheco Creek from Casa de Fruta downstream, existing channelization and constrained floodplain width (beginning approximately at creek mile 7), coupled with existing, perennially high groundwater levels (beginning at creek mile 12), have resulted in the current decline of sycamore alluvial woodlands. Due to the disturbed, channelized nature of the active stream corridor and high groundwater table, effects of the Proposed Project's perennial summer flow and muted scouring flows are not anticipated to substantially accelerate this decline relative to the baseline conditions or the No Project Alternative…Finally, the implementation of environmental pulse flows and dryback conditions as well as the Adaptive Management Plan would, further reduce impacts. As a result, impacts from operations on sycamore alluvial woodlands along Pacheco Creek downstream from creek mile 7 would be less than significant."[114]

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[111] *See* <https://scv-habitatagency.org/DocumentCenter/View/1201/03>. *See also* DEIR, Biological Resources - Botanical/Wildlife Appendix, Attachment B, Exhibit A.

[112] Grossinger RM, Beller EE, Salomon MN, Whipple AA, Askevold RA, Striplen CJ, Brewster E, Leidy RA. 2008. South Santa Clara Valley Historical Ecology Study, including Soap Lake, the Upper Pajaro River, and Llagas, Uvas-Carnadero, and Pacheco Creeks. Prepared for the Santa Clara Valley Water District and The Nature Conservancy. A Report of SFEI's Historical Ecology Program, SFEI Publication #558, San Francisco Estuary Institute, Oakland, CA. p. 89.

[113] *Ibid*, pp. 83 through 92.

[114] DEIR, p. 3.5-70.

According to earlier analysis in the DEIR, sycamore alluvial woodlands from creek mile 0 to creek mile 7 would be expected to shift to other riparian vegetation community types despite implementation of the pulse flows and drybacks.[115] Therefore, the rationale for the DEIR's conclusion that impacts would be less than significant downstream from creek mile 7 appears to be contingent on: (a) existing channelization, (b) the reduced floodplain width, and (c) perennially high groundwater levels beginning at creek mile 12. Sycamores require scouring flood flows for reproduction. These scouring flood flows currently occur downstream from creek mile 7; the Project would attenuate these scouring flows.

The fact that the creek is channelized and the floodplain is constrained downstream from creek mile 7 means there are reduced opportunities (i.e., due to the channelization) and a reduced area (i.e., due to the reduced floodplain width) for sycamore reproduction downstream from creek mile 7; the channelization does not render the Project's attenuation of the requisite scouring flows less than significant. The pulse flows proposed for the Project do not mitigate this impact because the pulse flows would not exceed the capacity of the existing primary channel.[116] It is unclear why the perennially high groundwater levels beginning at creek mile 12 reduce the Project's impacts; however, this factor would only apply to the limited sycamore alluvial woodland habitat downstream of creek mile 12.

Finally, there is no basis for the DEIR's statement that the Adaptive Management Plan would further reduce impacts. The DEIR does not contain an adaptive management plan, nor do any of the proposed mitigation measures require development and implementation of an adaptive management plan that would address the Project's impacts on sycamore alluvial woodlands. The DEIR cannot rely on an adaptive management plan that has yet to be formulated, and for which there are no assurances of proper implementation, as evidence that impacts would be mitigated to less than significant.

Moreover, even with adaptive management, it may not be possible to implement the Project while also preventing indirect impacts to sycamore alluvial woodland. Based on information provided by Grossinger et al. (2008) and the Conservation Biology Institute (2006), scientists have yet to formulate a regulated flow strategy that benefits both steelhead and sycamores because the needs of these two species are largely incompatible. Indeed, according to Grossinger et al. (2008), ***the only management strategy that could have a dramatic positive benefit for both sycamore alluvial woodlands and steelhead is decommissioning of the dam***.[117]

DEIR Table 3.5-7 indicates the Project would indirectly impact 35 acres of sycamore alluvial woodlands between creek mile 7 and San Felipe Lake. Mitigation Measure BI-2c requires compensatory mitigation for the Project's direct and indirect impacts on sycamore alluvial woodlands, but it does not identify the total mitigation requirement (i.e., total acres). The

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[115] *Ibid*.
[116] DEIR, p. 3.5-79.
[117] Grossinger RM, Beller EE, Salomon MN, Whipple AA, Askevold RA, Striplen CJ, Brewster E, Leidy RA. 2008. South Santa Clara Valley Historical Ecology Study, including Soap Lake, the Upper Pajaro River, and Llagas, Uvas-Carnadero, and Pacheco Creeks. Prepared for the Santa Clara Valley Water District and The Nature Conservancy. A Report of SFEI's Historical Ecology Program, SFEI Publication #558, San Francisco Estuary Institute, Oakland, CA. p. 88. *See also* Conservation Biology Institute. 2006. Report of Independent Science Advisors for Santa Clara Valley Habitat Conservation Plan / Natural Community Conservation Plan (HCP/NCCP).

DEIR's statement that impacts would be less than significant downstream from creek mile 7 suggests Valley Water does not intend to provide compensatory mitigation for impacts below creek mile 7. Therefore, the DEIR must be corrected to disclose which sycamore alluvial woodlands in the Project study area would be subject to the compensatory mitigation requirements imposed by Mitigation Measure BI-2c.

The DEIR determined that the mitigation proposed in Mitigation Measure BI-2c would reduce Project impacts on sycamore alluvial woodlands to less than significant levels. Mitigation Measure BI-2c proposes "minimum preservation ratios of 2:1 for direct impacts and 1:1 for indirect impacts or at ratios established in coordination with CDFW that will achieve equivalent or greater mitigation." The DEIR fails to justify these ratios, which are far too low for significant impacts to an extremely rare resource such as sycamore alluvial woodland.[118] The DEIR for the High-Speed Rail Project, for instance, requires a 4:1 compensatory mitigation ratio for impacts to sycamore alluvial woodlands. The SCVHP requires mitigation at a ratio of 7.7:1.[119]

The DEIR admits that the Project's indirect impacts are likely to result in the loss of sycamore alluvial woodlands (at least up to creek mile 7). Therefore, there is no scientific basis for the two different mitigation ratios proposed in Mitigation Measure BI-2c, because the end result of both impact types (i.e., direct and indirect) is the same: loss of the sycamore alluvial woodland.

Impact Bio-3: Impacts on Non-sensitive Oak Woodland Communities

The DEIR states that Proposed Project would directly impact up to 1,021 acres of blue oak woodland and coast live oak woodland communities (1,043 acres for Alternative A). The DEIR then concludes:

> "While there could be some variability in the types and quantities of vegetation communities that would be used to compensate for impacted California red-legged frog and California tiger salamander upland and dispersal habitat, the upland habitats preserved under Mitigation Measure BI-8b will also compensate for impacted blue oak woodland and coast live oak woodland alliances."[120]

Mitigation Measure BI-8b requires compensatory mitigation for Project impacts to "upland and aquatic habitat" for the CRLF and CTS. Mitigation Measure BI-8b does not require the habitat compensation lands to contain oak woodlands. As a result, the DEIR's conclusion that Mitigation Measure BI-8b would also compensate for Project impacts to up to 1,043 acres of oak woodlands is not supported.

[118] *See ranking in:* Keeler-Wolf T, Lewis K, Roye C. 1997. The Definition and Location of Central California Sycamore Alluvial Woodland. Prepared by Natural Heritage Division, Bay-Delta and Special Water Projects Division, California Department of Fish and Game. May. 111 pp. + appendices. *See also* Moilanen A, Van Teeffelen AJ, Ben-Haim Y, Ferrier S. 2009. How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. Restoration Ecology 17(4):470-8.
[119] *See* ICF International. 2012. Final Santa Clara Valley Habitat Plan. Mitigation ratio was calculated from values provided in Table 5-13.
[120] DEIR, p. 3.5-73.

The DEIR admits there "could be" some variability in the types and quantities of vegetation communities provided under Mitigation Measure BI-8b. In reality, this mitigation measure would need to provide a variety of vegetation communities to achieve the various benefits promoted in the DEIR. That is, although the DEIR claims Measure BI-8b would offset impacts to oak woodlands and over 20 different wildlife species, there is no single vegetation community (including an oak woodland) that provides habitat for all 20 of those wildlife species.

Mitigation Measure BI-8b incorporates a compensatory mitigation ratio of 2:1 for impacts to CRLF and CTS habitat. This equates to approximately 3,552 acres of compensatory habitat for the CRLF and CTS (if the Proposed Project is the adopted alternative). If Valley Water acquires 3,552 acres of oak woodlands to satisfy the mitigation requirement, there would be no compensatory habitat for species that are restricted to habitats without trees (e.g., northern harrier, burrowing owl, and grasshopper sparrow). Conversely, if Valley Water acquires 3,552 acres of grasslands to satisfy the mitigation requirement, there would be no offsetting mitigation for impacts to oak woodlands and species that require tree cavities for nesting. The only assurance provided by Mitigation Measure BI-8b is that it would provide 3,552 acres of CRLF and CTS habitat, while also providing anywhere between zero and 3,552 acres of compensation for each of the other resources supposedly being mitigated.

Because the significance determinations in the DEIR are contingent on the ability of Mitigation Measure BI-8b to offset impacts, the DEIR must identify the minimum compensation ratio that would be applied to offset impacts to the following resources:

a) 1,043 acres of blue oak and coast live oak woodlands.

b) 1,594 acres of potential nesting and foraging habitat for the western bumble bee and Crotch's bumble bee.

c) 20 acres of dispersal habitat for the FYLF.

d) 1,892 acres of upland/dispersal/nesting habitat for the western pond turtle.

e) 1,851 acres of habitat for the diverse suite of special-status birds addressed in Impact BIO-13 (but first the DEIR needs to identify the specific amount of habitat that would be impacted, by species).

f) 114 acres of nesting habitat for golden eagles and bald eagles.

g) 655 acres of foraging habitat for golden eagles.

h) 1,194 acres of roosting, denning, and foraging habitat for special-status bats and ringtails.

The DEIR assumes the 3,552 acres of CTS and CRLF mitigation would cover impacts to all other species—even though the DEIR admits the full extent of impacts to those species is not yet known (i.e., because no field surveys have been conducted in the access and utility impact areas). This is a major flaw in the DEIR's reasoning. That is, the DEIR determines that 3,552 acres of CTS and CRLF mitigation would be sufficient to mitigate significant impacts to special-status bat habitat (for example) no matter how much additional bat habitat is discovered when surveys are conducted in the access and utility area.

The DEIR states:

> "Downstream flows (including baseflow and pulse flows) associated with the new dam and expanded reservoir would have no impact on blue oak woodland and coast live oak woodland alliance natural communities, because they are largely associated with upland areas and outside the floodplain of Pacheco Creek. Therefore, there would be no impacts on these natural communities associated with operations."[121]

The statement that blue oak woodland and coast live oak woodland communities are largely associated with upland areas and outside the floodplain of Pacheco Creek is inconsistent with the vegetation maps provided in Attachment B of the Biology Appendix. According to Attachment B, the study area encompassed "approximately 17 miles of Pacheco Creek along the 100-year floodplain from the North Fork Dam downstream to San Felipe Lake (Figure 2-1) to account for potential changes in the creek's flow regime as a result of the Project."[122] Therefore, all oak woodland communities delineated on the maps of the downstream area are within the floodplain. Most of the patches of coast live oak woodland in the downstream area are immediately adjacent to the main channel of Pacheco Creek.[123] Changes in soil moisture levels or drainage around an oak can kill the tree.[124] Perennial flows can have negative impacts on oak woodland communities by creating conditions favorable to willows.[125] As a result, the Project's operational flows would have potentially significant, unmitigated impacts on oak woodland communities.

Impact Bio-4: Impacts on Waters of the United States or Waters of the State

DEIR Table 3.5-9 identifies Project impacts to waters of the United States and waters of the State. The impact values in this table appear erroneous. For example:

- According to Table 3.5-9, the Proposed Project would impact no more than 0.6 acre of riparian wetlands. However, the maps provided in the Aquatic Resources Delineation depict substantially more than 0.6 acre of riparian wetlands within areas that would be inundated by the Proposed Project.[126]
- The Project involves removal of the Pacheco Reservoir, which is 187 acres. However, according to Table 3.5-9, the Project would impact only 98.1 acres of "reservoir."

The DEIR states: (a) the Project would have short-term impacts to 107.2 acres of jurisdictional aquatic resources between the proposed dam and the existing dam due to removal of North Fork Dam and draining of Pacheco Reservoir, but (b) these impacts would be restored or reclaimed

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[121] DEIR, p. 3.5-74.
[122] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment B, p. 2-1.
[123] *Ibid*, Exhibit A (map figures).
[124] University of California Integrated Hardwood Range Management Program. 2010. Living Among the Oaks: A Management Guide for Landowners. Division of Agriculture and Natural Resources Publication #21538.
[125] White MD, Greer KA. 2006. The effects of watershed urbanization on the stream hydrology and riparian vegetation of Los Penasquitos Creek, California. Landscape and Urban Planning 74(2):125-38.
[126] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment C, Exhibit A (delineation maps).

following construction.[127] Most of these "short-term restored/reclaimed" impacts would be to the reservoir (88.5 acres) and seasonal wetlands (18.6 acres).

There are three reasons why the DEIR cannot classify these impacts as "short-term restored/reclaimed." First, the Project does not entail restoration of 88.5 acres of "reservoir" between the proposed dam and the existing dam (the new reservoir covers only about 20 acres of area inundated by the current, 187-acre reservoir). Creating a new reservoir further upstream would have long-term impacts on other aquatic (and terrestrial) resource types and would not be restoration (or reclamation). Second, the Proposed Project includes restoring approximately 1.8 miles of North Fork Pacheco Creek between the proposed dam and the existing dam. The restored creek channel "would convey typical daily flows (e.g., baseflow and pulse flow releases) *between the channel banks*."[128] There are no plans to restore 18.6 acres of seasonal wetlands between the proposed dam and the existing dam, nor are seasonal wetlands likely to establish naturally if releases are designed to keep flows "between the channel banks."

Third, the DEIR fails to provide a restoration plan for the area inundated by the current reservoir. Years of inundation have likely removed critical nutrients and mycorrhizal fungi from the soil in this area. Once the reservoir is drained it will be colonized by weedy species, and even if natives are planted, they likely will be less successful than weedy species that are adapted to disturbed environments and poor-quality soils.[129] The DEIR provides no evidence that there is a strategy for addressing this scenario. Indeed, the DEIR provides no assurances that any natural feature (or community) would be restored within the current inundation area, except perhaps the historic creek channel.

The DEIR states:

> "Mitigation Measure BI-4c will provide compensatory mitigation (at a 2:1 mitigation ratio or as determined by the appropriate regulatory agencies as achieving equivalent or greater mitigation) for loss (i.e., short-term and/or long-term impacts) of waters of the United States and waters of the State as a result of the Proposed Project. With these mitigation measures, this impact would be reduced to a less-than-significant level."[130]

The DEIR classifies impacts to aquatic resources as either: (1) long-term, (2) short-term, (3) short-term restored/reclaimed, or (4) temporary.[131] It appears Mitigation Measure BI-4c applies only to the long-term and short-term impacts. Therefore, the DEIR must establish the mitigation requirements for aquatic resources that are subject to temporary or "short-term restored/reclaimed" impacts.

The compensation ratio needed to mitigate the Project's impacts on wetlands and other jurisdictional waters depends on the functions that would be lost at the Project site in relation to

[127] DEIR, p. 3.5-74.
[128] DEIR, p. 2-21. [emphasis added].
[129] *See* Skillen J. 2015. The Revegetation of a Reservoir. Journal of Sierra Nevada History & Biography 6(1). Available at: <https://www.sierracollege.edu/ejournals/jsnhb/v6n1/skillen2.html>.
[130] DEIR, p. 3.5-78.
[131] DEIR, Table 3.5-9.

the functions that would be “gained” at the mitigation site. This establishes the baseline ratio, which is almost never below 1:1. The ratio is then adjusted to account for: (1) the mitigation site location, (2) the mitigation strategy (i.e., preservation, creation, or enhancement), (3) uncertainty in the success of the mitigation program, (4) any resource (or habitat) type conversion that would occur, (5) temporal loss, and (6) the extent of ecological buffers at the mitigation site.[132] There is no evidence that the DEIR analyzed these variables, and thus the 2:1 mitigation ratio proposed in the DEIR appears arbitrary and is likely inadequate.

CDFW’s Notice of Preparation scoping comments informed Valley Water that appropriate and effective compensatory mitigation for loss of riparian habitat would require replacement plantings (i.e., habitat creation or restoration) at a ratio of at least 3:1 per area impacted.[133] There is no evidence that a 2:1 mitigation ratio would reduce Project impacts to less-than-significant levels, or that it would achieve the “no net loss” standard for loss of aquatic resource functions and area.[134] This issue is compounded by the DEIR’s lack of performance standards for Mitigation Measure BI-4c. There is no ability for the public to understand whether compensatory mitigation at a 2:1 (or any other) ratio would mitigate Project impacts to less-than-significant levels until performance standards are established for Mitigation Measure BI-4c.

Impact Bio-5: Impacts on Special-status Plants

Special-status plant surveys were not conducted for the Project’s access and utility area. The DEIR rationalizes this omission by requiring botanical surveys after Project approval.[135] Conducting post-approval surveys is not a reliable mitigation strategy for at least two reasons. First, without reliable information on the species that occur—and as a result, the level and types of Project impacts to those species—Valley Water cannot conclude the proposed mitigation would reduce Project impacts to less-than-significant levels. Such a conclusion presumes all impacts can be mitigated to a less than significant level. That presumption is unrealistic, especially because the forthcoming surveys may yield completely unexpected results that cannot be mitigated by standard conditions.

Second, Mitigation Measure BI-5a does not require Valley Water to disclose the results of the surveys to the public, resource agencies, and scientific community. As a result, the DEIR lacks a mechanism for ensuring all potentially significant impacts to special-status plants are vetted before those plants are impacted by the Project.

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[132] *See* State Water Resources Control Board. 2019. State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State. Staff Report Including the Substitute Environmental Documentation. pp. 83 through 88. *See also* US Army Corps of Engineers, South Pacific Division. 2017. Regulatory Program Standard Operating Procedure for Determination of Mitigation Ratios.
[133] DEIR, Public and Agency Scoping Process Appendix, Attachment B, p. 1-6.
[134] In 1989 the United States government established the goal of achieving a “no overall net loss” of wetland acres and functions due to historic and ongoing wetland losses throughout the U.S. The State of California codified the “no net loss” policy in Executive Order W-59-93.
[135] DEIR, p. 3.5-82.

Impact Bio-6: Adverse Effects and Loss of Habitat for Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

The DEIR states:

> "No suitable vernal pools or seasonal wetlands inundated for sufficient durations to support vernal pool fairy shrimp and vernal pool tadpole shrimp were identified within the upstream and downstream areas. As such, within these areas the Proposed Project would have no impacts on vernal pool fairy shrimp or vernal pool tadpole shrimp."[136]

This determination is not supported by evidence. Both shrimp species occur in a wide variety of ephemeral wetland habitats, including stock ponds.[137] The vernal pool fairy shrimp requires aquatic habitat that continuously holds water for a minimum of 18 days, in all but the driest years.[138] The vernal pool tadpole shrimp requires aquatic habitat that continuously holds water for a minimum of 41 days, in all but the driest years.[139] The Project study area contains aquatic features that hold water for a minimum of 41 days.[140] Some of these features would be impacted by the Project.

The DEIR admits that some of the seasonal wetlands in the access and utility area may provide habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp.[141] Yet according to the DEIR: "[n]one of the seasonal wetlands that may provide habitat for vernal pool fairy shrimp and vernal pool tadpole shrimp in the access and utility area would be directly impacted by long-term or short-term activities."[142] This statement is not validated. Although the DEIR provides maps depicting aquatic resources within the access and utility area, it does not identify the Project's direct impact areas in relation to those aquatic resources. Based on my review of the maps provided in Attachment E of the Biology Appendix, it may be impossible to install the proposed access roads without directly impacting potential habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp.

Impact Bio-7: Adverse Effects and Loss of Habitat for Monarch Butterfly, Western Bumble Bee, and Crotch Bumble Bee

The Proposed Project would impact approximately 1,700 acres of habitat for special-status bumble bees and approximately 83 percent of the host plants for the monarch butterfly. Additional impacts would occur to habitat in the access and utilities area, or if Alternative A is selected. The DEIR concludes that significant impacts to bumble bee habitat would be reduced

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[136] DEIR, p. 3.5-83.
[137] U.S. Fish and Wildlife Service. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. U.S. Fish and Wildlife Service, Portland, Oregon. pp. II-191 through -210.
[138] U.S. Fish and Wildlife Service. 2005. Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Evaluation of Economic Exclusions from August 2003 Final Designation; Final Rule. Portland, Oregon.
[139] *Ibid.*
[140] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit D (CTS Site Assessment). CTS breeding habitats hold water for a minimum of 12 weeks (84 days).
[141] DEIR, p. 3.5-83.
[142] *Ibid.*

to less than significant levels through implementation of Mitigation Measure BI-8b. The DEIR provides the following rationale:

> "All the grassland vegetation communities that provide foraging habitat for western bumble bee and crotch bumble bee that would be affected overlap with California red-legged frog and California tiger salamander upland habitat that will be mitigated at a 2:1 ratio under Mitigation Measure BI-8b. While there could be some variability in the types and quantities of vegetation communities that would be used to compensate for impacted California red-legged frog and California tiger salamander upland and dispersal habitat, the upland habitats preserved under Mitigation Measure BI-8b will also compensate for impacted grassland vegetation communities that provide foraging habitat for western bumble bee and crotch bumble bee."[143]

Bumble bees depend on habitats containing sufficient floral resources throughout the colony's flight period (approximately February to October or November).[144] Mitigation Measure BI-8b provides no assurances that the compensatory habitat would contain floral resources sufficient to support bumble bees, or that the compensatory habitat would be managed to reduce threats posed by exposure to harmful pesticides, diseases, and competitors (e.g., non-native honey bees).[145] As a result, Mitigation Measure BI-8b does not reduce the Project's impacts on bumble bee habitat to less than significant levels.

Impact Bio-8: Adverse Effects and Loss of Habitat for California Tiger Salamander and California Red-legged Frog

The DEIR states:

> "Construction impacts associated with the Proposed Project total approximately two acres of potential aquatic habitat for California tiger salamander; two acres of potential aquatic habitat for California red-legged frog; and 1,776 acres of upland/dispersal habitat for these species that would be subject to long-term, short-term, and temporary impacts."[146]

The DEIR fails to identify the particular aquatic habitats (e.g., ponds) and upland/dispersal habitats that would be impacted by the Proposed Project or Project Alternatives. This precludes the ability to validate the DEIR's impact assessment. It also precludes the ability to assess landscape-level effects. The CTS and CRLF exhibit a metapopulation structure. A metapopulation is a population that consists of several discrete subpopulations linked together by immigration and emigration. These subpopulations are subject to periodic extinctions. As a result, persistence of the overall metapopulation is dependent on the organism's ability to recolonize areas that have experienced local extinctions. The DEIR's failure to provide landscape-level analysis (e.g., a map of the Project's footprint in relation to breeding habitat and

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143 DEIR, p. 3.5-85.
144 California Department of Fish and Wildlife. 2019. Evaluation of the Petition from the Xerces Society, Defenders of Wildlife, and the Center for Food Safety to List Four Species of Bumble Bees as Endangered Under the California Endangered Species Act. Report to the Fish and Game Commission.
145 *Ibid.*
146 DEIR, p. 3.5-85.

dispersal habitat) makes it impossible to understand how severely the Project would impact the metapopulation dynamics necessary for persistence of CTS and CRLF in the Project study area.

The DEIR discusses several potentially significant impacts and lists several project-specific avoidance and minimization measures ("PAMMs") that would: (a) "minimize the likelihood for indirect impacts on potential aquatic habitat" and, (b) "minimize the potential for direct and indirect impacts on these species." It then states: "[a]lthough these PAMMs would reduce the impacts on these species to varying degrees over time, ***this impact would be significant***."[147] The DEIR's analysis is confusing because the DEIR does not identify the specific impact that would remain significant despite implementation of the PAMMs.

> *The DEIR must identify the specific impact or impacts that would be significant despite implementation of the PAMMs, discuss the mitigation measures that would be implemented to reduce the impact(s) to less than significant levels, or conclude that the impact remains significant and unavoidable.*

<u>Construction Noise, Vibration, and Lighting</u>

The DEIR provides the following analysis of impacts caused by noise, vibration, and lighting:

> "These long-term, short-term, and temporary impacts associated with construction noise, vibration, and lighting would impact these species by deterring foraging, dispersal, and migration within and adjacent to the Project study area, while attracting predators that may target these species that may be attracted to temporary and permanent light sources… Implementation of PAMM BI-8 would minimize the potential for direct and indirect impacts associated with construction noise, vibration, and lighting on these species through the installation of wildlife exclusion fence to preclude these species from entering the Project site."

PAMM BI-8 (exclusion fencing) does not "preclude these species from entering the Project site" because it is limited to "*select areas* associated with construction traffic (e.g., roadways, proposed staging areas, etc.)." This suggests some (perhaps most) of the construction areas would not have exclusion fencing. The DEIR fails to identify the specific areas that would have exclusion fencing, and where the fencing would be installed in relation to construction areas that would generate noise, vibration, or lighting.

The location of proposed exclusion fencing is important for two reasons. First, migratory amphibians are highly susceptible to road mortality. Roads that intersect upland and breeding habitats can substantially reduce population abundance, survivorship, breeding, recruitment, and probability of long-term persistence.[148] As a result, the DEIR must disclose whether exclusion fencing would be installed along all of the Project's access roads. Second, the adverse effects of noise, vibration, or lighting can extend well beyond the source. As a result, the DEIR must

[147] DEIR, p. 3.5-86. [emphasis added].
[148] Brehme CS, Tracey JA, Ewing BAI, and five others. 2021. Responses of migratory amphibians to barrier fencing inform the spacing of road underpasses: a case study with California tiger salamanders (*Ambystoma californiense*) in Stanford, CA, USA. Global Ecology and Conservation 31: e01857.

establish how far the exclusion fencing would be installed from roads, staging areas, and other construction areas that would generate noise, vibration, or lighting.

Lighting-

The DEIR indicates the effects of lighting would extend approximately 500 feet from the proposed construction activities.[149] Even if the exclusion fencing is installed 500 feet beyond the boundary of the proposed construction activities, the fencing would not mitigate potentially significant impacts associated with permanent lighting at the proposed substation, pump station, and switch yard.

According to the DEIR, PAMM AES-1 is designed to "reduce potential for light trespass or skyglow visible from outside of the Project study area."[150] The DEIR states: "[e]mergency and service lighting at permanent facilities would be oriented downward, hooded, and motion-activated where practicable so as to concentrate light on task areas and reduce lighting spillover into locations outside of the Project study area."[151] Thus, PAMM AES-1 would reduce impacts from "astronomical light pollution" (whereby stars and other celestial bodies are washed out by light that is either directed or reflected upward), but it would not reduce impacts from "ecological light pollution" (artificial light that alters the natural patterns of light and dark in ecosystems).[152]

Ecological light pollution has demonstrable effects on the behavioral and population ecology of organisms, with serious implications on community ecology.[153] For example, artificial night lighting of similar intensity to moonlight reduces activity and movement of many nocturnal animals, particularly those that rely on concealment to reduce predation risk during nocturnal foraging.[154] Although nocturnal animals can respond to bright moonlight by shifting foraging and ranging activities to darker conditions, this option is not available to animals experiencing artificially increased illumination throughout the night. Under these circumstances, unless they abandon the lighted area, nocturnal animals have only two choices. One is to accept the risk of predation by foraging under bright light. The other option is to continue to minimize predation risk even at the cost of loss of body mass.

Noise-

Construction activities associated with the Project would generate noise levels up 87 dBA (at 50 feet) when multiple pieces of heavy-duty construction equipment are operating in the same

[149] DEIR, p. 3.2-16.
[150] DEIR, p. 3.2-16.
[151] DEIR, p. 3.2-6.
[152] Longcore T, Rich C. 2004. Ecological Light Pollution. Frontiers in Ecology and the Environment 2:191-198.
[153] *Ibid*.
[154] Beier P. 2006. Effects of Artificial Night Lighting on Terrestrial Mammals. Chapter 2 in: Ecological Consequences of Artificial Night Lighting, Rich C and Longcore T, editors. Island Press, Washington, DC.

location.[155] Blasting activities would generate noise levels of 94 dBA (at 50 feet). Noise at these levels far exceeds the level that is deleterious to wildlife.[156]

Research on the effects of traffic noise on breeding birds showed that ambient noise up to a given level resulted in no reduction in the density of bird populations.[157] However, once an ambient noise threshold level was exceeded, densities decreased exponentially with increased noise.[158] Threshold levels were found to range from 36 to 58 decibels, depending on the species.[159] The results of this research were consistent with Reijnen et al. (1997), who concluded sound levels above 50 dBA could be considered potentially deleterious to breeding birds.[160]

Noise generated by the Project's construction-related traffic would attenuate to 50 dBA at 232 feet from the access road.[161] Therefore, for PAMM BI-8 to effectively minimize the significant impacts of traffic noise, the exclusion fence would need to be installed 232 feet from the road shoulders. Because construction equipment would generate even louder noise levels, effectively minimizing the significant impacts of noise generated by the Project's construction activities would require installation of exclusion fencing approximately 3,500 feet from the edge of construction areas.[162] Even if exclusion fences are installed at these distances, they would not mitigate significant impacts of Project noise on volant (flying) species (e.g., birds and bats) that attempt to use habitat inside the exclusion fence.

Construction noise, vibration, and lighting would impact special-status species by "deterring foraging, dispersal, and migration within and adjacent to the Project study area."[163] The DEIR claims exclusion fencing included in PAMM BI-8 would mitigate this impact to less than significant.[164] However, implementation of PAMM BI-8 in itself would deter foraging, dispersal, and migration. For example, the exclusion fence prescribed under PAMM BI-8 could prevent CTS and CRLF from accessing breeding sites, or burrows that these species depend

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155 DEIR, p. 3.14-16.
156 Kaseloo PA, Tyson KO. 2004. Synthesis of Noise Effects on Wildlife Populations. US Department of Transportation, Federal Highway Administration. Publication No. FHWA-HEP-06-016. *See also* Reijnen R, Foppen R, Veenbaas G. 1997. Disturbance by traffic of breeding birds: evaluation of the effect and planning and managing road corridors. Biodiversity and Conservation 6:567-581. *See also* Ortega CP. 2012. Effects of Noise Pollution on Birds: A Brief Review of Our Knowledge. Ornithological Monographs 74:6-22. *See also* Bondello MC, Huntley AC, Cohen HB, Brattstrom BH. 1979. The effects of dune buggy sounds on the telencephalic auditory evoked response in the Mojave fringe-toed lizard, *Uma scoparia*. Pages 58-89 in Bondello MC, Brattstrom BH, eds. The experimental effects of off-road vehicle sounds on three species of desert vertebrates. U.S. Dept. Inter., Bur. Land Manage., Washington, DC. *See also* Shilling F. 2020 Jun 18. Noise & Vibration Effects of High-Speed Rail through the Coast Range and Coyote Valley. Comment letter submitted to the High-Speed Rail Authority.
157 Kaseloo PA. 2006. Synthesis of noise effects on wildlife populations. IN: Proceedings of the 2005 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermott KP. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp. 33-35.
158 *Ibid.*
159 *Ibid.*
160 Reijnen R, Foppen R, Veenbaas G. 1997. Disturbance by traffic of breeding birds: evaluation of the effect and planning and managing road corridors. Biodiversity and Conservation 6:567-581.
161 DEIR, p. 3.14-18.
162 Rate of noise decay was estimated using an online calculator (http://hyperphysics.phy-astr.gsu.edu/hbase/Acoustic/isprob2.html; Georgia State University, Department of Physics and Astronomy).
163 DEIR, pp. 3.5-87, -90, -93, -96, -103, -106, -108, and -112.
164 For example, *see* DEIR, p. 3.5-87.

upon for food, shelter, and protection from the elements and predation. As a result, impacts generated by construction noise, vibration, and lighting remain significant.

Project Operations Impacts

The DEIR concludes that the Project's modifications to the flow regime would have a less-than-significant effect on the CTS and CRLF, their habitats, or designated critical habitat for CRLF.[165] The DEIR provides three arguments in an attempt to support this conclusion. The first argument is that: "[b]aseflows would be released continuously from the expanded reservoir in all months allowing for existing California tiger salamander and California red-legged frog populations and aquatic habitat in the downstream area adjacent to Pacheco Creek to remain unchanged."[166] This argument is illogical. The Project involves substantial changes to the timing and volume of flow releases into Pacheco Creek.[167] Indeed, one of the primary objectives of the Project is to enhance steelhead habitat by altering the existing flow regime. There is no scientific basis for the proposition that the Project would substantially improve steelhead habitat in Pacheco Creek by changing flow regimes, but in-stream habitat for the CTS and CRLF would "remain unchanged."[168]

The DEIR's second argument is:

> "Under the Proposed Project the new flow regime (perennial, increased flow) would prevent American bullfrogs from breeding within the creek as the volume and velocity of flow would be too high for egg mass survival. Drybacks during dry and critical water years would disrupt invasive species' life cycles that require more permanent aquatic habitat (e.g., red swamp crayfish)."[169]

This argument is not supported by evidence and is inconsistent with scientific literature.[170] Bullfrog oviposition occurs much later than native frogs, and would be after the Project's proposed pulse flow period (Jan-May for the Proposed Project and Alternative C; Mar-Apr for Alternatives A, B, and D).[171] Therefore, the Project's pulse flows would have negative effects on egg masses of native frogs (e.g., CRLF and FYLF), but not on bullfrogs. In addition, bullfrog tadpoles require two growing seasons to metamorphose and therefore must survive winter floods.[172] Existing conditions limit bullfrog populations in Pacheco Creek because stream

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[165] DEIR, p. 3.5-88.
[166] DEIR, p. 3.5-88.
[167] For example, *see* DEIR, Table 3.12-12.
[168] Pacheco Creek is unlikely to support CTS. However, Pacheco Creek provides potential habitat for the CRLF. DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit C, p. 3-1: "[t]he CRLF inhabits…perennial creeks [and] intermittent streams…Preferred breeding habitat consists of still or slow-moving water or deep-water pools…"
[169] DEIR, p. 3.5-88.
[170] Kupferberg SJ, Moidu H, Adams AJ, and five others. 2021. Seasonal drought and its effects on frog population dynamics and amphibian disease in intermittent streams. Ecohydrology, e2395. *See also* Kupferberg SJ, Palen WJ, Lind AJ, and four others. 2012. Effects of Flow Regimes Altered by Dams on Survival, Population Declines, and Range-Wide Losses of California River-Breeding Frogs. Conservation Biology 26(3):513-524.
[171] *Ibid.*
[172] *Ibid.*

reaches tend to go dry in many years,[173] and bullfrog tadpoles that are able to persist in pools throughout the summer are killed by winter flood flows.[174]

The Proposed Project and all Project Alternatives would create perennial flow conditions throughout Pacheco Creek. In addition, the Proposed Project and all Project Alternatives would substantially reduce peak flood flows,[175] thus enabling survival of overwintering bullfrog tadpoles. These alterations to the existing flow regime would promote growth and expansion of the bullfrog population in Pacheco Creek.

As summarized by Kupferberg et al. (2021):

> "Intermittent streams are not well suited to the timing of the bullfrog life cycle. In California, bullfrogs lay eggs in early summer, and their tadpoles do not reach metamorphosis at the end of the first growing season; they must survive winter floods. In Coyote Creek, we observed that bullfrog tadpoles can persist through the dry season within large, deep scour pools that remain wet, whereas the rest of the stream channel dries. Overwintering tadpoles avoid flow-induced mortality during low precipitation winters, with relatively low peak flows (e.g., 2018 in Figure 2b). In contrast, the foothill yellow-legged frog life cycle and its breeding migrations (from resident tributary streams to mainstem channels) occur in close synchrony with the flood–drought flow regime."[176]

The DEIR's statement that "drybacks" disrupt invasive species' life cycles is correct. Under existing conditions, Pacheco Creek is subject to frequent drybacks because the existing reservoir does not have the capacity to maintain perennial flows in Pacheco Creek year-round. No drybacks would occur under Alternatives A, B, and D.[177] Although the Proposed Project and Alternative C involve drybacks, those drybacks would only occur approximately once every 8 to 12 years,[178] which is less frequent than existing conditions. Thus, conditions for invasive species would improve no matter which Project alternative is ultimately implemented.

The DEIR's final argument is:

> "With American bullfrogs and other invasive wildlife species already present in high abundances in/near areas adjacent to Pacheco Creek, the more permanent creek flows would not result in a significant increase in non-native wildlife species in comparison to the existing conditions given the creek would continue to provide the same amount and type of habitat as under the current condition (e.g., Pacheco Creek and the surrounding vicinity will continue to offer dispersal and

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[173] DEIR, p. 2-16.
[174] DEIR, p. 3.12-38 (stating that Pacheco Reservoir is not operated for flood control and provides no flood attenuation when the reservoir is full).
[175] *Ibid.*
[176] DEIR, p. 3.5-88.
[177] DEIR Appendix, Alternatives Development and Project Description, Table 3-44.
[178] Valley Water. 2021. Draft Meeting Summary: Operations Workshop #6, January 14, 2021. Available from: Valley Water, San Jose, CA.

> non-breeding habitat for American bullfrog). Therefore, there would be less-than-significant impacts on California red-legged frog associated with operations."[179]

This final argument is complete nonsense. Unlike their native counterparts, most non-native species either: (a) cannot persist, or (b) persist only at low densities in intermittent streams. The DEIR admits the Project would convert an intermittent stream into a perennial stream,[180,181] and that the Project would decrease flows in winter months compared to existing and future conditions.[182] These alterations to the hydrology of Pacheco Creek would substantially improve habitat conditions for non-native (invasive) species. Furthermore, it is not credible to claim that the Project substantially improves habitat conditions for steelhead survival throughout Pacheco Creek (as claimed in the DEIR),[183] while simultaneously providing "the same amount and type of habitat as under the current condition."

The DEIR's claim that the Project would not result in a significant increase in non-native wildlife species because American bullfrogs and other invasive wildlife species are already present in high abundances is not supported by survey data or other scientific information. Furthermore, the premise that Pacheco Creek currently lacks, and would continue to lack, breeding habitat for bullfrogs is incorrect. Bullfrog adults, subadults, *and larvae* have been detected in Pacheco Creek (including the main channel) at the Pacheco Creek Preserve.[184]

The premise that habitat conditions for CRLF and other native organisms would not change because invasive species already occur in high abundances ignores basic ecology of the American bullfrog: it cannot survive without permanent sources of water. As reported in the DEIR, drybacks can effectively control populations of non-native species. Therefore, it is common sense that a stream with infrequent (or no) drybacks is capable of supporting much larger populations of bullfrogs (and other invasive species) than one that experiences frequent drybacks. It also ignores the facts that the Project could: (a) drive bullfrog abundance even higher, and (b) promote the spread of bullfrogs into areas that are currently inhabitable (to bullfrogs).

In some locations, native frogs can co-exist with bullfrogs when there are environmental factors that favor the native species.[185] For example, Doubledee et al. (2003) found that winter floods,

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179 DEIR, p. 3.5-88.
180 DEIR, p. 3.6-3: "Pacheco Creek is a low gradient intermittent stream that typically has surface flow during the winter and spring but goes dry during the summer and remains dry through the fall most years."
181 DEIR, p. 3.12-29: "The Proposed Project would increase surface flows to the point where perennial streamflow would occur in all water year types through creek mile 8. The net effect of the Proposed Project would be increased flows in Pacheco Creek in spring, summer, and fall months, and decreased flows in winter months under existing and future conditions.
182 *Ibid.*
183 For example, *see* DEIR, pp. 3.6-46 and -77.
184 Santa Clara Valley Habitat Agency. 2020. Pacheco Creek Restoration Project Final Feasibility Study. Prepared by H.T. Harvey & Associates. p. 52.
185 Doubledee RA, Muller EB, Nisbet RM. 2003. Bullfrogs, disturbance regimes, and the persistence of California red-legged frogs. The Journal of Wildlife Management 67(2):424-438. *See also* Cook DG, Currylow AF. 2014. Seasonal spatial patterns of two sympatric frogs: California Red-legged Frog and American Bullfrog. Western Wildlife 1:1-7. *See also* Kupferberg SJ, Moidu H, Adams AJ, and five others. 2021. Seasonal drought and its effects on frog population dynamics and amphibian disease in intermittent streams. Ecohydrology, e2395.

which strongly increase mortality of bullfrogs but not red-legged frogs, facilitate coexistence if the floods occur more than once every 5 years. The Project proposes to eliminate the environmental variables (i.e., intermittent flows and winter floods) that facilitate co-existence of native and non-native species in Pacheco Creek, thus leading to an aquatic ecosystem that is largely devoid of native species that evolved adaptations to the local environment (i.e., the specialist species).

Finally, if the DEIR is correct in assuming that habitat conditions for the CRLF would not change because invasive species already occur at high abundances, then those same invasive species would preclude the ability to make substantial improvements to the reproductive success of SCCC steelhead in Pacheco Creek. This issue is discussed in the comment letter submitted by Aquatic Ecologist Thomas Cannon.

Impact Bio-9: Adverse Effects and Loss of Habitat for Foothill Yellow-legged Frog

According to the DEIR, the Proposed Project would impact 82 acres of aquatic habitat and 20 acres of dispersal habitat for the FYLF.[186] The DEIR fails to identify: (a) how these impact values were calculated, and (b) the specific habitat areas that would be impacted. Although FYLF make short distance excursions into terrestrial habitats, they do not disperse across terrestrial habitats. Therefore, it is unclear how the Project could impact 20 acres of dispersal habitat that is not also aquatic habitat. The only information the DEIR provides in this regard is that dispersal habitat for the FYLF is "present in Pacheco Creek downstream from North Fork Dam in the form of cobble and sand bank, rock outcrops, and deeper pools."[187] However, according to the DEIR, there would be no impacts to FYLF habitat in the downstream area. As with many of the other resource discussions in the DEIR, it is entirely unclear whether the error lies in the DEIR's description of the environmental setting, its accounting of Project impacts, or both.

Many populations of FYLF are already small and fragmented, so any adverse effects that the Project has on FYLF dispersal habitat could cause permanent extirpation of the species.[188] The DEIR does not disclose or analyze the ecological consequences of the Project's impacts on FYLF dispersal habitat, nor does it provide the public with the information needed for independent analysis (i.e., because the DEIR fails to identify where impacts to dispersal habitat would occur).

In addition, none of the PAMMs and mitigation measures proposed in the DEIR are designed to offset the Project's long-term impacts on FYLF dispersal habitat. Contrary to the DEIR's claim, provision of compensatory mitigation for impacts to dispersal habitat for the CTS and CRLF would not mitigate the impact to FYLF dispersal habitat because FYLF disperse along watercourses, whereas CTS and CRLF often disperse across terrestrial landscapes.[189] Mitigation

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[186] DEIR, Table 3.5-12.
[187] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibit E, p. 3-7.
[188] Hayes MP, Wheeler CA, Lind AJ, Green GA, Macfarlane DC, tech. coords. 2016. Foothill yellow-legged frog conservation assessment in California. Gen. Tech. Rep. PSW-GTR-248. Albany, CA: U.S. Forest Service, Pacific Southwest Research Station. pp. 20 and 164-165.
[189] Thomson RC, Wright AN, Shaffer HB. 2016. California Amphibian and Reptile Species of Special Concern. California Department of Fish and Wildlife. University of California Press, Oakland, California. *See also* U.S. Fish

Measure BI-4c would not mitigate the impact because it requires replacement of jurisdictional aquatic resources—not replacement of FYLF habitat. Furthermore, even if the compensatory mitigation provided under Mitigation Measure BI-4c could support FYLF, it would not reduce the potential for the Project to cause extirpation of the local FYLF population.

The DEIR claims:

> "Implementation of PAMM BI-8 would minimize the potential for direct and indirect impacts associated with construction noise, vibration, and lighting on this species through the installation of wildlife exclusion fence to preclude this species from entering the construction activity areas. With the implementation of this PAMM, direct and indirect impacts associated with construction noise, vibration, and lighting would be less than significant."

As discussed previously, PAMM BI8 would not minimize potentially significant impacts associated with construction noise, vibration, and lighting. Because the FYLF is a stream-dwelling frog, any construction noise, vibration, and lighting near potentially occupied streams could impact the species. Installing an exclusion fence adjacent to the stream would do nothing to prevent this impact.

The DEIR claims that impacts on the FYLF would be reduced to a less-than-significant level through implementation of Mitigation Measures BI-4c and BI-8b. This determination is not supported by evidence because mitigating impacts to aquatic resources (BI-4c) and upland/dispersal habitat for the CTS and CRLF (BI-8b) is not the same as mitigating impacts to habitat for the FYLF. Mitigation Measures BI-4c and BI-8b provide no assurances that the compensatory mitigation would provide FYLF habitat (as determined by species occupancy), or even that it would be within the current range of the species. Furthermore, the 2:1 mitigation ratio proposed in Measures BI-4c and BI-8b is far too low given: (a) the imperiled status of the FYLF, and (b) the tremendous amount of uncertainty in the effectiveness of either mitigation measure in offsetting impacts to the FYLF.[190]

<u>Impacts from Project Operations</u>

The DEIR's analysis of operational impacts to the FYLF has at least two major flaws. First, the DEIR acknowledges that alterations of flow regimes through dam releases and pulsed flows after oviposition can result in scouring of egg masses, displacement of tadpoles, or sediment inundation of egg masses and tadpoles.[191] FYLF oviposition occurs in spring after flood waters recede.[192] In the Project region, oviposition season commences in late March to early April

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and Wildlife Service. 2021 Dec 28. Endangered and Threatened Wildlife and Plants; Foothill Yellow-Legged Frog; Threatened Status with Section 4(d) Rule for Two Distinct Population Segments and Endangered Status for Two Distinct Population Segments. Proposed Rule. 86 Fed. Reg. 73914.

[190] Moilanen A, Van Teeffelen AJ, Ben-Haim Y, Ferrier S. 2009. How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. Restoration Ecology 17(4):470-8.

[191] DEIR, pp. 3.5-91 and -92.

[192] Thomson RC, Wright AN, Shaffer HB. 2016. California Amphibian and Reptile Species of Special Concern. California Department of Fish and Wildlife. University of California Press, Oakland, California.

depending on the rainfall year and temperature.[193] The Project's pulsed flow releases, which would occur through the month of May, would undoubtedly scour FYLF egg masses (personal communication with SJ Kupferberg on 18 Jan 2022). In addition, young tadpoles would be swept into the current and killed by pulse flows in May. The DEIR fails to address these significant impacts.

Second, the DEIR's conclusion pertaining to the Project's effects on American bullfrogs and other non-native species contradicts all available scientific evidence. For example, the DEIR states: "[u]nder the Proposed Project the more permanent flows would prevent American bullfrogs from breeding within the creek as the flow rate would be too high for egg mass survival."[194] As discussed previously, the timing of bullfrog oviposition is much later than FYLF, and would be after the proposed pulse flow period (Jan-May). Therefore, the pulse flows would scour FYLF egg masses, but not bullfrog egg masses. In addition, the Project's "more permanent flows" and reduction in winter flood waters would increase survivorship of bullfrogs, especially bullfrog tadpoles (which require two growing seasons to metamorphose).[195] These flows would also increase the abundance and distribution of non-native fish.[196] FYLF tadpoles are vulnerable to fish predation. Bullfrog tadpoles, in contrast, are noxious to many species of fish who eat them only as a last resort.[197] For these reasons, there is no scientific basis for the DEIR's determination that "there would be no impact on foothill yellow-legged frog associated with operations."[198] The DEIR must provide legitimate scientific analysis of the Project's potentially significant impacts on the FYLF, and it must incorporate feasible mitigation to address those impacts.

<u>Impacts to Henry Coe State Park and Romero Ranch</u>

The negative effects of large dams (and associated reservoirs) on FYLF have been well documented.[199] Some of those negative effects can be mitigated through flow management. However, no matter how carefully the flow releases are designed to avoid harming FYLF

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193 Kupferberg SJ, Moidu H, Adams AJ, and five others. 2021. Seasonal drought and its effects on frog population dynamics and amphibian disease in intermittent streams. Ecohydrology, e2395. *See also* Bobzien S, DiDonato JE. 2007. The status of the California Tiger Salamander (*Ambystoma californiense*), California Red-legged Frog (*Rana draytonii*), Foothill Yellow-legged Frog (*Rana boylii)* and other aquatic herpetofauna in the East Bay Regional Park District, California. *See also* Gonsolin TE. 2010. Ecology of foothill yellow-legged frogs in upper Coyote Creek, Santa Clara County, CA. Thesis. San Jose State University, San Jose, California, USA.

194 DEIR, p. 3.5-92.

195 Kupferberg SJ, Moidu H, Adams AJ, and five others. 2021. Seasonal drought and its effects on frog population dynamics and amphibian disease in intermittent streams. Ecohydrology, e2395. *See also* Doubledee RA, Muller EB, Nisbet RM. 2003. Bullfrogs, disturbance regimes, and the persistence of California red-legged frogs. The Journal of Wildlife Management 67(2):424-438.

196 Moyle PB, Light T. 1996. Biological invasions of fresh water: empirical rules and assembly theory. Biological Conservation 78:149-61.

197 California Herps. 2022. A Guide to the Amphibians and Reptiles of California: American Bullfrog - *Lithobates catesbeianus*. Available at: <http://www.californiaherps.com/frogs/pages/l.catesbeianus.html>. (Accessed 2 February 2022). *See also* Kupferberg SJ, Moidu H, Adams AJ, and five others. 2021. Seasonal drought and its effects on frog population dynamics and amphibian disease in intermittent streams. Ecohydrology, e2395.

198 DEIR, p. 3.5-92.

199 For example, *see* Palen WJ, Lind AJ, and four others. 2012. Effects of Flow Regimes Altered by Dams on Survival, Population Declines, and Range-Wide Losses of California River-Breeding Frogs. Conservation Biology 26(3):513-524.

downstream, the new reservoir would push the negative effects approximately eight miles further upstream into two conservation reserves (i.e., Henry Coe State Park and Romero Ranch). For example, creating a new reservoir upstream of the current location would assist bullfrogs in penetrating further upstream into the watershed than they can now from the present location of Pacheco Reservoir.

The USFWS recently issued a proposed ruling that would give the FYLF protection under the federal Endangered Species Act.[200] The main strategy for recovery of FYLF is re-introductions (personal communication with SJ Kupferberg on 18 Jan 2022). By extending the negative effects of the reservoir further upstream into Henry Coe State Park and Romero Ranch, the Project would remove otherwise protected land from the list of possible places where recovery actions could be taken.

Impact Bio-10: Adverse Effects and Loss of Habitat for Western Pond Turtle

The DEIR provides the following analysis of the Project's operational impacts on the western pond turtle:

> "Downstream flows (including baseflow and pulse flows) associated with the new dam and expanded reservoir would have a less-than-significant impact on western pond turtles and their aquatic habitat. Aquatic habitat would gradually change in some areas along the banks of Pacheco Creek to more of a mixed riparian community (as described in Impact Bio-2). However, Pacheco Creek would still provide aquatic habitat for western pond turtles in these areas, and basking /upland habitat for the species would persist in areas away from the primary channel of the creek within the floodplain and adjacent uplands. In addition, pulse flows would not exceed the capacity of the existing primary channel and would not impact nesting or dispersal habitat for western pond turtles adjacent to the primary channel. Therefore, operation impacts on western pond turtles and their habitat would be less than significant. Impacts on dispersal and migratory corridors are addressed in Impact Bio-18."[201]

The western pond turtle is an ectotherm and a pool specialist. Pond turtles that occur in flowing waterways are associated with deep, low-velocity waters. Pools provide navigable, surface-warmed waters and an accumulation of debris that potentially functions as cover, a basking substrate, and material for nutrient cycling and aquatic insect production. Juvenile pond turtles have higher metabolic rates and poorer swimming abilities than adults, and thus are especially dependent on low-velocity, warm waters. Dam-induced changes, including filling of pools with sediment, increased water velocities along the shoreline, and lowered water temperatures, can be deleterious to turtles.[202] The DEIR fails to contemplate how the Project's alterations to water temperatures and velocities would affect pond turtle habitat in Pacheco Creek.

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[200] U.S. Fish and Wildlife Service. 2021 Dec 28. Endangered and Threatened Wildlife and Plants; Foothill Yellow-Legged Frog; Threatened Status with Section 4(d) Rule for Two Distinct Population Segments and Endangered Status for Two Distinct Population Segments. Proposed Rule. 86 Fed. Reg. 73914.
[201] DEIR, p. 3.5-95.
[202] Reese DA. 1996. Comparative demography and habitat use of western pond turtles in northern California: the effects of damming and related alterations. University of California, Berkeley.

The DEIR concludes: "[c]ompensatory mitigation for this species [western pond turtle] would be mitigated under Mitigation Measure BI-4c for impacts on aquatic resources and Mitigation Measure BI-8b for upland/dispersal habitat (due to the overlapping upland/dispersal habitat covered under mitigation for California tiger salamander and California red-legged frog)." This conclusion is not justified for the following reasons:

a) Pond turtles do not travel as far into uplands as CTS and CRLF. Most pond turtle movements into terrestrial habitats are within approximately 300 feet of aquatic habitat.[203] In contrast, CTS and CRLF may travel across upland habitat for a mile or more.[204] Therefore, only a subset of the compensatory habitat required under Mitigation Measure BI-8b would mitigate impacts to pond turtle habitat.

b) Measure BI-4c does not require in-kind mitigation, nor does it require compensation sites to provide habitat (defined by occupancy) for pond turtles.

c) There is not 100% overlap in aquatic habitat types used by CTS and CRLF, and those used by pond turtles. For example, CTS can occur in small, shallow seasonal wetlands, whereas pond turtles require aquatic habitats with deep pools. Consequently, compensatory mitigation that provides aquatic habitat for CTS and CRLF does not necessarily provide habitat for pond turtles.

Impact Bio-11: Adverse Effects and Loss of Habitat for Silvery Legless Lizard, San Joaquin Coachwhip, and Coast Horned Lizard

The DEIR indicates the Project would impact up to 1,853 acres of potential habitat for the silvery legless lizard, coast horned lizard, and San Joaquin coachwhip.[205] It then states:

> "Given the low potential for silvery legless lizard and coast horned lizard to occur due to the poor quality of habitat present; the abundance of similar habitat in the Project study area and immediate vicinity; and with the implementation of PAMM BI-2, PAMM BI-3, and PAMM BI-8 direct and indirect impacts on silvery legless lizard, coast horned lizard, and San Joaquin coachwhip would be less than significant."[206]

The rationale for concluding that impacts on the silvery legless lizard and coast horned lizard would be less than significant is inconsistent with the significance criterion in the DEIR. Specifically, the DEIR indicates that the Project would have a significant impact if it caused: "[a]dverse effects and **loss of habitat** for silvery legless lizard, San Joaquin coachwhip, and coast horned lizard."[207] The DEIR admits: (a) the Project would impact up to 1,853 acres of potential habitat for the silvery legless lizard, coast horned lizard, and San Joaquin coachwhip;[208] and (b) that the Project could have other adverse effects on these three species. Thus, the

[203] Rathbun GB, Scott NJ Jr, Murphey TJ. 2002. Terrestrial Habitat Use by Pacific Pond Turtles in a Mediterranean Climate. Southwestern Naturalist 47(2):225-235.
[204] *See* DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment A, Exhibits C and D.
[205] DEIR, Table 3.5-14.
[206] DEIR, p. 3.5-97.
[207] DEIR, p. 3.5-53. [emphasis added].
[208] DEIR, Table 3.5-14.

Project's impacts on the silvery legless lizard and coast horned lizard would be significant under the threshold in the DEIR.

The statement that there is an "abundance of similar habitat in the Project study area and immediate vicinity" is not supported by evidence and would not apply to the San Joaquin coachwhip even at larger spatial scales. According to the DEIR, the Project study area contains approximately 4,196 acres of habitat for the San Joaquin coachwhip.[209] The Project would eliminate 44% of that habitat, and fragment the habitat that remains. Much of the "similar habitat" that purportedly remains in the vicinity of the Project study area is being eliminated by solar energy development (which was not considered in the DEIR's cumulative impacts assessment).[210]

The San Joaquin coachwhip is a California endemic species that is already restricted to a small range within a heavily disturbed part of the state.[211] Loss and fragmentation of the coachwhip's remaining habitat are major threats to the species.[212] Moreover, because the Project is located in the northwest portion of San Joaquin coachwhip's range, the Project's substantial impacts to habitat could cause further contraction of the species' range.[213]

For these reasons, and because the DEIR does not include compensatory mitigation for the Project's impacts to 1,853 acres of relatively high-quality habitat, impacts to the San Joaquin coachwhip would remain significant.

Impact Bio-13: Adverse Effects and Loss of Habitat for Special-status Avian Species and Nesting Migratory Birds and Raptors (excluding bald and golden eagles)

Impact BIO-13 addresses impacts to 13 special-status bird species. Although DEIR Table 3.5-15 summarizes impacts to each vegetation type, nowhere does the DEIR clearly articulate how much habitat for each species would be impacted by the Project.

The DEIR states: "[c]onstruction-related impacts on nesting tricolored blackbirds, Swainson's hawk, California condor, and American peregrine falcon would not occur given the lack of nesting habitat present in/near the areas where construction activities would occur under the Proposed Project."[214] This statement conflicts with the DEIR's description of the environmental setting, which states: (a) there are approximately 4,000 acres of suitable nesting for the Swainson's hawk in the Project study area; and (b) the access and utility contains approximately

[209] DEIR, p. 3.5-36.
[210] Including, but not limited to: San Luis Solar Project, Wright Solar Park Project, Las Camas Solar Project, and Quinto Solar PV Project. In addition, the Bureau of Reclamation has determined that it is reasonably foreseeable that renewable energy development may occur on 1,200 acres of federal lands within the San Luis Reservoir State Recreation Area. *See* Bureau of Reclamation. 2018 May. Final Environmental Assessment and Plan of Development, San Luis Solar Project. p. 65.
[211] Thomson RC, Wright AN, Shaffer HB. 2016. California Amphibian and Reptile Species of Special Concern. California Department of Fish and Wildlife. University of California Press, Oakland, California.
[212] *Ibid.*
[213] *Ibid.*
[214] DEIR, p. 3.5-97.

2,601 acres of potentially suitable nesting and foraging habitat for "these eight special-status and protected raptor species" (including the Swainson's hawk and American peregrine falcon).[215]

Overhead power lines are a major source of bird mortality.[216] Loss et al. (2014) estimated that between 12 and 64 million birds are killed each year at U.S. power lines, with between 8 and 57 million birds killed by collision and between 0.9 and 11.6 million birds killed by electrocution.[217] The DEIR's analysis of impacts associated with the proposed transmission line and substation is limited to the statement that: "[t]he installation of the new transmission line and substation also presents an increased risk of electrocution on special-status avian species and other migratory bird and raptor species."[218] The DEIR fails to disclose and analyze the avian *collision hazard* associated with the proposed transmission line. The Project's transmission line would have an optical ground wire,[219] which is the wire most frequently associated with bird collisions due to its small diameter and elevated position on the transmission line.[220]

The Project study area contains a high density of golden eagles. Electrocution from, and collision with, transmission lines is one of the leading causes of golden eagle mortality.[221] The golden eagle population is extremely sensitive to additive mortality because: (a) golden eagles occur at very low densities, (b) a relatively high percentage of juveniles do not survive to breeding age (typically the 4th or 5th year of life), and (c) the population is already declining.[222] As a result, take of even one golden eagle due to the Project would constitute a significant impact under CEQA (i.e., because it would hasten decline of the species). In addition, any Project-related take of a golden eagle would violate the Bald and Golden Eagle Protection Act ("Eagle Act") if an eagle take permit from the USFWS is not obtained in advance of the take.

The DEIR states:

> "With extensive foraging habitat present in the Project study area and immediate vicinity, implementation of PAMM BI-1 would avoid impacts on nesting migratory birds and raptors through pre-construction nesting bird surveys and protective buffers for active nests. With the implementation of this PAMM direct and indirect impacts to grasshopper sparrow, yellow warbler, yellow breasted chat, loggerhead shrike, purple martin, short-eared owl, western burrowing owl, Northern harrier and white-tailed kite would still be significant."[223]

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215 DEIR, pp. 3.5-38 and -39.

216 Loss SR, Will T, Marra PP. 2014. Refining Estimates of Bird Collision and Electrocution Mortality at Power Lines in the United States. PLOS ONE 9(7):1-10.

217 *Ibid.*

218 DEIR, p. 3.5-98.

219 DEIR Appendix, Alternatives Development and Project Description, p. 3-27.

220 Avian Power Line Interaction Committee (APLIC). 2012. Reducing Avian Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute and APLIC. Washington, D.C. Available at: <https://www.aplic.org/uploads/files/15518/Reducing_Avian_Collisions_2012watermarkLR.pdf>.

221 U.S. Fish and Wildlife Service, Division of Migratory Bird Management. 2009. Final Environmental Assessment, Proposal to Permit Take as Provided Under the Bald and Golden Eagle Protection Act. Washington: Dept. of Interior.

222 *Ibid.*

223 DEIR, p. 3.5-103.

The DEIR's analysis fails to identify the specific impacts that "would still be significant" despite implementation of PAMM BI-1. This precludes the ability to evaluate whether the mitigation measures proposed in the DEIR would reduce those (unspecified) impacts to less than significant levels. Furthermore, the DEIR's analysis fails to address impacts to: (a) breeding and foraging habitat for the long-eared owl, and (b) foraging habitat for the American peregrine falcon, California condor, and tricolored blackbird. According to the DEIR, the Project site provides potential habitat for all four of these species.[224]

The DEIR assumes that compensatory mitigation for Project impacts to upland and dispersal habitat for the CTS and CRLF would also mitigate the Project's significant impacts to 1,851 acres of habitat for special-status birds. This is not a valid assumption due to the differing habitat requirements of the special-status species that would be significantly impacted by the Project. CTS and CRLF utilize a broad array of upland cover types for dispersal and refugia, whereas many of the bird species addressed in the DEIR require specific cover types and habitat elements. For example, even if Mitigation Measure BI-8b includes compensatory mitigation in the form of oak woodlands, those woodlands would not provide habitat for purple martins unless the trees contain concentrations of nesting cavities, relatively open air space above accessible nest sites, and relatively abundant aerial insect prey.[225]

Furthermore, Mitigation Measures BI-4c and BI-8b would not mitigate the Project's impacts unless the compensatory habitat is: (a) occupied by the species, and (b) within the range of the species. For example, a mitigation site that provides dispersal habitat for CTS and CRLF has no ecological value to the burrowing owl if the site is outside the geographic range of the burrowing owl—especially because burrowing owls rarely colonize new sites, or re-colonize historical sites from which they have been extirpated.[226] Mitigation Measures BI-4c and BI-8b are designed to mitigate the Project's significant impacts on aquatic resources and upland/dispersal habitat for CTS and CRLF. The DEIR provides no assurances that either measure would mitigate significant impacts to any other sensitive biological resources.

Impact Bio-14: Adverse Effects and Loss of Habitat for Nesting Bald Eagles and Golden Eagles

The DEIR states:

> "The majority of the upstream and downstream areas provide suitable nesting habitat for bald eagles and golden eagles; however, only three active eagle nests (two bald eagle and one golden eagle) were observed in or near the Project study area during the surveys conducted in 2020 (Biological Resources – Botanical/Wildlife Appendix Attachment D). Within the access and utility area,

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[224] DEIR, pp. 3.5-37 through -39.

[225] Shuford WD, Gardali T, editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

[226] Wilkerson RL, Siegel RB. 2010. Assessing changes in the distribution and abundance of burrowing owls in California, 1993-2007. Bird Populations 10:1-36.

> potential suitable nesting habitat for these species was also identified based on desktop analysis."[227]

There are at least three critical flaws with the DEIR's statements. First, bald eagles and golden eagles require mature trees that are capable of supporting a large, heavy eagle nest. The DEIR fails to provide evidence that "the majority of the upstream and downstream areas" contain large trees capable of supporting eagle nests. Second, if the majority of the upstream and downstream areas provide suitable nesting habitat, then the DEIR's claim that impacts would be limited to 96 acres of nesting habitat is clearly incorrect.[228] Third, the statement that "only three active eagle nests were observed" is misleading because it implies that three active nests is inconsequential, or perhaps that the study area provides relatively low-quality nesting habitat. To the contrary, the Project study area is known to contain consistently occupied and productive breeding sites that contribute to stability of the local-area populations of bald eagles and golden eagles.[229] The fact that the Project biologists detected three active nests and inferred presence of an additional three active nests reflects an extremely high density of eagle territories in the study area.

Breeding golden eagles occupy discrete territories, which are often occupied for many decades.[230] These territories maintain the local-area eagle population.[231] When one of the eagles dies, it is replaced by a "floater" (subadult or nonbreeding adult) that fills the territory vacancy. However, when the territory is eliminated (e.g., due to development), the pair is forced to become "floaters" and there is an overall net loss in the reproductive potential of the local-area population (i.e., under most circumstances the pair cannot simply establish a new territory elsewhere). Consequently, although death of an eagle has an impact on the population, the primary threat to persistence of the local-area population is the loss of historical nesting territories, such as those found in the Project impact area.

The DEIR states:

> "Bald eagle use of the survey area appears to be closely tied to Pacheco Reservoir, Pacheco Creek, and San Felipe Lake, though upland habitats in the vicinity were also utilized. Based on nest locations and observations of bald eagles, the survey area appears to support, at least to some extent, three bald eagle pairs; two active nests were observed during the 2020 nesting season, and the inactive nest in the floodplain of Pacheco Creek is also likely a bald eagle nest.

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[227] DEIR, p. 3.5-104.
[228] DEIR, p. 3.5-105.
[229] Wiens JD, Kolar PS, Fuller MR, Hunt WG, Hunt T, Bell DA. 2018. Spatial Patterns in Occupancy and Reproduction of Golden Eagles During Drought: Prospects for Conservation in Changing Environments. The Condor: Ornithological Applications 120:106-124. *See also* Hunt WG, Wiens JD, Law PR, Fuller MR, Hunt TL, Driscoll DE, Jackman RE. 2017. Quantifying the demographic cost of human-related mortality to a raptor population. PloS one;12(2):e0172232.
[230] *See* U.S. Fish and Wildlife Service. 2016. Final Programmatic Environmental Impact Statement for the Eagle Rule Revision. Available at: <https://www.fws.gov/migratorybirds/pdf/management/FINAL-PEIS-Permits-to-Incidentally-Take-Eagles.pdf>.
[231] The local-area population is a geographic scale used for management of eagles. It is defined as the 90^{th} quantile of the natal dispersal distance for golden eagles (109 mi), and the median female natal dispersal distance for bald eagles (86 mi). *See* U.S. Fish and Wildlife Service. 2016. Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. Division of Migratory Bird Management, Washington D.C., USA.

> Golden eagle use of the survey area is more difficult to discern than bald eagle use primarily due to the broader range of habitats used by golden eagles; the extent and availability of those habitats in the survey area; and golden eagles typically have a larger territorial ranges than bald eagles. Based on nest locations and observations of golden eagles, the upland habitat upstream of the North Fork Dam appears to support, at least to some extent, three golden eagle pairs."[232]

This information is insufficient for the purposes of an impact assessment. The DEIR fails to disclose critical factors, including: (1) where the nest sites and territories are located in relation to Project impacts; (2) how many nest sites would be directly eliminated by the Project; and (3) how much habitat within each territory would be impacted. This information is critical to evaluating the likelihood that eagles will abandon their territories if the Project is constructed and operated.

The DEIR correctly acknowledges that "[a]n incidental take permit from the USFWS must be obtained for new activities/projects that are located near eagle nests, roosting sites, and foraging areas and have potential to result in take of the species. If it is determined the Project would result in take of bald eagles or golden eagle, an incidental take permit from the USFWS would be required."[233] Yet the DEIR does not discuss or analyze the likelihood that the Project would result in take of eagles, nor does it provide the USFWS and the public with the information needed to evaluate the likelihood of take (i.e., because the DEIR fails to include information on eagle nests, roosting sites, and foraging areas in relation to Project impact areas).

As defined in the Bald and Golden Eagle Protection Act, take of eagles includes: "human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment."[234] At a minimum, the Project would cause take of the bald eagle pair that occurs in the upstream area because the nest tree is located in the middle of the proposed inundation area.

Mitigation Measure BI-14b states: "[i]f there is an inadvertent take of a bald eagle or golden eagle during project activities, Valley Water will provide compensatory mitigation through the Bald Eagle and Golden Eagle Electrocution Prevention In-lieu Fee Program (USFWS 2018b)."[235] Mitigation Measure BI-14b violates the Eagle Act. Under the Eagle Act, acquisition of a take permit (and associated compensatory mitigation) is required *prior to* implementing an activity that is likely to cause take.[236]

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[232] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment D, p. 4-1.
[233] DEIR, p. 3.5-42.
[234] 50 CFR Part 22.
[235] DEIR, p. 3.5-323.
[236] 50 CFR Part 22.

Impacts to Eagle Habitat

The DEIR states:

> "Construction impacts associated with the Proposed Project total approximately 96 acres of potential nesting habitat and up to about 98 acres of potential foraging habitat for bald eagle associated with Pacheco Reservoir. For golden eagles, 96 acres of potential nesting habitat and 574 acres of foraging habitat would be subject to long-term, short-term, and temporary impacts."[237]

The DEIR fails to explain how these impact values were calculated. The impact values appear erroneous for the following reasons:

1. Both species nest in trees or on cliff ledges. According to DEIR Table 3.5-15, the Proposed Project would impact 1,144.7 acres of woodlands (most of which would be long-term impacts). The DEIR provides no evidence that only 96 acres of those woodlands provide potential nesting habitat for eagles.
2. Bald eagles prey on a variety of small animals, usually fish or waterfowl, and they eat carrion, including deer and cattle.[238] At a minimum, the reservoir and riverine waters at the Project site provide potential foraging habitat for bald eagles. Therefore, construction activities associated with the Proposed Project would impact at least 290 acres of bald eagle foraging habitat (103 acres of riverine foraging habitat and approximately 187 acres of reservoir foraging habitat).[239]
3. Golden eagles forage in a variety of open habitat types, including grasslands, savannahs, and early successional stages of forest and shrub habitats.[240] The DEIR does not explain how impacts to golden eagle foraging habitat were calculated; however, it appears the DEIR did not consider any of the "woodlands" to be potential foraging habitat. Based on my review of the vegetation maps provided in Attachments B and E of the Biology Appendix, at least some of the woodlands have a low density of trees and provide potential foraging habitat. This is consistent with my own observations during site visits to the upstream portion of the Project area in September and December 2021.

The DEIR states that the Project would have direct impacts on potential nesting and foraging habitat for eagles (and other nesting birds). It then concludes that: "[i]mplementation of PAMM BI-1 would avoid impacts on nesting migratory birds and raptors by conducting pre-construction nesting bird surveys and establishing protective buffers for active nests. With the implementation of this PAMM, direct and indirect impacts would be less than significant."[241]

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[237] DEIR, pp. 3.5-104 and -105.

[238] California Department of Fish and Wildlife. 2022. Bald Eagles in California [webpage]. Available at: <https://wildlife.ca.gov/Conservation/Birds/Bald-Eagle>. (Accessed 27 Jan 2022).

[239] DEIR, Table 3.5-9. According to DEIR (p. 3.6-59), the surface area of the existing reservoir is 187 acres.

[240] California Department of Fish and Wildlife. California Interagency Wildlife Task Group. 2005. CWHR version 9.0 personal computer program. Sacramento, CA. Life history account for Golden Eagle. Available at: <https://wildlife.ca.gov/Data/CWHR/Life-History-and-Range>. (Accessed 26 Jan 2022).

[241] DEIR, p. 3.5-105.

Implementation of PAMM BI-1 would not prevent impacts to eagles. As discussed previously, human-caused alterations to habitat can have significant impacts on nesting eagles even if the alterations to habitat do not occur during the nesting season. Significant impacts to eagles include: "alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment."

The DEIR fails to analyze the extent to which the Project would alter habitat for the three golden eagle pairs (territories) that occur upstream of the North Fork Dam.[242] However, at a minimum, the Project would cause the bald eagles along North Fork Pacheco Creek to abandon the nest site (territory) because the nest tree would be inundated by the new reservoir. Implementation of PAMM BI-1 would not mitigate this significant impact.

The DEIR states:

> "In addition to direct impacts, indirect impacts on potential nesting and foraging habitat for these species could occur during construction activities associated with the Proposed Project. Construction activities would result in the degradation of suitable nesting habitat because of removal of trees for nesting, vegetation cover for prey species, or changes in vegetation structures for prey species. Project construction in or near suitable nesting and foraging habitat may take multiple years to complete; therefore, direct and indirect impacts could occur over several years. Although no nests were observed within the upstream area of the Project study area, potentially suitable habitat for this species does occur upstream. Implementation of PAMM BI-4, PAMM BI-5, PAMM BI-11, and PAMM BI-12 would minimize the potential for indirect impacts on potential foraging habitat by reducing the introduction of NNIPs and pathogens. With implementation of these PAMMs indirect impacts would be less than significant."[243]

The DEIR's conclusion pertaining to the significance of the Project's indirect impacts on eagles after implementation of the cited PAMMs lacks any credible basis. None of the PAMMs address the impacts that "would result" from the "removal of trees for nesting, vegetation cover for prey species, or changes in vegetation structures for prey species."

Although the DEIR admits: "[p]roject implementation could result in the degradation of suitable nesting habitat because of removal of trees for nesting, vegetation cover for prey species, or changes in vegetation structures for prey species," it argues: "the expanded reservoir would provide additional aquatic foraging habitat relative to existing conditions for bald eagle. Project construction in or near suitable nesting and foraging habitat may take multiple years to complete; therefore, direct and indirect impacts could occur over several years."[244]

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[242] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment D, p. 4-1.
[243] DEIR, p. 3.5-106.
[244] *Ibid.*

The idea that a future larger reservoir could eventually benefit bald eagles is speculative and unsupported. It would take several years for the reservoir to be built and fill with water. It would take many more years for the reservoir to develop an aquatic prey base large enough to support bald eagles. Bald eagles are likely to abandon their territories during this time. Although the new reservoir might eventually provide additional aquatic foraging habitat relative to existing conditions, bald eagles are unlikely to recolonize their historic territories if their nest trees (or alternates) are under water. This potentially significant impact on eagles was not contemplated in the DEIR.

I could not independently evaluate the relative severity of the Project's impacts on the bald eagle population for two reasons. First, the DEIR does not provide any information on the size class of trees that would remain outside the inundation area. Second, the DEIR overinflates the amount of bald eagle nesting habitat in the Project study area. Specifically, it states that the Project study area provides: "[a]pproximately 4,000 acres of woodland and scrub habitats provide suitable nesting for bald eagle."[245] However, bald eagles do not nest in "scrub habitats;" they nest in large trees near water. Therefore, the DEIR fails to provide the information needed to understand how much nesting habitat would remain in the study area after construction of the Project.

The DEIR recognizes that noise, vibration, and lighting associated with the Project could have significant impacts on eagles. It then claims:

> "Implementation of PAMM BI-1 would minimize the potential for direct and indirect impacts associated with construction noise, vibration, and lighting on these [eagle] species through the use of pre-construction nesting bird surveys and establishing protective buffers for active nests. With the implementation of this PAMM direct and indirect impacts associated with construction noise, vibration, and lighting would be less than significant."[246]

Golden eagles are known to be highly sensitive to human activity, noise, and many other types of disturbance.[247] As a result, the USFWS recommends a one-mile no-disturbance buffer surrounding golden eagle nesting sites (two miles for blasting and other loud non-regular noise).[248] This buffer applies to vehicles driving on dirt or gravel roads that are not part of a routinely used transportation corridor.[249] Consequently, it may not be feasible to construct the

[245] DEIR, p. 3.5-38.
[246] DEIR, p. 3.5-106.
[247] Ruddock M, Whitfield DP. 2007. A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage. 181 pp. *See also* Steenhof K, Brown JL, Kochert MN. 2014. Temporal and Spatial Changes in Golden Eagle Reproduction in Relation to Increased Off Highway Vehicle Activity. Wildlife Society Bulletin 38(4):682–688. *See also* Suter GW III, Joness JL. 1981. Criteria for Golden Eagle, Ferruginous Hawk and Prairie Falcon Nest Site Protection. Raptor Research 15(1):12-18. *See also* Pagel JE, Whittington DM, Allen GT. 2010 Feb. Interim Golden Eagle inventory and monitoring protocols; and other recommendations. Division of Migratory Birds, United States Fish and Wildlife Service.
[248] U.S. Fish and Wildlife Service. 2021 May. Recommended Buffer Zones for Ground-based Human Activities around Nesting Sites of Golden Eagles in California and Nevada. Available at: <https://www.fws.gov/cno/conservation/migratorybirds/pdf-files/USFWS-Pacific-Southwest-Region-golden-eagle-nest-buffer-recommendations-May2021.pdf>
[249] *Ibid.*

Project, while also maintaining a one-mile or two-mile buffer around golden eagle nesting sites. For example, a golden eagle nest within one mile of the Project's main access road would preclude construction vehicles from accessing the Project site between approximately December and August.[250]

The DEIR's analysis concludes by stating that Mitigation Measures BI-7, BI-8b, BI-13a, BI-14a, and BI-14b would reduce construction-related impacts on eagles to less than significant levels.[251] The DEIR's conclusion is not supported by evidence for the following reasons:

1. Mitigation Measure BI-7 consists of reconnaissance-level surveys designed to determine the potential for special-status animal species to occur in the access and utility area portion of the Project study area and to quantify the amount of suitable habitat. Conducting surveys to establish the environmental setting and quantify the Project's impacts does not constitute mitigation.
2. Mitigation Measure BI-8b consists of compensatory mitigation for impacts to habitat for the CTS and CRLF. Mitigation Measure BI-8b does not require the compensatory mitigation site(s) to provide habitat for eagles. Furthermore, there is no basis for the DEIR's conclusion that the approximately 3,400 acres of habitat required under Mitigation Measure BI-8b "would more than cover the impacts on bald eagle and golden eagle habitat"[252] until Valley Water: (a) conducts the surveys needed to determine use of habitat in the access and utility area by eagles, and (b) determines how many eagle territories would be significantly impacted by the Project. Mitigating significant impacts on eagle habitat requires compensation that offsets the reproductive output lost due to the habitat destruction (or degradation).[253] Whereas the provision of compensatory habitat could theoretically offset the Project's impacts to eagles, there is no scientific basis for concluding that the impact would indeed be offset without first knowing: (a) the expected reproductive loss from the Project site (which is a function of territories impacted), and (b) the compensation site's ability to allow the eagle population to grow by an amount equivalent to that loss.
3. Contrary to the DEIR's claim, Mitigation Measure BI-13a does not entail "retrofitting of existing power poles and transmission lines within the Project study area to reduce electrocution hazards to eagles."[254] Mitigation Measure BI-13a is limited to design standards for the Project's proposed (new) transmission line. Implementation of the APLIC design standards would reduce the avian collision and electrocution hazard. However, implementation of the APLIC design standards would not prevent collisions and electrocutions (i.e., the APLIC standards are not 100% effective in preventing

[250] Breeding begins with the start of courtship, which begins as early as December in California. Golden eagles are especially sensitive to human activity during the courtship and nest-building phase. *See* U.S. Fish and Wildlife Service. 2016. Final Programmatic Environmental Impact Statement for the Eagle Rule Revision. Available at: <https://www.fws.gov/migratorybirds/pdf/management/FINAL-PEIS-Permits-to-Incidentally-Take-Eagles.pdf>.
[251] DEIR, p. 3.5-107.
[252] *Ibid.*
[253] U.S. Fish and Wildlife Service. 2016. Final Programmatic Environmental Impact Statement for the Eagle Rule Revision. Available at: <https://www.fws.gov/migratorybirds/pdf/management/FINAL-PEIS-Permits-to-Incidentally-Take-Eagles.pdf>. *See also* U.S. Fish and Wildlife Service. 2013 Apr. Eagle Conservation Plan Guidance: Module 1—Land-based Wind Energy, Ver 2.
[254] DEIR, p. 3.5-322.

collisions and electrocutions).[255] The USFWS has determined that the golden eagle population cannot withstand any additive mortality.[256] As a result, even one golden eagle fatality caused by the Project would be a significant impact.

4. The DEIR assumes the protocol-level surveys required under Mitigation Measure BI-14a would be capable of identifying all eagle nests and territories within the vicinity of the Project study area. However, that assumption is inconsistent with scientific literature and the results of the eagle surveys conducted for the DEIR.[257] For example, the DEIR's eagle survey report noted that it was difficult to discern golden eagle use of the survey area, and thus the biologists could only speculate where the territories are located.[258] In addition, although the biologists believed the study area supports three golden eagle and three bald eagle pairs (nest territories), the biologists could only locate thee active nests.[259] Although the results of the surveys required under Mitigation Measure BI-14a would be used in the application of PAMM BI-1 (nest buffers), the measure does not mitigate the Project's long-term impacts on eagles because there are no provisions to modify the Project's footprint or mitigation measures (e.g., habitat compensation requirements) in response to the survey data. For example, installation of power lines near eagle nest sites can have negative impacts on both the eagle territory and population.[260] However, the DEIR does not include any intent or requirement to modify the alignment of the proposed power line if the forthcoming surveys reveal presence of a nest site within the alignment.

5. Finally, the DEIR claims: "Mitigation Measure BI-14b will provide compensatory mitigation for impacts on bald and golden eagle nesting and foraging habitat."[261] This claim is false. The Golden Eagle Electrocution Prevention In-lieu Fee Program described in Mitigation Measure BI-14b does not mitigate significant impacts to eagle nesting and foraging habitat, but rather, it offsets incidental take by retrofitting high-risk power poles.[262] Furthermore, Mitigation Measure BI-14b only requires contribution to the program "if there is an inadvertent take of a bald eagle or golden eagle during project activities." If the Project causes direct take of an eagle, the take is unlikely to be detected because the DEIR does not require any monitoring activities conducive to take detection.

The DEIR admits the Project would degrade and eliminate habitat for eagles. My own site reconnaissance surveys revealed that at least one bald eagle nest site would be eliminated by construction of the reservoir. Although foraging habitat might eventually be restored for bald

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[255] U.S. Fish and Wildlife Service. 2016. Final Programmatic Environmental Impact Statement for the Eagle Rule Revision. pp. 83 and 159 through 161.
[256] U.S. Fish and Wildlife Service. 2016. Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. Division of Migratory Bird Management, Washington D.C., USA.
[257] Wiens JD, Kolar PS, Fuller MR, Hunt WG, Hunt T. 2015. Estimation of Occupancy, Breeding Success, and Abundance of Golden Eagles (*Aquila chrysaetos*) in the Diablo Range, California, 2014. U.S. Geological Survey Open-File Report 2015-1039.
[258] DEIR Appendix, Biological Resources – Botanical/Wildlife, Attachment D, p. 4-1.
[259] *Ibid*, pp. 3-1 and 4-1.
[260] U.S. Fish and Wildlife Service. 2016. Final Programmatic Environmental Impact Statement for the Eagle Rule Revision. pp. 83 and 159 through 161.
[261] DEIR, p. 3.5-107.
[262] DEIR, p. 3.5-323.

eagles, it would take many years, and bald eagles are likely to abandon their territories in the interim.

The Project's most significant impacts to golden eagle habitat would occur in the upstream area, where an estimated three golden eagle territories are located. At least one of these territories is likely to be abandoned due anthropogenic disturbance and the substantial loss of foraging habitat. Although the DEIR admits the Project would have significant impacts on eagles, it offers no compensatory mitigation to offset the Project's impacts on habitat, territories, and the local-area eagle populations.

For the reasons described above, the DEIR's "less than significant" determinations are unsupported, and the Project's significant impacts on eagles remain unmitigated.

Impact Bio-15: Adverse Effects and Loss of Habitat for Mountain Lion and American Badger

The DEIR states: "[c]onstruction impacts associated with the Proposed Project total approximately 1,858 acres of potential denning and foraging habitat and includes long-term, short-term, and temporary impacts on mountain lion and American badger." The DEIR then states:

> "Although there would be a long-term and short-term loss of habitat for these species, it would not significantly reduce denning and foraging habitat that occurs within the surrounding area adjacent to the Project site; ample habitat would remain within the Project study area and the surrounding vicinity (Biological Resources – Botanical/Wildlife Appendix Attachment A, Exhibit E). With the implementation of these PAMMs direct and indirect impacts would be less than significant."[263]

The DEIR's argument is not supported by evidence and lack scientific merit. Habitat loss and fragmentation are primary threats to the mountain lion and American badger. The DEIR fails to provide landscape-level analysis to support the claim that "ample habitat would remain," especially given the large habitat patch size requirements of both species. Furthermore, there is no scientific explanation for the conclusion that loss of grassland habitat would significantly impact other grassland species (e.g., burrowing owl, grasshopper sparrow), but not the American badger or mountain lion.

The DEIR claims:

> "A shoreline buffer of 200 feet around the expanded reservoir would be acquired (e.g., fee title, easement) by Valley Water as part of all action alternatives which would minimize the potential for direct and indirect impacts associated with construction noise, vibration, and lighting on these species by providing suitable dispersal and migration corridors around construction activities; therefore,

[263] DEIR, p. 3.5-108.

> impacts associated with construction noise, vibration, and lighting would be less than significant."[264]

The DEIR's claim that a 200-foot buffer would somehow mitigate direct and indirect impacts on the mountain lion and American badger is unsupported. The shoreline buffer area would be subject to noise, vibration, and lighting from construction-related activities (e.g., vegetation removal) in adjacent areas.[265] Furthermore, animals would not be able to use the shoreline buffer area to go "around construction activities" because the Proposed Project and every Project alternative involves construction activities (e.g., borrow areas and access roads) within the buffer area.[266] For example, if Project Alternative A is constructed, animals would need to travel across two construction access roads, and through two borrow areas (SBA-1 and CBA-2). Even if those constraints are eliminated, there is no scientific evidence or analysis to support the claim that the (unidentified) habitat within the shoreline buffer would be suitable for every species, especially those with very narrow habitat requirements.

Impact Bio-17: Adverse Effects and Loss of Habitat for Special-status Bats (Pallid Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-eared Bat) and Ringtail

The availability of suitable roost sites is the limiting factor for most bat populations.[267] Most California bat species, including some of the species that may occur at the Project site, form nursery colonies in the summer.[268] These maternity roosts can contain hundreds or thousands of individuals.[269] Thus, the loss of a roost site can have relatively severe implications on the overall population. Moreover, a single disturbance event can lead to roost abandonment, and if poorly timed, mass mortality of pups.[270]

The Project would impact 945 acres to 1,154 acres of potential roosting for special-status bats, depending on the Project alternative that would be constructed.[271] However, according to the DEIR:

> "Compensatory mitigation for special-status bats and ringtail will be covered under the compensatory mitigation for impacts to aquatic resources under Mitigation Measure BI-4c and California tiger salamander and California red-legged frog upland/dispersal habitat (as these habitats overlap with foraging habitat for special-status bats) under Mitigation Measure BI-8b. These measures include the restoration and planting of vegetation, including trees, to compensate for impacts on suitable roosting/denning and foraging habitat. With

[264] *Ibid*.
[265] DEIR Appendix, Alternatives Development and Project Description, Exhibits 21 through 25.
[266] *Ibid*.
[267] Western Bat Working Group. 2005 (Update). Species Accounts. Available at: <http://wbwg.org/western-bat-species/>. *See also* California Department of Fish and Wildlife. 2014. California Interagency Wildlife Task Group. CWHR version 9.0 personal computer program. Sacramento, CA.
[268] *Ibid.*
[269] *Ibid.*
[270] *Ibid.*
[271] DEIR, Table 3.5-17.

implementation of these mitigation measures, this impact would be reduced to a less-than-significant level."[272]

There are several reasons why Mitigation Measures BI-4c and BI-8b would not mitigate significant impacts to special-status bats and ringtails. First, neither mitigation measure is designed to mitigate the Project's significant impacts on bat roosts, nor does either measure require presence of bat foraging habitat at the compensatory mitigation site(s).

Second, neither mitigation measure requires "restoration and planting of vegetation, including trees, to compensate for impacts on suitable roosting/denning and foraging habitat." Even if Valley Water intends to plant trees at the mitigation site, it would take decades or even centuries for those trees to offset the Project's impacts to tree-roosting bat species. For example, Townsend's big-eared bats are known to roost in basal hollows of trees. Basal hollows form over decades or centuries due to repeated fire scarring and healing of the tree.

Third, the DEIR determined that the Project would have potentially significant impacts on the western mastiff bat.[273] The western mastiff bat is a "cliff-roosting" species. Maternity colonies of the western mastiff bat are typically located high above the ground in exfoliating rock slabs, or in similar crevices in large boulders and buildings.[274] Planting trees, or acquiring a mitigation site containing trees, does nothing to mitigate the Project's significant impacts to roosting habitat for the western mastiff bat (or other cliff-roosting bat species).

Impact Bio-18: Impacts on Wildlife Dispersal and Migration Corridors

The Project would be located on largely undisturbed lands that provide movement corridors for myriad wildlife, and the Project would directly impact land that the CDFW has classified as an "Irreplaceable and Essential Corridor" for terrestrial connectivity (Figure 4, below).[275] The DEIR fails to disclose, analyze, or provide mitigation for this significant impact on terrestrial connectivity.

With respect to the impact of construction and operation of the proposed new reservoir, the DEIR states:

> "The magnitude of long-term impacts on wildlife dispersal and migration corridors would primarily be associated with the expanded reservoir, new dam, and associated facilities and infrastructure and would vary depending upon the species and environmental factors such as water year and the season. These long-term impacts may not differ significantly from the existing condition given that existing roads (e.g., SR 152, Kaiser-Aetna Road), Pacheco Reservoir and North

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[272] DEIR, p. 3.5-112.
[273] DEIR, p. 3.5-111.
[274] Western Bat Working Group. 2005 (Update). Species Accounts. Available at: <http://wbwg.org/western-bat-species/>.
[275] California Department of Fish and Wildlife. 2019. Areas of Conservation Emphasis, Terrestrial Connectivity dataset [ds868]. Calif. Dept. of Fish and Wildlife. Biogeographic Information and Observation System (BIOS). Retrieved 9 Feb 2022 from: <https://apps.wildlife.ca.gov/bios/>.

> Fork Dam all currently preclude some degree of wildlife movement both spatially and temporally."[276]

The DEIR admits that no geospatial analysis has been conducted to assess the Project's impacts on wildlife movement corridors. Thus, the DEIR resorts to the uninformative statement that long-term impacts "may not differ significantly from the existing conditions" (which also implies that they may differ significantly).

I concur with the DEIR's statement that Pacheco Reservoir and North Fork Dam currently preclude some degree of wildlife movement. However, the effects of the Project on wildlife movement are not comparable to existing conditions. The proposed reservoir would have a surface area over seven times larger than the existing reservoir, would create a movement barrier that extends approximately 5.2 miles (east-west) by 3.75 miles (north-south), and would block an approximately 1.5-mile-wide pathway between two large conservation reserves (Romero Ranch and Henry Coe State Park).[277] For some species, the movement barrier would be even larger than the reservoir itself due to the base flows and pulse flows released from the Project's dam, the new transmission line and substation, and the access roads. For example, California tiger salamanders do not swim through flowing waters, and thus would perceive the perennial flows generated by the Project as a movement barrier.

The DEIR provides the following additional analysis:

> "The new expanded reservoir under the Proposed Project would not have an increased impact compared to existing conditions because the expanded reservoir would typically be full during winter and early spring, with water surface variability occurring throughout the year depending on seasonal climatic conditions (as illustrated in Table 3.17-5 [Recreation)]). Furthermore, larger animals such as mountain lion and badger, which have larger dispersal and home ranges, would be less affected by the expanded reservoir even when the reservoir is full given the mobility of the species. Aquatic and semi-aquatic species such as western pond turtle may utilize the expanded reservoir to their advantage for dispersal (e.g., swimming to unoccupied areas within the Project study area). The expanded reservoir would also provide a larger water source for animals during the dry months and increase the prey base for many species in the surrounding area."[278]

The DEIR's rationale is totally illogical. If water acts as a movement barrier to terrestrial animals, a 1,367-acre reservoir that is typically full would not have the same impact as a 187-acre reservoir that is infrequently full. Furthermore, there is no basis to conclude that terrestrial species such as the mountain lion and American badger would be "less affected" by a landscape with less habitat than existing conditions. Unlike existing conditions, the Proposed Project would force terrestrial species to travel many miles to achieve east-west movement around the new reservoir. For example, moving ¼ mile from the east side of the new reservoir to the west side of the new reservoir would require the animal to travel at least 10 miles (as measured from

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[276] DEIR, p. 3.5-113.
[277] See DEIR, Figure 3.5-2. Conservation Easements in Project Study Area.
[278] DEIR, p. 3.5-113.

approximately the mid-point of the proposed reservoir). This level of travel would be prohibitive for most species, even highly mobile ones. In reality, the new reservoir would fragment, and functionally eliminate, a portion of the organism's home range.

Of the special-status species analyzed in the DEIR, the only aquatic or semi-aquatic organism that could theoretically benefit from the proposed reservoir is the western pond turtle. However, pond turtles migrate between aquatic habitat and upland nesting habitat, and they have high fidelity to nesting sites.[279] Therefore, the DEIR must analyze how the Project would affect movement between aquatic habitat and nesting habitat. Similarly, because pond turtles exhibit a metapopulation structure, the variable of conservation significance is the ability to disperse among aquatic habitats. Although it is theoretically possible that the new reservoir could facilitate dispersal between the reservoir and other aquatic habitats (e.g., ponds), the DEIR does not provide geospatial analysis substantiating that benefit (e.g., there is no map of dispersal corridors among aquatic habitats).

The DEIR makes the vague statement that the new reservoir would provide a larger water source for animals and "increase the prey base for many species in the surrounding area."[280] However, the DEIR fails to identify the specific species that are most likely to benefit from the supplemental food and water resources, or how benefitting those (unidentified) species would affect ecosystem health. This is important because provision of supplemental resources can eliminate the mechanism that limits population growth. Often this results in negative consequences on the ecosystem. For example, supplemental food and water resources have caused a massive increase in raven populations and a concomitant decline in its prey (ravens depredate nests of other birds and prey on small animals such as young birds, herpetofauna, small mammals, and insects).[281] Irrespective of the new reservoir's role as a supplemental water source for terrestrial animals, it would undoubtedly facilitate expansion of the bullfrog population.

The DEIR provides the following analysis of the Project's operational impacts on wildlife movement in areas below the proposed dam:

> "In addition, the creek would still be crossable by wildlife species, since flows would remain within the existing primary channel (i.e., water depths and velocities would not change significantly) and would not hinder the ability for wildlife to continue to utilize and access the culverts and bridge under crossings. In addition to baseflows, pulse flows would not exceed the capacity of the existing primary channel and would be similar to peak flows during winter months under the current conditions; therefore, there are no impacts on wildlife dispersal and migration corridors associated with operations."[282]

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[279] Reese DA. 1996. Comparative demography and habitat use of western pond turtles in northern California: the effects of damming and related alterations. University of California, Berkeley.
[280] DEIR, p. 3.5-113.
[281] Shields T, Currylow A, Hanley B, Boland S, Boarman W, Vaughn M. 2019. Novel management tools for subsidized avian predators and a case study in the conservation of a threatened species. Ecosphere 10(10):e02895.
[282] DEIR, p. 3.5-114.

The DEIR's analysis is misdirected. There are two issues that must be analyzed to address impacts caused by alterations to the flow regime. The first issue is whether the Project would create flow conditions that would prevent an organism from crossing the creek. Some species are not adapted to swimming (or walking) through flowing water. Under existing conditions, portions of the creek are dry, at least during some years. This allows movement from one side of the creek to the other. Even if this movement across the creek is a rare event, it is an essential component of population dynamics (e.g., exchange of genetic material).

The second issue is whether the Project would create flow conditions that preclude (or impair) wildlife movement through culverts and bridge under crossings. A study conducted by Pathways for Wildlife (2020) found that: (a) wildlife movement along Pacheco Creek occurred on the creek banks, and (b) high flows prevented wildlife movement under the Pacheco Creek bridge because rip-rap adjacent to the creek channel acted as a movement barrier.[283] The DEIR's conclusion that the Project would have no impacts on wildlife movement because its pulse flows "would be similar to peak flows during winter months under the current conditions" contradicts the results of the study conducted by Pathways for Wildlife.

The DEIR's conclusion that the Project (including impacts from construction, the larger reservoir footprint, and alterations to Pacheco Creek flows) would not have a significant impact on wildlife movement is unsupported and incorrect.

[283] Pathways for Wildlife. 2020. Wildlife Permeability and Hazards across Highway 152 Pacheco Pass: Establishing a Baseline to Inform Infrastructure and Restoration. Report for the Santa Clara Valley Habitat Agency, Morgan Hill, CA.

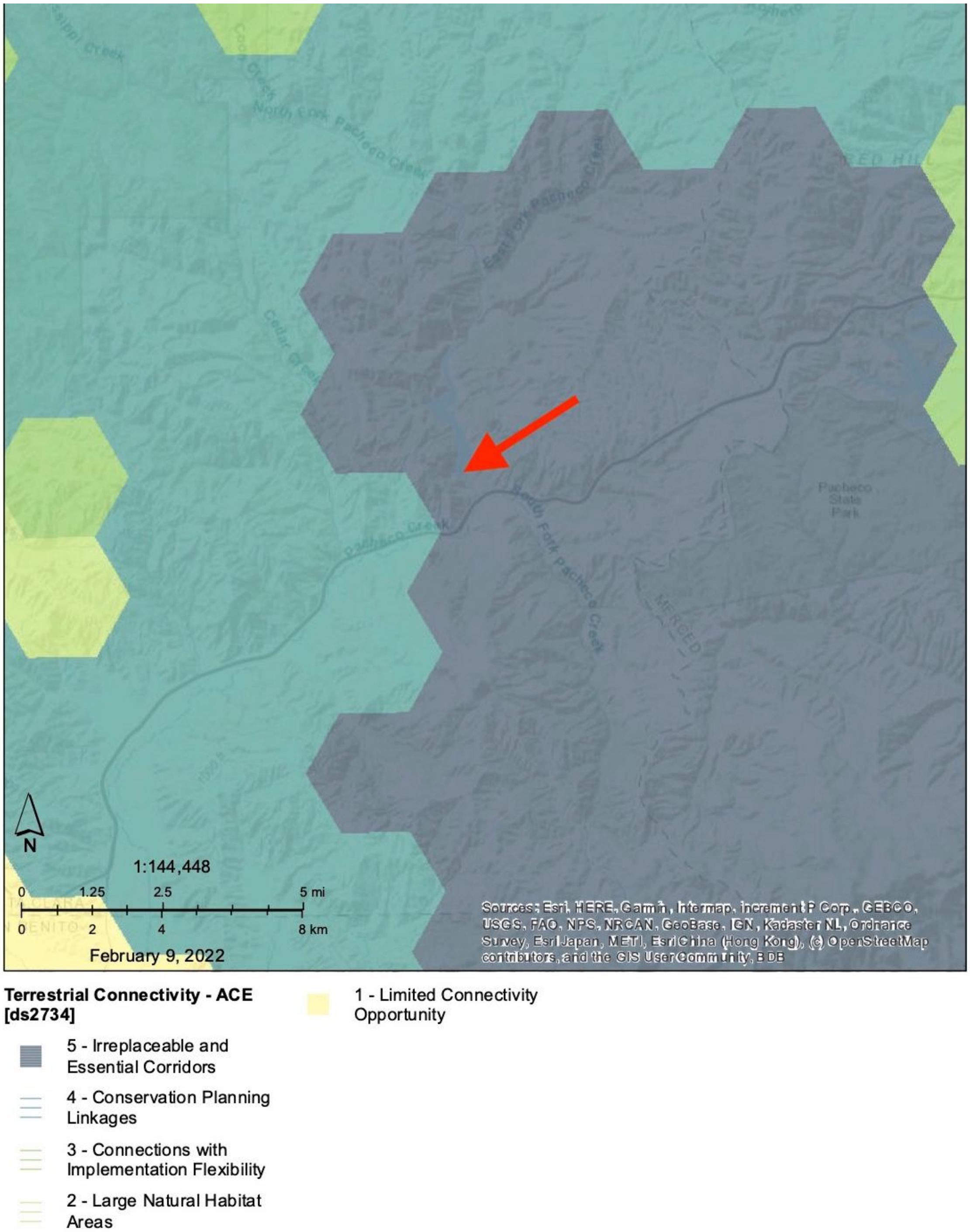

Figure 4. Project study area in relation to an Irreplaceable and Essential Corridor for terrestrial connectivity. Red arrow points to the existing North Fork Dam.

Impact Bio-19: Conflict with the Santa Clara Valley Habitat Plan ("SCVHP")

The DEIR states that the flows associated with the Project could have significant indirect impacts on the sycamore alluvial woodlands within the Pacheco Creek Preserve. The DEIR then states:

> "Therefore, Mitigation Measure BI-2c would reduce impacts from conflicts with the SCVHP, including conflicting with Action LAND-R3 to a less-than-significant level by prioritizing potential mitigation opportunities outside of the SCVHP boundaries, thereby providing the SCVHA the opportunity to potentially acquire California alluvial sycamore woodlands that would otherwise be used for Project mitigation."[284]

Mitigation Measure BI-2c does not mitigate conflicts with the SCVHP because it does not address the Project's impacts to the Pacheco Creek Reserve, which has already been acquired by the Santa Clara Valley Habitat Agency ("SCVHA") to help achieve the requirements of Action LAND-R3 (acquisition of 40 acres of sycamore alluvial woodland with stands that are at least 10 acres in size and contiguous). Indirect impacts caused by the Project's proposed flows would potentially derail the SCVHA's capstone sycamore alluvial mitigation strategy, which includes 8 acres of preservation and up to 20 acres of restoration/creation credits at the Pacheco Creek Preserve.

"Prioritizing" potential mitigation opportunities outside of the SCVHP boundaries does not mitigate Impact BIO-19 because there are no assurances that habitat compensation for the Project's impacts on sycamore alluvial woodlands would indeed occur outside of the SCVHP boundaries. That is, although mitigation opportunities would be prioritized outside of the SCVHP boundaries: (a) Mitigation Measure BI-2c does not prevent Valley Water from conducting the mitigation within the SCVHP boundaries; or (b) Valley Water may find that there are no mitigation opportunities outside of the SCVHP boundaries. For these reasons, Mitigation Measure BI-2c does not ensure that conflicts with the SCVHP would be mitigated to a less-than-significant level.

Impact Fish-11: Adverse Effects and Loss of Habitat for California Floater Mussel

Freshwater mussels have suffered precipitous declines in abundance and distribution and are considered, together with freshwater gastropods, to be the most imperiled faunal group in North America, with about 71% of the 297 known species considered endangered, threatened, or of special concern.

The California floater mussel (*Anodonta californiensis*) is one of the species that has experienced precipitous declines[285] and it is now considered an imperiled species in California.[286] There are historic records of California floater mussels in Pacheco Creek, and in 2021, one of the Project

[284] DEIR, p. 3.5-115.
[285] Howard JK, Furnish JL, Box JB, Jepsen S. 2015. The decline of native freshwater mussels (Bivalvia: Unionoida) in California as determined from historical and current surveys. California Fish and Game 101(1):8-18.
[286] California Natural Diversity Database. 2022 Jan. Special Animals List. California Department of Fish and Wildlife. Sacramento, CA.

biologists found evidence that a population of California floaters inhabits Pacheco Reservoir.[287] Despite this discovery, Valley Water made no efforts to assess the distribution and abundance of California floaters in the reservoir.

The DEIR acknowledges that excavation of sediments stored in Pacheco Reservoir in conjunction with the restoration of lower North Fork Pacheco Creek would result in displacement or destruction of California floater mussel habitat, and individuals.[288] The DEIR then states:

> "Implementation of PAMM Fish-3 would require qualified biologists to identify populations during Phase one construction efforts and relocate them to locations that provide suitable habitat within the Pacheco Creek or Pajaro River watersheds. This impact would be less than significant because impacts to California floater mussels would not be substantial. Operation of the Proposed Project would result in perennial flows, which would allow California floater mussels to remain submerged in a wetted environment. This impact would be beneficial."

There is no scientific basis for the DEIR's determination that impacts to California floater mussels "would not be substantial." PAMM Fish-3 is nothing more than an unenforceable commitment to develop and implement a California Floater Mussel Relocation Plan. Previous efforts at mussel relocation have not been overwhelming successful.[289] Furthermore, the potential for success is dependent on a variety of factors including the availability of suitable habitat, population density at the relocation site, and handling during relocation.[290] The DEIR fails to address any of those factors. Indeed, PAMM Fish-3 admits that Valley Water has yet to identify whether there are viable locations for relocation of the California floater mussels that occur in Pacheco Reservoir. Even if Valley Water is able to identify a site that contains suitable habitat for mussels, its ability to deposit mussels at that site would be contingent on landowner approval.

The DEIR fails to establish scientific standards for the relocation site or the relocation efforts.[291] There are no performance standards for PAMM Fish-3, nor does PAMM Fish-3 require monitoring to evaluate the fate of the relocated mussels. The DEIR's failure to incorporate scientific standards for the relocation program virtually guarantees that most (or all) of the mussels will die.

The DEIR's analysis of impacts due to Project operations is cursory and myopic. Freshwater mussels release larvae (which encyst in fish gills) in synchrony with periods of low flow. Unnatural pulses in stream discharge from dams (pulse flows) can: (a) interfere with dispersal of larvae to hosts, and (b) prevent settlement of juveniles in the substrate after they leave hosts.[292]

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[287] DEIR, p. 3.6-3.
[288] DEIR, p. 3.6-48.
[289] Luzier C, Miller S. 2009. Freshwater Mussel Relocation Guidelines. Pacific Northwest Native Freshwater Mussel Workgroup. 7pp.
[290] *Ibid.*
[291] *Ibid.*
[292] Jepsen S, LaBar C, Zarnoch J. 2005. Profile and maps for: *Anodonta californiensis* (Lea, 1852) / *Anodonta nuttalliana* (Lea, 1838). Available at: <https://xerces.org/sites/default/files/publications/10-029.pdf>.

In addition, Project operations would alter Pacheco Creek's fish fauna, substrate composition, benthic community, water chemistry, dissolved oxygen levels, and temperatures.[293] These alterations have the potential to cause extinction of the mussel population, as demonstrated at numerous other dam sites throughout North America.[294]

For these reasons, the Project would have significant, unmitigated impacts on the California floater mussel.

Cumulative Impacts

The DEIR considered three projects in its analysis of cumulative impacts to botanical and wildlife resources: (1) California High-Speed Rail, (2) Gonzaga Ridge Wind Repowering Project, and (3) Pacheco Creek Restoration Project.[295] Although the DEIR provides a brief description of each project, the DEIR fails to provide the information needed for the public to understand the severity of cumulative impacts to botanical and wildlife resources. For example, there is no information on the magnitude of each project's impacts (e.g., acres impacted), nor does the map provided in DEIR Figure 3.1-1 depict the footprint of each project. This precludes the public from understanding the extent of cumulative impacts to habitat (for example) within the geographic area analyzed in the DEIR.

14 Ca. Code Regs. ("CEQA Guidelines") § 15130(b)(3) states that lead agencies should define the geographic scope of the area affected by the cumulative effect and provide a reasonable explanation for the geographic limitation used. The DEIR fails to explain why the DEIR's cumulative effects analysis was limited to the Pacheco Creek watershed (the Project would extend to the eastern border of the watershed, so all projects east of the Project were omitted from the DEIR's analysis).

Whereas the Pacheco Creek watershed may be the appropriate scope for other environmental resources (e.g., hydrology), it is not the appropriate scope for assessing cumulative impacts to botanical and wildlife resources. The Project site is located in the Diablo Range portion of the Coast Ranges Geomorphic Province.[296] Many of the special-status plant and animal species that occur at the Project site are associated with the specific habitats that occur in the Diablo Range. Because the cumulative effects analysis was limited to other projects in the Pacheco Creek watershed, it fails to consider projects on the east side of the Diablo Range. Some of those projects are located relatively close to the Project site and would affect many of the same botanical and wildlife resource as the Proposed Project.

At a minimum, the following projects occur in the immediate vicinity of the Project site and therefore must be included in the analysis of cumulative effects to botanical and wildlife

[293] *Ibid.*
[294] *Ibid.*
[295] DEIR, pp. 3.5-325 and -326.
[296] DEIR, p. 3.5-3.

resources: (1) Quinto Solar PV Project, (2) Las Camas Solar Project, (3), Wright Solar Park Project (4) San Luis Solar Project, and (5) San Luis Transmission Project.[297]

In addition, the DEIR's analysis of cumulative impacts on biological resources suffers from the following flaws:

1) In accordance with USFWS guidelines, the geographic scope for analysis of cumulative effects to eagles should occur at the scale of the local-area eagle population (a population within a distance of 43 miles for bald eagles and 140 miles for golden eagles).[298]
2) The Project would impact critical habitat for the CRLF in recovery unit STC-2. To enable understanding of the Project's effects on recovery of the CRLF, the DEIR must consider all other projects within recovery unit STC-2.
3) The ability to mitigate the Project's impacts on sycamore alluvial woodlands is contingent on the assumption that there are opportunities to acquire mitigation properties containing 211.5 acres of sycamore alluvial woodlands.[299] The best available scientific information indicates there are only 17 significant stands of sycamore alluvial woodland (totaling approximately 2,000 acres) remaining in the state. Seven of the stands are located on public land or are already protected by a conservation easement. This leaves 10 stands (three of which are already partially protected by a conservation easement) on private land that theoretically could be acquired as mitigation. A critical piece of analysis missing from the DEIR is whether any of these 10 stands would be (or have been) impacted by an approved development agreement. The DEIR's cumulative effect analysis must provide this information.

Cumulative Impact Determinations

The DEIR states: "[c]umulative impacts of the Proposed Project and Alternatives A through D in conjunction with the three projects listed above on jurisdictional waters are significant, and the Proposed Project's and action alternatives' incremental contribution is cumulatively considerable premitigation."[300] The DEIR provides the same conclusions for: sensitive natural communities, oak woodlands, special-status plants and animals, and conflicts with the SCVHP.[301] The DEIR then claims that with implementation of the mitigation measures proposed in the DEIR, the Project's contribution to significant impact would be less than cumulatively considerable, and therefore, less than significant.

The DEIR's rationale is flawed because the mitigation measures proposed in the DEIR are ***designed to reduce potentially significant impacts, not eliminate all impacts entirely***. As a

[297] Information on the Quinto, Las Camas, and Wright Solar projects is available from the Merced Planning Department at: <https://www.co.merced.ca.us/412/Project-Environmental-Review-CEQA>. *See also* Bureau of Reclamation. 2018 May. Final Environmental Assessment and Plan of Development, San Luis Solar Project. *See also* Western Area Power Association, San Luis Transmission Project [web page]. Available at: <https://www.wapa.gov/regions/SN/Pages/san-luis-transmission-project.aspx>.
[298] For example, *see* U.S. Fish and Wildlife Service. 2013 Apr. Eagle Conservation Plan Guidance: Module 1—Land-based Wind Energy, Ver 2. p. iv.
[299] Based on DEIR Table 3.5-7 and the terms of Mitigation Measure BI-2c.
[300] DEIR, p. 3.5-327.
[301] DEIR, pp. 3.5-327 through -330.

result, there would be residual impacts. For example, the DEIR does not incorporate compensatory mitigation for permanent impacts to habitat for the San Joaquin coachwhip; thus, there would be residual impacts on this species.

Similarly, there would be residual impacts on special-status birds because the DEIR does not require compensatory mitigation for fatalities caused by the Project's the new power line facilities. Whereas these residual impacts may not rise to the level of significance at the Project level, they may be significant at the cumulative level when combined with the residual impacts of other projects. For example, when viewed in isolation, the number of bird fatalities caused by a project may appear biologically insignificant. However, when all projects causing bird fatalities are considered, the impact may be very significant. Indeed, this very situation is occurring in the Diablo Range due to the rapid increase in development of renewable energy facilities and associated power transmission infrastructure. The Project's contribution to this significant cumulative impact is cumulatively considerable because it would place 4.1 miles of new power lines and a new electrical substation in an area that supports numerous birds (e.g., raptors) that are highly susceptible to collisions with, and electrocutions from, electrical power lines.

According to CEQA Guidelines § 15130(a)(3):

> "An EIR may determine that a project's contribution to a significant cumulative impact will be rendered less than cumulatively considerable and thus is not significant. A project's contribution is less than cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact. The lead agency shall identify facts and analysis supporting its conclusion that the contribution will be rendered less than cumulatively considerable."

In this case, none of the DEIR's biological resource mitigation measures are designed to alleviate the cumulative impact; they are all specific to the Proposed Project and Project alternatives. Therefore, there is no basis for the DEIR's conclusion that the Project's contribution to significant cumulative impacts would be less than cumulatively considerable.

<u>Sycamore Alluvial Woodland</u>

The DEIR provides the following analysis of the Project's contribution to significant cumulative impacts to sycamore alluvial woodlands: "[w]ith implementation of mitigation measures for the Proposed Project and Alternatives A through D, the Proposed Project's and action alternatives' incremental contribution [to sycamore alluvial woodlands] is less than cumulatively considerable; and therefore, less than significant."

The DEIR's analysis ignores the legitimate possibility that past, present, and reasonably foreseeable future projects could have a cumulatively significant impact that no longer can be mitigated to a less-than-significant level. The DEIR provides no analysis of how past and present projects are affecting sycamore alluvial woodlands, nor how reasonably foreseeable projects would affect those woodlands. Instead, the DEIR resorts to the flawed reasoning that the Project's impacts would not be cumulatively considerable as long as Valley Water can protect some of the few remaining woodlands before another party protects them. Mitigation Measure BI-2c does not require creation of "new" woodlands to offset the woodlands that would be eliminated by the Project (nor is there evidence that such an endeavor can be accomplished). As a result, the Project would result in an overall net loss of sycamore alluvial woodlands. If the DEIR's logic is applied, there would never be a cumulatively considerable impact as long as a project's impacts did not exceed the self-imposed compensatory mitigation requirement—no matter how few sycamore alluvial woodlands remain.

The sycamore alluvial woodland is an extremely rare and highly imperiled natural community. Even the stands of sycamore alluvial woodlands that have been protected from development are declining due to the adverse effects of water impoundments, hybridization, pathogens (e.g., sycamore anthracnose and *Phytophthora*), and climate change (among other threats). Given the current status of sycamore alluvial woodlands, *any net loss in area* would further increase the risk of extinction. Because the Project would impact one of the largest remaining stands of sycamore alluvial woodland, and because the mitigation proposed in the DEIR does not alleviate the risk of extinction, the Project's contribution to significant cumulative impacts would be cumulatively considerable.

Botanical Resources

The DEIR states:

> "The cumulative projects listed above will implement design and mitigation measures (e.g., focused botanical surveys prior to construction, avoiding special-status plant populations, minimizing spread and introduction of NNIP species) similar to those described for the Proposed Project and Alternatives A through D to avoid and/or minimize adverse impacts on special-status plant species and sensitive natural communities, including the development of a mitigation plan that describes minimization, avoidance, and compensatory mitigation measures."[302]

This statement is false. The DEIR for the Gonzaga Ridge Wind Repowering Project does not include mitigation to minimize the spread and introduction of NNIP species, nor does it require compensatory mitigation for impacts to special-status plant populations.[303]

For the reasons described above, the DEIR's analysis of cumulative impacts on biological resources is fatally flawed and must be rewritten and recirculated.

PROJECT-SPECIFIC AVOIDANCE AND MINIMIZATION MEASURES

The Project-Specific Avoidance and Minimization Measures ("PAMMs") listed in the DEIR lack performance standards, a monitoring and reporting program, and mechanisms for enforceability. As a result, the PAMMs cannot be relied on as evidence that significant impacts to biological resources would be reduced to less-than-significant levels.

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[302] DEIR, p. 3.5-327.
[303] California Department of Parks and Recreation. 2019. Draft Environmental Impact Report for the Gonzaga Ridge Wind Repowering Project. pp. 3.2-97 and -98.

The PAMMs listed in the Project Description chapter of the DEIR differ from those in the Biological Resources chapter.[304] As a result, the specific measures that would be implemented to avoid and minimize impacts to biological resources remain unclear. The subsequent comments conservatively assume the PAMMs listed in the Project Description chapter of the DEIR would be implemented because these PAMMs are more detailed than those in the Biological Resources chapter.

PAMM BI-1 – Avoid Impacts to Nesting Migratory Birds and Raptors

PAMM BI-1 states:

> "To prevent impacts to nesting birds, pre-construction nesting bird surveys will be performed during the avian nesting season (i.e., January 15 through September 1) by a qualified biologist prior to any activity that could result in take of an active nest. Surveys for active nests within the specified distance will be performed within two weeks prior of the proposed activity…Should an active nest be found during the pre-construction surveys, an avoidance buffer will be established around the nest based on the species, location, and status/age of the nest by a qualified biologist."[305]

The statement that the surveys would be performed prior to "any activity that could result in take of an active nest" is vague. The PAMM does not define "active nest," or identify the specific activities that would trigger the need for the surveys. For example, would surveys be conducted prior to an increase in human activity within a given area, even if no ground disturbance activities would occur?

PAMM BI-1 must identify the: (a) nest searching techniques, (b) minimum level of effort (i.e., survey hours per unit area), and (c) minimum levels of expertise for the "qualified biologist." As explained below, the ability to successfully locate nests in the Project area is dependent on these three variables.

Several of the birds that have the potential to nest at the Project site are ground-nesting species. Ground-nesting birds construct nests that are inconspicuous and thus extremely hard to find unless special techniques are implemented.[306] Because PAMM BI-1 does not require implementation of those techniques, it provides no assurances that the Project would avoid take of ground-nesting birds.

Many biologists do not understand the level of effort needed to locate bird nests. Locating all bird nests prior to a Project activity that could result in take would require a considerable level of

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[304] *See* DEIR, pp. 2-42 through -47, and 3.5-49 through -52.
[305] DEIR, p. 2-42.
[306] Galligan EW, Bakken GS, Lima SL. 2003. Using a thermographic imager to find nests of grassland birds. Wildlife Society Bulletin 31(3):865-869. *See also* Martin TE, Geupel GR. 1993. Nest-Monitoring Plots: Methods for Locating Nests and Monitoring Success. J. Field Ornithol. 64(4):507-519. *See also* Rodewald AD. 2004. Nest-Searching Cues and Studies of Nest-Site Selection and Nesting Success. J. Field Ornithol. 75(1):31-39. *See also* Winter M, Hawks SA, Shaffer JA, Johnson DH. 2003. Guidelines for Finding Nests of Passerine Birds in Tallgrass Prairie. The Prairie Naturalist 35(3):197-211.

effort given the size of the Project area. Because PAMM BI-1 does not establish standards for the survey effort (e.g., minimum number of survey hours per unit area), it does not ensure all bird nests that may be affected by the Project would be located.

The success of any nest-searching method depends on the surveyor's knowledge of where birds nest, how nesting birds behave, and the best time of day to search for nests.[307] Attaining this knowledge requires training and experience.[308] Because PAMM BI-1 fails to establish standards (minimum qualifications) for the person that would conduct the nesting bird surveys, it does not ensure that person would have the qualifications needed to successfully locate all nests prior to an activity that could result in take.

The DEIR also incorrectly assumes the biologist would be able to locate bird nests within the two-week window prior to the activity that could result in take, irrespective of the timing of that activity in relation to the nesting cycle. For example, Swainson's hawk nests are extremely difficult to locate during certain times of the year and even the most experienced surveyor will miss them.[309] As a result, the CDFW recommends project proponents implement the Swainson's hawk survey protocol developed by the Swainson's Hawk Technical Advisory Committee.[310] The protocol is designed to "maximize the potential for locating nesting Swainson's hawks, and thus reducing the potential for nest failures as a result of project activities/disturbances."[311] The DEIR does not require implementation of the Swainson's hawk survey protocol.

The response of nesting birds to human-related disturbance activities is dependent on numerous site-specific and species-specific variables. Consequently, determining the appropriate buffer distance requires knowledge of species-specific responses to various types of disturbance in various settings. Many biologists that have experience conducting nesting bird surveys have no experience with (or knowledge of) avian responses to disturbance. As a result, PAMM BI-1 lacks assurances that the "qualified biologist" would establish appropriate, species-specific no-disturbance buffers around all active nests. This issue is compounded by the lack of a monitoring program that would validate the adequacy of a nest buffer installed by the biologist.

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[307] Winter M, Hawks SA, Shaffer JA, Johnson DH. 2003. Guidelines for Finding Nests of Passerine Birds in Tallgrass Prairie. The Prairie Naturalist 35(3):197-211.
[308] *Ibid. See also* Martin TE, Geupel GR. 1993. Nest-Monitoring Plots: Methods for Locating Nests and Monitoring Success. J. Field Ornithol. 64(4):507-519.
[309] Swainson's Hawk Technical Advisory Committee. 2000. Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley. p. 3.
[310] *See* California Department of Fish and Wildlife. 2021. Survey and Monitoring Protocols and Guidelines [website]. Available at: <https://wildlife.ca.gov/Conservation/Survey-Protocols#377281284-birds>. (Accessed 21 Dec 2021).
[311] Swainson's Hawk Technical Advisory Committee. 2000. Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley. p. 1.

PAMM BI-5 – Management of Invasive Plant and Noxious Weed Populations

PAMM BI-5 states:

> "Invasive plant and noxious weed populations encountered during construction, operation and management activities will be removed, handled and/or disposed of in such a manner as to prevent further spread of these species."[312]

This PAMM is vague and lacks assurances that the Project would not result in the colonization or spread of invasive plant and noxious weed populations. Reliance on chance encounters during construction activities is not a reliable strategy. Minimizing the colonization or spread of invasive plants requires proactive efforts, such as those described in the "Early Detection Rapid Response" (EDRR) Framework.[313]

The DEIR needs to clarify the geographic and temporal scope of the activities performed under PAMM BI-5. For example, the DEIR needs to clearly articulate whether the weed management activities would be conducted throughout the entire Project study area throughout the entire life of the Project. In addition, the DEIR must incorporate measurable success criteria, and monitoring and reporting requirements, for PAMM BI-5.

PAMM BI-6 – Channel Restoration

PAMM BI-6 states:

> "Restoration of stream channel segments affected by temporary and permanent road construction will be designed in a way to reestablish the functions and values necessary to sustain aquatic and riparian organisms (e.g., riparian canopy, sinuosity, floodplain, and natural channel bed)."[314]

PAMM BI-6 is vague. The DEIR must identify the specific organisms (or indicator species) that would be "sustained" by the restoration activities. In addition, PAMM BI-6 must incorporate: (a) performance standards, and (b) a monitoring and reporting program that would demonstrate restoration of the functions and values.

PAMM BI-8 – Wildlife Exclusion Fencing

PAMM BI-8 states:

> "Fabric exclusion fences will be installed at select areas associated with construction traffic (e.g., roadways, proposed staging areas, etc.) to preclude special-status species from entering the project site and avoid redirecting the animals into unsuitable habitat or harm's way. The placement of 18-inch above grade exclusionary fences will be placed under the direction and supervision of a

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312 DEIR, p. 2-43.

313 U.S. Department of the Interior. 2016. Safeguarding America's lands and waters from invasive species: A national framework for early detection and rapid response, Washington D.C., 55p.

314 DEIR, p. 2-44.

> qualified biologist and will be buried to a minimum of 6-inches below grade to prevent animal entry."[315]

As discussed previously, the value of PAMM BI-8 in minimizing construction-related mortality of animals cannot be evaluated because the DEIR does not identify the "select areas" where exclusion fences would be installed. An exclusion fence that is 18-inch above grade and buried 6-inches below grade would not preclude mountain lions, badgers, or San Joaquin kit foxes from entering the Project site. As a result, there is no basis for the DEIR's statement that implementation of PAMM BI-8 "would minimize the potential for direct and indirect impacts on these species."[316]

PAMM BI-9a – Wetland Buffers

PAMM BI-9a states:

> "Except for those areas specifically identified where impacts cannot be practicably avoided outside the inundation area, a minimum 25- foot buffer surrounding all wetlands and other jurisdictional waters located on or within 25 feet of the project area (excluding the area below the existing full pool elevation of Pacheco Reservoir) will be clearly designated on the final project construction plans and marked on the site with orange exclusionary fencing."[317]

One of the important factors that determines the effectiveness of a buffer is its size. Based on their review of the literature, Castelle et al. (1994) reported that a buffer of at least 15 meters (49 feet) was needed to protect wetland and stream functions under most conditions.[318] However, a range of buffer widths from 3 to 200 meters was found to be effective, depending on site-specific conditions. Consequently, Castelle et al. recommended evaluation of four criteria to determine the appropriate buffer size: (1) resource functional value, (2) intensity of adjacent land use, (3) buffer characteristics, and (4) specific buffer functions required. The DEIR does not include evaluation of these criteria, nor does it provide evidence that a 25-foot buffer would be sufficient to prevent significant impacts to wetlands.

PAMM BI-9b – Swallow Exclusion

PAMM BI-9b states:

> "At least six months prior to the start of construction, a qualified biologist will identify swallow colonies nesting in, and within 100 feet of construction areas. During the months of September through February, a qualified biologist shall supervise the installation of netting or screens to prevent colonies from becoming established on or near structures that will be destroyed by construction (after verifying that no swallows would be trapped)."[319]

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[315] *Ibid*.
[316] DEIR, pp. 3.5-108 and -109.
[317] DEIR, p. 2-44.
[318] Castelle AJ, Johnson AW, Conolly C. 1994. Wetland and Stream Buffer Size Requirements—A Review. J. Environ. Qual. 23:878-882.
[319] DEIR, pp. 2-44 and -45.

Netting is known to be an entanglement hazard to wildlife and has resulted in mass fatality of swallows.[320] As a result, PAMM BI-9b would cause a significant impact that was not disclosed or analyzed in the DEIR.

PAMM BI-9c – Exclusion for Special-Status Bat Species

PAMM BI-9c states:

> "At least six months prior to the start of construction, a qualified biologist shall identify potential special-status bat maternity sites in, and within 500 feet of construction areas. If potential sites have been identified, during the months of November through February, a qualified biologist shall supervise the installation of screens at potential roosts to prevent bat use (after verifying that no bats would be trapped by screening). The biologist will monitor the effectiveness of the netting if it remains in place during any portion of the bat maternity roosting period until the structure or netting is removed."[321]

Locating maternity roosts can be extremely difficult, so it is impractical for the DEIR to imply that the biologist would be able to identify all maternity roosts within 500 feet of construction areas. This issue is exacerbated by the DEIR's failure to specify the techniques that need to be implemented to locate maternity roosts. This is important because detection of bat roosts requires specialized techniques (e.g., acoustic monitoring) that vary by species.

The DEIR must clarify whether PAMM BI-9c allows the installation netting (an entanglement hazard). Some bat species use the roost site as both a maternity roost and a winter roost. Installing screens over the maternity roost between November and February could entrap wintering bats. Bat roosts generally occur in places that can't be visually inspected by a biologist. This makes it difficult (or impossible) to determine whether a roost is unoccupied. As a result, preventing impacts to roosting bats requires installation of one-way exclusion devices that remain in place for at least seven days prior to removal of the roost.[322] Because PAMM BI-9c does not identify methods for confirming the roost is unoccupied, and because PAMM BI-9c does not require installation of one-way exclusion devices, Project impacts to bat roosts remain potentially significant.

PAMM BI-9c does not address potentially significant impacts to winter roosts. This is important because the metabolic cost of waking bats from hibernation can be very high and can be enough to reduce their energy supply to the point where survival is not possible.[323]

[320] Center for Biological Diversity. 2014 Jan 16. Press Release: Caltrans to Remove Bird-killing Nets at Highway Project, Vows to Use Safer Methods. Available at: <https://www.biologicaldiversity.org/news/press_releases/2014/caltrans-01-16-2014.html>.
[321] DEIR, p. 2-45.
[322] Bat Conservation International [website]. 2021. Bats in Homes & Buildings. Available at: <https://www.batcon.org/about-bats/bats-in-homes-buildings/>. (Accessed 21 Dec 2021).
[323] H.T. Harvey & Associates. 2004. California Bat Mitigation Techniques, Solutions, and Effectiveness. p. 30.

PAMM BI-14 – Comply with Restrictions on Herbicide Use in Aquatic Areas

PAMM BI-14 states: "[c]onsistent with provisions of Q751D02: Control and Oversight of Pesticide Use, only herbicides and surfactants registered for aquatic use will be applied within the banks of channels within 20 feet of any water present."[324] The adverse effects of this PAMM cannot be evaluated because Q751D02 was not included in the DEIR, nor is it a publicly-available document.

In addition, on May 17, 2010, the U.S. District Court for the Northern District of California issued a stipulated injunction establishing a series of no-use buffers on 75 pesticide active ingredients for the protection of 11 species in Santa Clara and several other Bay Area counties.[325] PAMM BI-14 does not appear to comply with the stipulated injunction.

PAMM Fire-1 – Fire Protection and Prevention Plan

PAMM Fire-1 entails preparation of a Fire Protection and Prevention Plan.[326] The activities that would be implemented under PAMM Fire-1 (e.g., routine clearance of vegetation) have the potential to cause habitat fragmentation, habitat type conversion, or other potentially significant impacts on biological resources.[327] Deferral of the Fire Protection and Prevention Plan precludes the public from understanding the extent and magnitude of environmental impacts associated with PAMM Fire-1.

PAMM WQ-5 –Seeding and Other Measures for Erosion Control, Weed Suppression, and Site Improvement

PAMM WQ-5 states:

> "Disturbed areas shall be seeded with native seed consistent with Valley Water and other agency requirements and/or have other erosion control and weed suppression measures applied as soon as construction activities have been completed at the respective locations within the Project area. Other erosion control and weed suppression measures may include on-site wood chips, on-site chipped or masticated (crushed) brush or clearing slash, or other organic and inorganic materials."[328]

Most soil binders (chemical dust suppressants), including varieties that are "non-toxic" to humans, can have adverse effects on the environment. Therefore, the DEIR must clarify whether soil binders might be used as an erosion control method at the Project site.

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[324] DEIR, p. 2-47.
[325] *See* <https://www.epa.gov/sites/default/files/2015-07/documents/order-stip.pdf>.
[326] DEIR, p. 2-51.
[327] For example, *see* Keeley JE. 2002. Fire management of California shrublands. Environmental Management 29:395–408.
[328] DEIR, p. 2-55.

Moving wood chips or slash from one location to another location has the potential to spread *Phytophthora ramorum* and other plant pathogens. Therefore, the DEIR must clarify the distance wood chips and slash would be moved within the site.

MITIGATION MEASURES

The DEIR's core strategy for mitigating the Project's most significant impacts is the formulation of mitigation "plans" after termination of the CEQA review period. The DEIR defers fundamental components of those plans, including: (1) performance standards (or success criteria) for the mitigation; (2) the monitoring and reporting requirements; (3) criteria for the selection of compensatory mitigation sites; (4) the adaptive management framework; and (5) the financial assurances. The pledge to formulate a "plan" of unknown quality and scientific rigor is not mitigation.

Deferring fundamental aspects of the mitigation measures until after completion of the CEQA review process—as proposed in the DEIR—precludes the ability to evaluate the sufficiency of the proposed measures, and thus, whether they would mitigate the Project's significant impacts to less-than-significant levels. It also effectively robs the public, resource agencies, and scientific community from being able to submit informed comments pertaining to the adequacy of the mitigation measures, and from having those comments vetted during the environmental review process.

CEQA specifically prohibits deferral of mitigation that a lead agency relies on for its findings unless the lead agency: (1) commits itself to the mitigation, (2) adopts specific performance standards the mitigation will achieve, (3) identifies the type(s) of potential action(s) that can feasibly achieve that performance standard and that will be considered, analyzed, and potentially incorporated in the mitigation measure, and (4) demonstrates in the record that a detailed description of the mitigation measure(s) was impractical or infeasible during the Project's environmental review phase.[329] The DEIR fails to satisfy these requirements.

Many of the mitigation measures proposed in the DEIR entail surveys to establish the environmental baseline. Surveys do not constitute mitigation.[330] Furthermore, the DEIR fails to incorporate a mechanism for disclosing the results of the surveys to the public, thus precluding public knowledge of the Project's actual impacts on the environment.

Many of the mitigation measures state: "Valley Water will mitigate for long-term and short-term impacts…" Consequently, it appears compensatory mitigation measures would not be implemented for the Project's "temporary" impacts (which may in fact be permanent). The DEIR must clearly articulate: (a) which impact types would require compensatory mitigation, and (b) the specific amount of compensatory mitigation that would be provided for each resource significantly impacted by the Project.

[329] CEQA Guidelines § 15126.4.
[330] CEQA Guidelines § 15370.

Contrary to what the mitigation measures suggest, purchasing credits at a mitigation or conservation bank is not a feasible option for mitigating many of the Project's impacts. For example, there are no conservation banks that sell credits for impacts to the FYLF.[331]

Habitat is defined as: "the resources and conditions present in an area that produce occupancy—including survival and reproduction—by a given organism."[332] However, the DEIR does not require the compensatory mitigation sites to be occupied by the special-status animals that would be significantly impacted by the Project. As a result, the DEIR provides no assurances that the mitigation measures would mitigate the corresponding impacts to less-than-significant levels.

Many of the mitigation measures require activities by a "qualified biologist." However, nowhere does the DEIR establish the expertise the biologist would need to possess to be considered "qualified." The fact that a biologist has done something before (e.g., a nesting bird survey) does not automatically make that person "qualified." The DEIR must establish an objective mechanism for vetting the qualifications of the biologists that would implement the mitigation measures proposed in the DEIR.

The DEIR fails to incorporate mitigation consistent with CDFW guidelines for impacts to the Swainson's hawk and burrowing owl. Contrary to CDFW mitigation guidelines, the DEIR does not require any habitat compensation for impacts to Swainson's hawk habitat.[333] Although Mitigation Measure BI-13b requires surveys and no-disturbance buffers in accordance with CDFW's Staff Report on Burrowing Owl Mitigation, it does not require habitat compensation in accordance with the Staff Report.[334]

Mitigation Measure BI-1d: Compensatory Mitigation for Impacts on Riparian Habitats and Sensitive Natural Communities, Excluding Sycamore Alluvial Woodlands

Mitigation Measure BI-1d states:

> "Valley Water will avoid sensitive natural communities and riparian habitats under CDFW jurisdiction when feasible following the results of the surveys conducted prior to construction activities as described in Mitigation Measure BI-1c. For all impacts determined to be unavoidable following pre-construction surveys on riparian habitats and sensitive natural communities (e.g., valley oak woodlands), excluding sycamore alluvial woodlands, Valley Water will prepare a compensatory mitigation plan for review and approval by CDFW to acquire mitigation lands to offset direct upstream and indirect downstream impacts on riparian habitats and sensitive natural communities a minimum preservation ratio of 2:1, or at ratios established in coordination with CDFW that will achieve

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[331] *See* California Department of Fish and Wildlife. 2021. Conservation and Mitigation Banks Established in California by CDFW [webpage]. Available at: <https://wildlife.ca.gov/Conservation/Planning/Banking/Approved-Banks#r3>. (Accessed 26 Nov 2021).
[332] *See* Hall L, Krausman P, Morrison M. 1997. The Habitat Concept and a Plea for Standard Terminology. Wildlife Society Bulletin 25(1):173-182.
[333] California Department of Fish and Game. 1994. Staff report regarding mitigation for impacts to Swainson's hawks (*Buteo swainsoni*) in the Central Valley of California.
[334] California Department of Fish and Game. 2012. Staff Report on Burrowing Owl Mitigation.

> equivalent or greater mitigation… Should restoration or enhancement be approved by CDFW, a restoration plan will be prepared as part of a compensatory mitigation plan. This plan will include items such as: site objectives (comparison of existing and proposed resources and method[s] of compensation), site selection criteria, baseline information, restoration work plan (as applicable), maintenance plan, performance standards (as applicable), monitoring methods and requirements, long-term plan for site management, adaptive management plan, financial assurances, and other pertinent site information."[335]

The DEIR improperly defers formulation of elements critical to the efficacy of Mitigation Measure BI-1d. Although it may have been infeasible to identify the specific properties that would be acquired as mitigation, there is no excuse for the DEIR's deferral of the site selection criteria, performance standards, and monitoring requirements.

The DEIR needs to clarify the relationship between the mitigation strategy (i.e., preservation, restoration, or enhancement) and the 2:1 mitigation ratio proposed in Mitigation Measure BI-1d. For example, it is unclear whether 200 acres of compensatory mitigation could be satisfied by preserving 100 acres and then enhancing those 100 acres, or whether at least 200 acres must be preserved, then enhanced if those 200 acres do not provide ecological functions equivalent to those impacted by the Project.

CDFW's scoping comments informed Valley Water that riparian vegetation provides many important ecosystem functions, and that appropriate and effective compensatory mitigation for loss of riparian habitat would require replacement plantings (i.e., habitat creation or restoration) at a ratio of at least 3:1 per area impacted.[336] The DEIR proposes implementation of a 2:1 ratio, which appears arbitrary. Therefore:

> *The DEIR must explain why the DEIR does not incorporate the compensatory mitigation ratio requested by CDFW. In addition, scientific evidence and analysis demonstrating a 2:1 ratio would ensure the Project's impacts are reduced to less than significant levels must be provided.*

The DEIR claims that:

> "Potential compensatory mitigation sites may include areas within the Project study area (e.g., 200-foot buffer around the expanded reservoir proposed for watershed management/shoreline buffer and access), locations within the SCVHP boundary such as watersheds adjacent to Pacheco Creek and the northern portions of North Fork Pacheco Creek, and locations outside of the SCVHP and Santa Clara County boundaries such as the Los Banos Creek watershed."[337]

The Project's compensatory mitigation requirements are substantial. The northern portions of North Fork Pacheco Creek do not appear to contain feasible mitigation sites because they are located in Henry Coe State Park. If the mitigation requirements are satisfied within the SCVHP

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[335] DEIR, p. 3.5-312.
[336] DEIR, Public and Agency Scoping Process Appendix, Attachment B, p. 1-6.
[337] DEIR, p. 3.5-312.

boundary, it could have adverse effects on the SCVHA's ability to acquire properties needed to satisfy the terms of the SCVHP. The DEIR makes the conclusory statement that a potential conflict with the SCVHP is limited to sycamore alluvial woodlands, but that statement is not accompanied by any evidence demonstrating the absence of conflicts with other land cover types. To the contrary, the SCVHA has concluded: "[i]f Valley Water's need to mitigate for hundreds of acres of high value conservation land results in the introduction of a new competitor for the same dwindling resources, then the Conservation Strategy becomes increasingly difficult to implement. This would be a conflict with an existing habitat conservation plan and would result in a significant impact under CEQA."[338]

The DEIR states that potential compensatory mitigation sites may be located outside of the SCVHP and Santa Clara County boundaries, *such as* in the Los Banos Creek watershed.[339] This statement is relatively uninformative because it does not establish a geographic limit on the location of potential compensatory mitigation sites.

The reservoir's 200-foot buffer would not be a viable compensatory mitigation site because the new reservoir would negatively impact adjacent ecosystems.[340] For example, the 200-foot buffer would not serve as a viable mitigation site for many of the special-status animals due to the number of bullfrogs (and other exotic species) that would inhabit the reservoir. Indeed, the 200-foot buffer would likely function as a population sink for some of the species (e.g., CTS and CRLF). The 200-foot buffer would not serve as a viable mitigation site for special-status plants, and many sensitive natural communities, due to: (a) dramatic changes in groundwater availability caused by the reservoir and associated fluctuations in water levels; and (b) the likelihood that the littoral zone would be colonized by invasive plants. The DEIR does not provide a map of (or otherwise identify) the vegetation communities, habitats, and soil types that currently occur in the 200-foot buffer, nor does it analyze which ones are likely to persist in the buffer given the environmental influences of the reservoir.

The 200-foot buffer zone around the reservoir would effectively function as a habitat "doughnut" with a circumference of approximately 35 miles. There would be no ability to control the threats beyond the 200-foot buffer, and thus the DEIR must assume that all of the "mitigation species" could be sustained by habitat within the buffer. This is not a valid assumption, especially for species that migrate, have large home ranges, or depend on metapopulation dynamics.

Mitigation Measure BI-2c: Compensatory Mitigation for Impacts on Sycamore Alluvial Woodlands

Mitigation Measure BI-2c defers formulation of the compensatory mitigation plan for Project impacts to sycamore alluvial woodlands. The Project would eliminate one of the last large stands of sycamore alluvial woodlands remaining in the state, and it may not be possible to

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[338] Santa Clara Valley Habitat Agency. 2022 Feb 8. Pacheco Reservoir Expansion Project (PREP) Draft EIR/EIS Comments. p. 2.
[339] DEIR, p. 3.5-312.
[340] Chen Z, Yuan X, Roß-Nickoll M, Hollert H, Schäffer A. 2020. Moderate inundation stimulates plant community assembly in the drawdown zone of China's Three Gorges Reservoir. Environmental Sciences Europe 32(1):1-11. *See also* Zohary T, Ostrovsky I. 2011. Ecological impacts of excessive water level fluctuations in stratified freshwater lakes. Inland waters 1(1):47-59.

mitigate that impact given the scarcity of potential mitigation sites. Therefore, it is absolutely essential that the public be given the opportunity to comment on the DEIR's compensatory mitigation plan during the CEQA review period.

The DEIR states:

> "Based on The Definition and Location of Central California Sycamore Alluvial Woodland (Keeler-Wolf, et al. 1997) and the California Protected Areas Database, approximately 550 acres of sycamore alluvial woodlands that are not currently under land protections are present in neighboring Alameda, Stanislaus, and Merced Counties (GreenInfo Network 2021)."[341]

This information is misleading. There are only three occurrences (i.e., #1, #3, and #14) of sycamore alluvial woodland on private lands in Alameda, Stanislaus, and Merced Counties.[342] Approximately 120 acres of occurrence #1 (425.9 acres in Merced County) is already protected.[343] Approximately 100 acres of occurrence #3 (249 acres in Stanislaus County) is already protected. Occurrence #14 (87.4 acres in Alameda County) remains unprotected. Thus, there are approximately 541 acres of sycamore alluvial woodlands that could potentially be acquired (or otherwise protected) to satisfy the Project's mitigation requirement (211.5 acres for the Proposed Project). This is consistent with the DEIR's statement that there are approximately 550 acres of potential mitigation lands in Alameda, Stanislaus, and Merced Counties.

Occurrence #14 consists of "small to medium sized" sycamores in a linear band extending for over two miles along Arroyo Mocho. Numerous private parcels overlap this occurrence. It is unlikely Valley Water would be able to acquire (or otherwise protect) all of those parcels. I was unable to identify the number of parcels associated with occurrence #1 and occurrence #3. Thus, it is unknown how many property owners would need to be willing to work with Valley Water to protect these two occurrences. However, the fact that there are only three occurrences on private lands in neighboring counties, and that not all private landowners may be willing to sell their property (or have it encumbered by a conservation easement), is substantial evidence that the sycamore alluvial woodland mitigation proposed in the DEIR may not be feasible.

Specifically:

a) If Valley Water is unable to acquire (or otherwise protect) occurrence #1, it would need to acquire nearly all of both occurrence #3 and occurrence #14 to satisfy the Project's mitigation requirement.

However,

b) It is unlikely Valley Water would be able to acquire (or otherwise protect) all of the parcels associated with occurrence #3 and occurrence #14 (due to the number of landowners).

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[341] DEIR, p. 3.5-315.

[342] California Natural Diversity Database. 2022. RareFind 5 [Internet]. California Department of Fish and Wildlife [Jan 30, 2022].

[343] California Protected Areas Database. 2021. Available at: <https://www.calands.org/>. (Accessed 6 Feb 2022).

There is substantial evidence that Mitigation Measure BI-2c may not be feasible due to the difficulty in finding unhybridized seed sources;[344] the limited number of sites that potentially could be acquired for compensatory mitigation; conflicts with the Santa Clara Valley Habitat Plan;[345] and competition with the California High-Speed Rail Authority to acquire sycamore alluvial woodland compensation sites.[346] The DEIR allows Valley Water to implement Mitigation Measure BI-2c "concurrent the construction period."[347] As a result, the DEIR opens the possibility that the Project would impact sycamore alluvial woodlands before the feasibility of the mitigation can be demonstrated.

For the reasons discussed above, the Project's impacts on sycamore alluvial woodlands would be extremely significant (severe) and potentially unmitigable.

Mitigation Measure BI-5b: Avoidance of Special-Status Plant Populations

Mitigation Measure BI-5b requires avoidance buffers a minimum of 100 feet from special-status plant species populations. The DEIR fails to provide evidence or analysis justifying the assumption that a 100-foot no disturbance buffer would be sufficient to avoid impacts to special-status plants, nor does it incorporate performance standards that would ensure efficacy of the 100-foot buffer. The buffer size needed to protect special-status plants from indirect impacts is site- and species-specific, and it requires: (1) identifying risk factors and potential impacts to the species of concern, and (2) determining the permeability of the urban-wildland boundary to vectors of those risk factors.[348] Although no bright line rule exists, based on my review of relevant scientific literature and consultations with other experts, 200 feet is the *absolute minimum* set-back distance needed to protect a special-status plant from indirect impacts.[349]

Mitigation Measure BI-5c: Mitigation for Impacts on Special-Status Plants and Monarch Butterfly

The cornerstone of the mitigation strategy proposed in Mitigation Measure BI-5c is deferral of the Mitigation and Monitoring Plan and its most critical components (e.g., success criteria, monitoring requirements, and adaptive management framework). In addition to violating CEQA, deferral of the Mitigation and Monitoring Plan robs the public from being able to submit comments on the Plan's adequacy in mitigating the Project's significant impacts.

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344 California Department of Fish and Wildlife. 2019 Oct 2. Comments on the San Luis Low Point Improvement Project Draft Environmental Impact Statement/Environmental Impact Report. Available at: <https://ceqanet.opr.ca.gov/2002082020/3>. (Accessed 23 Nov 2021).

345 DEIR, p. 3.5-114.

346 The San Jose to Merced Project Section requires 50.4 acres of compensatory mitigation for impacts to sycamore alluvial woodlands. *See* California High-Speed Rail Authority. 2020 Apr. Draft Environmental Impact Report / Environmental Impact Statement: San Jose to Merced Section. pp. 3.7-165 and -183. I was unable to determine whether additional mitigation is required for any of the other high-speed rail segments.

347 DEIR, p. 3.5-315. "Implementation of Mitigation Measure BI-2c will occur concurrent [with] the construction period identified for the Proposed Project or Alternatives A through D, and for a period of time afterwards."

348 *See review provided in:* Conservation Biology Institute. 2000. Review of potential edge effects on the San Fernando Valley spineflower (*Chorizanthe parryi* var. *fernandina*). Unpublished report prepared for Ahmanson Land Company, West Covina, California, by CBI, San Diego California.

349 *Ibid*.

Mitigation Measure BI-5c states:

> "Where feasible as determined by Valley Water and CDFW, seeds and/or plants grown from seed (depending upon the species) will be planted to either supplement the impacted population or establish a new population in suitable habitat near where the seeds were collected within the same watershed (e.g., next to the plant population affected)."[350]

Attempts to establish new plant populations are experimental and often unsuccessful.[351] Furthermore, if plants are installed to "supplement the impacted population," those plants presumably would be subject to indirect impacts (e.g., weeds and other edge effects) associated with the activity that caused the initial impacts. As a result, it is absolutely essential that the DEIR establish: (a) scientifically defensible success criteria for Mitigation Measure BI-5c, and (b) monitoring and reporting requirements for Mitigation Measure BI-5c. These specific elements of the Mitigation and Monitoring Plan must be vetted by the public and natural resource agencies before the EIR is adopted. Because Mitigation Measure BI-5c is nothing more than a commitment to formulate a "plan" of unknown quality and scientific rigor, Project impacts to special-status plants and the monarch butterfly remain potentially significant.

Mitigation Measure BI-7: Access and Utility Area Special-Status Animal Species Habitat

Mitigation Measure BI-7 requires surveys to identify habitat in the access and utility area. It states:

> "These surveys will be reconnaissance in nature and will be performed to determine the potential for special-status animal species to occur in the access and utility area portion of the Project study area and to quantify the amount of suitable habitat. Impacts on identified suitable habitat for each special-status animal species that may occur in the access and utility area will be quantified and added to the other impacts identified within the upstream and downstream areas."[352]

The mitigation measure confirms that the "desktop analysis" used for the DEIR was incapable of providing an accurate estimate of Project impacts to habitat in the access and utility area.

Mitigation Measure BI-8b: Compensatory Mitigation for Impacts on California Tiger Salamander, California Red-legged Frog, Foothill Yellow-legged Frog, and Western Pond Turtle

Mitigation Measure BI-8b serves as the central component of the DEIR's proposed mitigation strategy for direct, indirect, and cumulative impacts to thousands of acres of oak woodlands and wildlife habitat. Indeed, according to the DEIR, if a special-status animal would be significantly impacted by habitat loss caused by the Project, Mitigation Measure BI-8b would reduce the

[350] DEIR, p. 3.5-318.
[351] Fiedler PL. 1991. Mitigation-related transplantation, relocation and reintroduction projects involving endangered and threatened, and rare plant species in California. Final Report to the California Department of Fish and Game.
[352] DEIR, pp. 3.5-319 and -320.

impact to "less than significant."[353] The DEIR attempts to get away this bold assertion by deferring formulation of the compensatory mitigation plan required under Mitigation Measure BI-8b.

Not only does the DEIR defer formulation of the plan, but it also defers formulation of the plan's most critical elements. These elements include, but are not limited to: (1) the specific vegetation communities or habitat types that would qualify as compensatory mitigation; (2) selection criteria (e.g., geographic bounds) for potential mitigation sites; (3) performance standards for the mitigation site; (4) monitoring and reporting requirements; (5) the adaptive management framework; (6) the specific timeline for implementation in relation to Project impacts; and (7) mechanisms (e.g., financial security) that ensure the mitigation is implemented and the mitigation site is properly managed in perpetuity. These elements must be defined and disclosed for public review because they are critical to the plan's ability to mitigate many of the Project's significant impacts.

For example, both the California Tiger Salamander Recovery Plan and the California Red-legged Frog Recovery Plan emphasize the importance of viable metapopulations. One of the recovery criteria for the CRLF is: "[p]opulations are geographically distributed in a manner that allows for the continued existence of viable metapopulations despite fluctuations in the status of individual subpopulations (i.e., when populations are stable at each core area)."[354] This is important because it may not be possible to satisfy the compensatory mitigation requirement (approximately 3,552 acres for the Proposed Project alternative) in Santa Clara County due to conflicts with the Santa Clara Valley Habitat Plan and scarcity of large parcels available for acquisition. Whereas acquiring compensation lands may be possible in other regions (e.g., counties or watersheds), that approach would not mitigate impacts to the CTS and CRLF metapopulations affected by the project.[355]

Mitigation Measure BI-8c: Translocation Plan

The DEIR identifies Mitigation Measure BI-8c as one of the measures that would reduce significant impacts on special-status amphibians and reptiles to less than significant levels.[356] Mitigation Measure BI-8c entails development of a translocation plan that is submitted to the USFWS and CDFW for review at least 30 days prior to the start of construction.

Most reptile and amphibian translocation efforts are unsuccessful.[357] At best, mitigation-driven translocations reduce the number of deaths that occur as a direct result of the project. However, poorly planned translocations can result in high mortality rates of both the translocated animals

[353] DEIR, pp. 3.5-85, -88, -91, -94, -95, -104, -107, and -112.
[354] U.S. Fish and Wildlife Service. 2002. Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*). U.S. Fish and Wildlife Service, Portland, Oregon. viii + 173 pp.
[355] The California tiger salamander, California red-legged frog, foothill yellow-legged frog, and western pond turtle have metapopulation structures.
[356] DEIR, pp. 3.5-88, -91, -94, and -95.
[357] Dodd CK Jr., Seigel RA. 1991. Relocation, repatriation, and translocation of amphibians and reptiles: Are they conservation strategies that work? Herpetologica 47(3):336-350. *See also* Germano JM, Field KJ, Griffiths RA, Clulow S, Foster J, Harding G, Swaisgood RR. 2015. Mitigation-driven translocations: Are we moving wildlife in the right direction? Frontiers in Ecology and the Environment 13.

and the animals at the receptor sites. As a result, it imperative that a scientifically defensible translocation plan is vetted by the scientific community before any animals are translocated from the Project site. Submittal of a translocation plan 30 days prior to the start of construction is not an acceptable approach. Due to the severity of the potential consequences, the timing of the activities associated with Mitigation Measure BI-8c must be driven by a sound ecological assessment—not the Project's development schedule.

Some of the animals intended for translocations are inadvertently killed while being captured, handled, and moved. The animals that survive this process are likely to die if habitat at the release site is not high quality. Germano and Bishop (2008) concluded "[i]f the release habitat is not of high quality, then the chances of a positive outcome are low even when all other factors are taken into consideration. Although we could not evaluate habitat quality in the publications we reviewed, poor or unsuitable habitat was one of the most often reported reasons for translocation failure."[358]

Moving animals from one population to another can introduce disease or cause other negative impacts to animals at the release site (e.g., due to competition with translocated animals).[359] The potential for Mitigation Measure BI-8c to spread disease is high given the prevalence of chytridiomycosis in California's amphibian populations.

Mitigation Measure BI-8c states:

> "The plan will also include maps and descriptions of agency-approved recipient sites for translocated individuals when translocation within or immediately adjacent to the Project study area is not feasible due to active construction that may harm a species or if there is a risk of the species re-entering the Project study area."[360]

This provision does not resolve the problem because there are no assurances that the agency (USFWS or CDFW) would conduct the assessment needed to identify appropriate recipient sites (e.g., sites that could support translocated animals), nor is it likely that such an assessment could be conducted in the 30 days prior to start of construction. Furthermore, although Mitigation Measure BI-8c establishes provisions for equipment sterilization, there are no provisions for disease testing prior to moving potentially infected animals from the Project site to the recipient sites.

The DEIR fails to disclose and analyze the potentially significant impacts associated with Mitigation Measure BI-8c. Because the DEIR incorrectly assumed that Mitigation Measure BI-8c would reduce impacts on special-status reptiles and amphibians to a less than significant level, and because the DEIR does not incorporate a strategy for reducing the potentially significant impacts caused by Mitigation Measure BI-8c, impacts to special-status reptiles and amphibians remain significant.

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[358] Germano JM, Bishop PJ. 2008. Suitability of amphibians and reptiles for translocation. Conservation Biology 23(1):7-15.
[359] Dodd CK Jr., Seigel RA. 1991. Relocation, repatriation, and translocation of amphibians and reptiles: Are they conservation strategies that work? Herpetologica 47(3):336-350.
[360] DEIR, p. 3.5-322.

Mitigation Measure BI-13a: Avian Transmission Line Design Avoidance Measures, and Mitigation for Loss of Habitat

Electrocution from, and collision with, power lines is one of the leading causes of golden eagle and California condor mortality, and it is known to be a limiting factor for both species.[361] Mitigation Measure BI-13a states:

> "To minimize the potential for collision and electrocution to eagles, California condors, and other passerine and raptor species, the new transmission line will incorporate the APLIC transmission line and tower component separation standards. In addition, this measure will incorporate the recommendations to reduce collision risk that are included in these standards to minimize/avoid electrocution of eagles and other raptors (including California condors) attempting to perch or nest on the towers and avoid collisions with transmission lines between towers during low-level flights. The APLIC design standards typically address configuration and spacing of transmission lines, use of line marking devices/diverters, and appropriate spacing of electrical components affixed to towers/poles."[362]

Implementation of the APLIC standards is an effective tool for reducing electrocutions. However, even APLIC admits: "[a]lthough avian-safe construction minimizes electrocution risk, electrocutions can never be completely eliminated. Because wet feathers and wet wood are conducive, birds can be electrocuted during wet weather on normally benign poles."[363]

The APLIC standards are less effective at reducing avian collisions because there are no universal solutions to mitigating the collision risks. Consequently, the APLIC documents are intended to facilitate understanding of the collision risks, and to illuminate the suite of solutions that can be utilized in a "toolbox" fashion to reduce the risks. Minimizing the collision risks begins with studies (e.g., geospatial analysis) designed to identify the site-specific circumstances that contribute to the risks. For example, the studies might reveal that a proposed power line should be installed on the north side of the hill, because installing it on the south side of the hill would place it directly in the flight path of a nearby eagle nest.

The DEIR does not include the analysis needed to minimize the collision risks associated with the Project's proposed power line. Implementing remedial actions (e.g., flight diverters) after the power line is installed is not nearly as effective as siting the power line away from site-specific

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[361] U.S. Fish and Wildlife Service. 2016. Final Programmatic Environmental Impact Statement for the Eagle Rule Revision. Washington: Dept. of Interior. *See also* Lehman RN, Savidge JA, Kennedy PL, Harness RE. 2010. Raptor electrocution rates for a utility in the intermountain western United States. The Journal of Wildlife Management 74(3):459-70.
[362] DEIR, p. 3.5-322.
[363] Avian Power Line Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute and APLIC. Washington, D.C. p. 56.

landscape features (e.g., saddles) conducive to avian collisions.[364] This is especially true for species that are adapted to flying in open airspace clear of hazards. For example, one of the reasons flight diverters are relatively ineffective in preventing golden eagle collisions with power lines is because a golden eagle's vision is usually directed at the ground where prey items are located—*not* at the airspace ahead of them where foreign hazards (with or without bird diverters) might be located.[365]

Because California condor and golden eagle populations cannot withstand any additional take, even one electrocution or collision caused by the Project would constitute a significant impact. The DEIR fails to incorporate mitigation for this impact. As discussed previously, if the Project has the potential to cause take of a California condor or golden eagle, a federal take permit must be issued prior to the taking.

Mitigation Measure BI-13b: Burrowing Owl Surveys

Mitigation Measure BI-13b states:

> "the entire proposed impact area (excluding the proposed inundation area) as well as a 150-meter (500-foot) buffer, where suitable habitat exists, would be assessed prior to conducting the species surveys. The purpose of the assessment is to document the habitat vegetation, topography, potential burrow sites, burrowing owl sign (i.e., scat, pellets, whitewash), burrowing owl individuals, and to determine the probability of the habitat supporting burrowing owl."[366]

These statements confirm absence of the assessment needed to provide an accurate description of the Project's environmental setting and impacts to burrowing owls. Furthermore, there is no basis for excluding the proposed inundation area, which would be subject to direct impacts (e.g., vegetation removal, blasting, and construction of temporary access roads) that could cause take of burrowing owls.

According to CDFW's 2012 Staff Report on Burrowing Owl Mitigation ("Staff Report"):

> "the current scientific literature supports the conclusion that mitigation for permanent habitat loss *necessitates replacement with an equivalent or greater habitat area* for breeding, foraging, wintering, dispersal, presence of burrows, burrow surrogates, presence of fossorial mammal dens, well drained soils, and abundant and available prey within close proximity to the burrow."[367]

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[364] Barrientos R, Ponce C, Palacin C, Martin CA, Martin B, Alonso JC. 2012. Wire Marking Results in a Small but Significant Reduction in Avian Mortality at Power Lines: A BACI Designed Study. PLoS ONE 7(3):e32569. *See also* U.S. Fish and Wildlife Service. 2013 Apr. Eagle Conservation Plan Guidance: Module 1—Land-based Wind Energy, Ver 2. Appendix C: Stage 2—Site-Specific Surveys and Assessment.

[365] The height of the Project's power line would be above the height of naturally occurring obstacles (e.g., trees). *See* DEIR, p. 2-21.

[366] DEIR, p. 3.5-323.

[367] California Department of Fish and Game. 2012 Mar 7. Staff Report on Burrowing Owl Mitigation, p. 8. [emphasis added].

The DEIR does not require mitigation for the Project's permanent habitat loss, even if the surveys required by Mitigation Measure BI-13b reveal presence of a core breeding population. As discussed previously, there are no assurances that the compensatory mitigation required under Measure BI-8b (for CRLF and CTS) would have any value as burrowing owl habitat. As a result, potentially significant impacts to burrowing owls remain significant and unmitigated.

Mitigation Measure BI-14b: Compensatory Mitigation for Impacts on Bald and Golden Eagle

Mitigation Measure BI-14b states: "[i]f there is an inadvertent take of a bald eagle or golden eagle during project activities, Valley Water will provide compensatory mitigation through the Bald Eagle and Golden Eagle Electrocution Prevention In-lieu Fee Program (USFWS 2018b)."[368]

Incidental detection of take (e.g., a dead eagle) during "project activities" is not a reliable strategy for mitigating the Project's significant impacts on eagles. For example, the DEIR does not incorporate an objective mechanism for determining whether the take was likely caused by the Project. Furthermore, "take" includes reduced reproduction, territory abandonment, and other consequences that would not be detectable without dedicated monitoring. As a result, the DEIR must incorporate a monitoring program that would assess how much "take" is being caused by the Project. At a minimum, the Project is likely to cause take of the bald eagle territory that occurs in the proposed inundation area. Therefore, in accordance with federal regulations, Valley Water must obtain an incidental take permit (which would include compensatory mitigation requirements) *before any take occurs*.

Mitigation Measure BI-17: Special-Status Bats and Ringtail Pre-Construction Measures

Bats

The DEIR proposes the following measures to mitigate potentially significant impacts to special-status bats:

> "In conjunction with the pre-construction nesting bird surveys described in PAMM BI-1, Valley Water will retain a qualified biologist to conduct surveys of suitable bat roosting locations in and within 250 feet of the Project study area 48 hours prior to disturbance to determine the need for installation of exclusionary netting. The pre-construction survey will be performed to determine if existing trees or structures are being used by special-status bats as roosting locations."[369]

The timing of the bat surveys proposed in Mitigation Measure BI-17 are inconsistent with those proposed in PAMM BI-9c.

Mitigation Measure BI-17 has the same flaws as those discussed previously for PAMM BI-9c. Furthermore, it is not effective to conduct surveys for bat roosting locations concurrent with

[368] DEIR, p. 3.5-323.
[369] *Ibid*.

surveys for nesting birds. Only some bat species extrude guano that is visible outside the roost. As a result, detection of bat roosts (and bird nests) generally requires tracking individuals and observing their behaviors. There is almost no opportunity for a biologist to simultaneously observe bird and bat behavior because most bird species are active during the day, whereas bats are active at dusk and night.

Mitigation Measure BI-17 acknowledges the Project could result in the loss of a maternity or winter (hibernation) roost. The DEIR does not incorporate mitigation (e.g., replacement roosts) for this significant impact. This issue is compounded by the DEIR's failure to incorporate appropriate minimization measures (e.g., exclusion netting kills birds and bats). As a result, the Project's impacts on bats remain significant and unmitigated.

Ringtail

Mitigation Measure BI-17 proposes the following measures for potentially significant impacts to ringtails:

> "Given that work will occur during the natal denning period for ringtail (March 1 to June 30), a qualified biologist will conduct pre-construction surveys no more than three days prior to construction activities within suitable denning habitat. If an active denning location is identified during the survey, CDFW will be contacted to determine the necessary protection and avoidance measures. These measures may include removing vegetation around the potential denning site to discourage occupation within three days prior to removal of the potential denning location."[370]

Mitigation Measure BI-17 improperly defers the mitigation strategy. The DEIR must identify the suite of feasible options that could be implemented to avoid significant impacts to ringtail dens. Removing vegetation around the den is not a protection or avoidance measure, but rather an eviction technique with potentially significant consequences on the associated ringtails.

Ringtails are nocturnal, and their dens (nests) are extremely difficult to detect because they are located in rock recesses, hollow trees, logs, snags, abandoned burrows, or woodrat nests. Because the ringtail is a fully protected species, the DEIR must provide a reliable strategy for detecting (and protecting) all active dens. The DEIR fails to establish minimum standards for the pre-construction survey methods and level of effort. However, even if nocturnal surveys are conducted, it would be impossible for a biologist to detect all active dens within the three-day window proposed in Mitigation Measure BI-17. As a result, Mitigation Measure BI-17 does not reduce the Project's impacts to ringtails to less-than-significant levels.

[370] DEIR, p. 3.5-324.

Mitigation Measure BI-20: Compensatory Mitigation for Impacts on the Romero Ranch

Mitigation Measure BI-20 states:

> "Valley Water will provide compensatory mitigation to offset impacts on the Romero Ranch Conservation Easement at a 2:1 preservation ratio of lands with the same ecological values as the lands impacted by the Proposed Project or Alternatives A through D in addition to any other compensatory mitigation proposed for the impacted resources within the conservation easement. For example, any California red-legged frog habitat impacted within lands subject to a conservation easement will be mitigated for at a 2:1 preservation ratio under the species' respective mitigation measure plus an additional 2:1 preservation ratio for impacts to lands subject to a conservation easement for a total preservation mitigation ratio of 4:1."[371]

There are no assurances that this measure would be effective because there is no mechanism (e.g., focused surveys) for determining the specific sensitive resources that would be impacted within Romero Ranch.

The DEIR requires compensatory mitigation for impacts to CTS and CRLF habitat; the DEIR does not require "other compensatory mitigation" for impacts to sensitive wildlife resources as suggested in Mitigation Measure BI-20. Therefore, if the Project would impact 100 acres of golden eagle habitat in Romero Ranch, but no habitat for CTS or CRLF, the total mitigation ratio would remain 2:1 (thus failing to account for impacts to golden eagle resources in a conservation reserve). The DEIR must disclose: (a) the specific biological resources that would be impacted in Romero Ranch; (b) the quantify of those impacts, by resource; and (c) the specific mitigation ratio that would be applied to each resource.

Mitigation Measure BI-20 adds the following clause:

> "Alternatively, compensatory mitigation could be satisfied through habitat improvement projects or management actions developed through consultation with and approved by the conservation easement holder, property owner(s), and any third-party beneficiaries to the conservation easement within the lands subject to an affected conservation easement."[372]

The DEIR must clarify the relationship between habitat improvement projects (or management actions) and the mitigation ratios proposed in Mitigation Measure BI-20. For example, if the Project would impact 10 acres of CRLF habitat in Romero Ranch, would enhancements to 40 acres of existing CRLF habitat in Romero Ranch satisfy the mitigation obligation? Irrespective of any agreements between Valley Water and the conservation easement holder, if habitat improvement projects or management actions are implemented to mitigate impacts to a sensitive (public) resource, the DEIR must incorporate assurances (e.g., enforceable performance standards) that those actions would be successful.

[371] *Ibid*.
[372] *Ibid*.

This concludes my comments on the DEIR.

Sincerely,

Scott Cashen, M.S.
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Scott Cashen, M.S.
Senior Wildlife Biologist

Scott Cashen has 28 years of professional experience in natural resources management. During that time he has worked as a field biologist, forester, environmental consultant, and instructor of Wildlife Management. Mr. Cashen focuses on CEQA/NEPA compliance issues, endangered species, scientific field studies, and other topics that require a high level of scientific expertise.

Mr. Cashen has knowledge and experience with numerous taxa, ecoregions, biological resource issues, and environmental regulations. As a biological resources expert, Mr. Cashen is knowledgeable of the various agency-promulgated guidelines for field surveys, impact assessments, and mitigation. Mr. Cashen has led field investigations on several special-status species, including ones focusing on the yellow-legged frog, red-legged frog, desert tortoise, steelhead, burrowing owl, California spotted owl, northern goshawk, willow flycatcher, Peninsular bighorn sheep, red panda, and various forest carnivores.

Mr. Cashen is a recognized expert on the environmental impacts of renewable energy development. He has been involved in the environmental review process of over 100 solar, wind, biomass, and geothermal energy projects. Mr. Cashen's role in this capacity has encompassed all stages of the environmental review process, from initial document review through litigation support. Mr. Cashen provided expert witness testimony on several of the Department of the Interior's "fast-tracked" renewable energy projects. His testimony on those projects helped lead agencies develop project alternatives and mitigation measures to reduce environmental impacts associated with the projects.

Mr. Cashen was a member of the independent scientific review panel for the Quincy Library Group project, the largest community forestry project in the United States. As a member of the panel, Mr. Cashen was responsible for advising the U.S. Forest Service on its scientific monitoring program, and for preparing a final report to Congress describing the effectiveness of the Herger-Feinstein Forest Recovery Act of 1998.

AREAS OF EXPERTISE

- CEQA, NEPA, and Endangered Species Act compliance issues
- Comprehensive biological resource assessments
- Endangered species management
- Renewable energy development
- Scientific field studies, grant writing and technical editing

EDUCATION

M.S. Wildlife and Fisheries Science - The Pennsylvania State University (1998)
Thesis: *Avian Use of Restored Wetlands in Pennsylvania*
B.S. Resource Management - The University of California, Berkeley (1992)

PROFESSIONAL EXPERIENCE

Litigation Support / Expert Witness

Mr. Cashen has served as a biological resources expert for over 125 projects subject to environmental review under the California Environmental Quality Act (CEQA) and/or the National Environmental Policy Act (NEPA). As a biological resources expert, Mr. Cashen reviews CEQA/NEPA documents and provides his clients with an assessment of biological resource issues. He then submits formal comments on the scientific and legal adequacy of the project's environmental documents (e.g., Environmental Impact Report). If needed, Mr. Cashen conducts field studies to generate evidence for legal testimony, or he can obtain supplemental testimony from his deep network of species-specific experts. Mr. Cashen has provided written and oral testimony to the California Energy Commission, California Public Utilities Commission, and U.S. district courts. His clients have included law firms, non-profit organizations, and citizen groups.

REPRESENTATIVE EXPERIENCE

Solar Energy
- Abengoa Mojave Solar Project
- Avenal Energy Power Plant
- Beacon Solar Energy Project
- Blythe Solar Power Project
- Calico Solar Project
- California Flats Solar Project
- Calipatria Solar Farm II
- Carrizo Energy Solar Farm
- Catalina Renewable Energy
- Fink Road Solar Farm
- Genesis Solar Energy Project
- Heber Solar Energy Facility
- Imperial Valley Solar Project
- Ivanpah Solar Electric Generating
- Maricopa Sun Solar Complex
- McCoy Solar Project
- Mt. Signal and Calexico Solar
- Panoche Valley Solar
- San Joaquin Solar I & II
- San Luis Solar Project
- Stateline Solar Project
- Solar Gen II Projects
- SR Solis Oro Loma
- Vestal Solar Facilities
- Victorville 2 Power Project
- Willow Springs Solar

Geothermal Energy
- Casa Diablo IV Geothermal
- East Brawley Geothermal
- Mammoth Pacific 1 Replacement
- Orni 21 Geothermal Project
- Western GeoPower Plant

Wind Energy
- Catalina Renewable Energy
- Ocotillo Wind Energy Project
- SD County Wind Energy
- Searchlight Wind Project
- Shu'luuk Wind Project
- Tres Vaqueros Repowering Project
- Tule Wind Project
- Vasco Winds Relicensing Project

Biomass Facilities
- CA Ethanol Project
- Colusa Biomass Project
- Tracy Green Energy Project

Other Development Projects
- Cal-Am Desalination Project
- Carnegie SVRA Expansion Project
- Lakeview Substation Project
- Monterey Bay Shores Ecoresort
- Phillips 66 Rail Spur
- Valero Benecia Crude By Rail
- World Logistics Center

Project Management

Mr. Cashen has managed several large-scale wildlife, forestry, and natural resource management projects. Many of the projects have required hiring and training field crews, coordinating with other professionals, and communicating with project stakeholders. Mr. Cashen's experience in study design, data collection, and scientific writing make him an effective project manager, and his background in several different natural resource disciplines enable him to address the many facets of contemporary land management in a cost-effective manner.

REPRESENTATIVE EXPERIENCE

Wildlife Studies

- Peninsular Bighorn Sheep Resource Use and Behavior Study: (*CA State Parks*)
- "KV" Spotted Owl and Northern Goshawk Inventory: (*USFS, Plumas NF*)
- Amphibian Inventory Project: (*USFS, Plumas NF*)
- San Mateo Creek Steelhead Restoration Project: (*Trout Unlimited and CA Coastal Conservancy, Orange County*)
- Delta Meadows State Park Special-Status Species Inventory: (*CA State Parks, Locke*)

Natural Resources Management

- Mather Lake Resource Management Study and Plan – (*Sacramento County*)
- Placer County Vernal Pool Study – (*Placer County*)
- Weidemann Ranch Mitigation Project – (*Toll Brothers, Inc., San Ramon*)
- Ion Communities Biological Resource Assessments – (*Ion Communities, Riverside and San Bernardino Counties*)
- Del Rio Hills Biological Resource Assessment – (*The Wyro Company, Rio Vista*)

Forestry

- Forest Health Improvement Projects – (*CalFire, SD and Riverside Counties*)
- San Diego Bark Beetle Tree Removal Project – (*SDG&E, San Diego Co.*)
- San Diego Bark Beetle Tree Removal Project – (*San Diego County/NRCS*)
- Hillslope Monitoring Project – (*CalFire, throughout California*)

Biological Resources

Mr. Cashen has a diverse background with biological resources. He has conducted comprehensive biological resource assessments, habitat evaluations, species inventories, and scientific peer review. Mr. Cashen has led investigations on several special-status species, including ones focusing on the foothill yellow-legged frog, mountain yellow-legged frog, desert tortoise, steelhead, burrowing owl, California spotted owl, northern goshawk, willow flycatcher, Peninsular bighorn sheep, red panda, and forest carnivores.

<u>REPRESENTATIVE EXPERIENCE</u>

Biological Assessments/Biological Evaluations ("BA/BE")

- <u>Aquatic Species BA/BE</u> – Reliable Power Project (*SFPUC*)
- <u>Terrestrial Species BA/BE</u> – Reliable Power Project (*SFPUC*)
- <u>Management Indicator Species Report</u> – Reliable Power Project (*SFPUC*)
- <u>Migratory Bird Report</u> – Reliable Power Project (*SFPUC*)
- <u>Terrestrial and Aquatic Species BA</u> – Lower Cherry Aqueduct (*SFPUC*)
- <u>Terrestrial and Aquatic Species BE</u> – Lower Cherry Aqueduct (*SFPUC*)
- <u>Terrestrial and Aquatic Species BA/BE</u> – Public Lands Lease Application (*Society for the Conservation of Bighorn Sheep*)
- <u>Terrestrial and Aquatic Species BA/BE</u> – Simon Newman Ranch (*The Nature Conservancy*)
- <u>Draft EIR (Vegetation and Special-Status Plants)</u> - Wildland Fire Resiliency Program (*Midpeninsula Regional Open Space District*)

Avian

- <u>Study design and Lead Investigator</u> - Delta Meadows State Park Special-Status Species Inventory *(CA State Parks: Locke)*
- <u>Study design and lead bird surveyor</u> - Placer County Vernal Pool Study *(Placer County: throughout Placer County)*
- <u>Surveyor</u> - Willow flycatcher habitat mapping *(USFS: Plumas NF)*
- <u>Surveyor</u> - Tolay Creek, Cullinan Ranch, and Guadacanal Village restoration projects *(Ducks Unlimited/USGS: San Pablo Bay)*
- <u>Study design and Lead Investigator</u> - Bird use of restored wetlands research *(Pennsylvania Game Commission: throughout Pennsylvania)*
- <u>Study design and surveyor</u> - Baseline inventory of bird species at a 400-acre site in Napa County *(HCV Associates: Napa)*
- <u>Surveyor</u> - Baseline inventory of bird abundance following diesel spill *(LFR Levine-Fricke: Suisun Bay)*

- Study design and lead bird surveyor - Green Valley Creek Riparian Restoration Site *(City of Fairfield: Fairfield, CA)*
- Surveyor - Burrowing owl relocation and monitoring *(US Navy: Dixon, CA)*
- Surveyor - Pre-construction burrowing owl surveys *(various clients: Livermore, San Ramon, Rio Vista, Napa, Victorville, Imperial County, San Diego County)*
- Surveyor - Backcountry bird inventory *(National Park Service: Eagle, Alaska)*
- Lead surveyor - Tidal salt marsh bird surveys (*Point Reyes Bird Observatory: throughout Bay Area*)
- Surveyor – Pre-construction surveys for nesting birds (*various clients and locations)*

Amphibian

- Crew Leader - Red-legged frog, foothill yellow-legged frog, and mountain yellow-legged frog surveys *(USFS: Plumas NF)*
- Surveyor - Foothill yellow-legged frog surveys *(PG&E: North Fork Feather River)*
- Surveyor - Mountain yellow-legged frog surveys *(El Dorado Irrigation District: Desolation Wilderness)*
- Crew Leader - Bullfrog eradication *(Trout Unlimited: Cleveland NF)*

Fish and Aquatic Resources

- Surveyor - Hardhead minnow and other fish surveys *(USFS: Plumas NF)*
- Surveyor - Weber Creek aquatic habitat mapping (*El Dorado Irrigation District: Placerville, CA*)
- Surveyor - Green Valley Creek aquatic habitat mapping *(City of Fairfield: Fairfield, CA)*
- GPS Specialist - Salmonid spawning habitat mapping *(CDFG: Sacramento River)*
- Surveyor - Fish composition and abundance study (*PG&E: Upper North Fork Feather River and Lake Almanor*)
- Crew Leader - Surveys of steelhead abundance and habitat use *(CA Coastal Conservancy: Gualala River estuary)*
- Crew Leader - Exotic species identification and eradication *(Trout Unlimited: Cleveland NF)*

Mammals

- Principal Investigator – Peninsular bighorn sheep resource use and behavior study (*California State Parks: Freeman Properties*)

- Scientific Advisor –Study on red panda occupancy and abundance in eastern Nepal *(The Red Panda Network: CA and Nepal)*
- Surveyor - Forest carnivore surveys *(University of CA: Tahoe NF)*
- Surveyor - Relocation and monitoring of salt marsh harvest mice and other small mammals *(US Navy: Skagg's Island, CA)*
- Surveyor – Surveys for Monterey dusky-footed woodrat. Relocation of woodrat houses (*Touré Associates: Prunedale*)

Natural Resource Investigations / Multiple Species Studies

- Scientific Review Team Member – Member of the scientific review team assessing the effectiveness of the US Forest Service's implementation of the Herger-Feinstein Quincy Library Group Act.
- Lead Consultant - Baseline biological resource assessments and habitat mapping for CDF management units *(CDF: San Diego, San Bernardino, and Riverside Counties)*
- Biological Resources Expert – Peer review of CEQA/NEPA documents (*various law firms, non-profit organizations, and citizen groups)*
- Lead Consultant - Pre- and post-harvest biological resource assessments of tree removal sites *(SDG&E: San Diego County)*
- Crew Leader - T&E species habitat evaluations for Biological Assessment in support of a steelhead restoration plan *(Trout Unlimited: Cleveland NF)*
- Lead Investigator - Resource Management Study and Plan for Mather Lake Regional Park *(County of Sacramento: Sacramento, CA)*
- Lead Investigator - Biological Resources Assessment for 1,070-acre Alfaro Ranch property *(Yuba County, CA)*
- Lead Investigator - Wildlife Strike Hazard Management Plan *(HCV Associates: Napa)*
- Lead Investigator - Del Rio Hills Biological Resource Assessment *(The Wyro Company: Rio Vista, CA)*
- Lead Investigator – Ion Communities project sites (*Ion Communities: Riverside and San Bernardino Counties*)
- Surveyor – Tahoe Pilot Project: Validation of California's Wildlife Habitat Relationships (CWHR) Model *(University of California: Tahoe NF)*

Forestry

Mr. Cashen has five years of experience working as a consulting forester on projects throughout California. Mr. Cashen has consulted with landowners and timber operators on forest management practices; and he has worked on a variety of forestry tasks including selective tree marking, forest inventory, harvest layout, erosion control, and supervision of logging operations. Mr. Cashen's experience with many different natural resources enable him to provide a holistic approach to forest management, rather than just management of timber resources.

REPRESENTATIVE EXPERIENCE

- Lead Consultant - CalFire fuels treatment projects *(SD and Riverside Counties)*
- Lead Consultant and supervisor of harvest activities – San Diego Gas and Electric Bark Beetle Tree Removal Project *(San Diego)*
- Crew Leader - Hillslope Monitoring Program *(CalFire: throughout California)*
- Consulting Forester – Forest inventories and timber harvest projects *(various clients throughout California)*

Grant Writing and Technical Editing

Mr. Cashen has prepared and submitted over 50 proposals and grant applications. Many of the projects listed herein were acquired through proposals he wrote. Mr. Cashen's clients and colleagues have recognized his strong scientific writing skills and ability to generate technically superior proposal packages. Consequently, he routinely prepares funding applications and conducts technical editing for various clients.

PERMITS

U.S. Fish and Wildlife Service Section 10(a)(1)(A) Recovery Permit for the Peninsular bighorn sheep

PROFESSIONAL ORGANIZATIONS / ASSOCIATIONS

The Wildlife Society

Cal Alumni Foresters

Mt. Diablo Audubon Society

OTHER AFFILIATIONS

Scientific Advisor and Grant Writer – *The Red Panda Network*

Scientific Advisor – *Mt. Diablo Audubon Society*

Grant Writer – *American Conservation Experience*

TEACHING EXPERIENCE

Instructor: Wildlife Management - The Pennsylvania State University, 1998

Teaching Assistant: Ornithology - The Pennsylvania State University, 1996-1997

PUBLICATIONS

Gutiérrez RJ, AS Cheng, DR Becker, S Cashen, et al. 2015. Legislated collaboration in a conservation conflict: a case study of the Quincy Library group in California, USA. Chapter 19 *in*: Redpath SR, et al. (eds). Conflicts in Conservation: Navigating Towards Solutions. Cambridge Univ. Press, Cambridge, UK.

Cheng AS, RJ Gutiérrez RJ, S Cashen, et al. 2016. Is There a Place for Legislating Place-Based Collaborative Forestry Proposals?: Examining the Herger-Feinstein Quincy Library Group Forest Recovery Act Pilot Project. Journal of Forestry.

EXHIBIT 2

Comments on Biological Resources – Fisheries (Chapter 3.6)
Draft EIR Pacheco Reservoir Expansion Project
February 14, 2022

Prepared by
Thomas Cannon
Senior Aquatic Ecologist

I prepared the comments that follow on Chapter 3, Section 3.06 of the Draft Environmental Impact Report (DEIR) for the Pacheco Reservoir Expansion Project (proposed project). The comments are divided into General and Specific comments below. My resume is attached.

General Comments

A. PROPOSED PROJECT OPERATION NOT SPECIFIED

The project operation includes minimum instream base flows and pulse flows released to the lower North Fork (NF) of Pacheco Creek. The DEIR does not specify how such releases would be made from the various outlets in the proposed dam. Furthermore, it does not specify rules for storage level, including one for minimum storage to maintain the needed cold-water release volume. The DEIR has not specified a necessary storage level above the lower outlet that would continue to provide cold water to the NF of Pacheco Creek below the proposed dam. Such a minimum level might be 20-50 ft above the lower outlet. Nor does it provide rules for the tradeoffs between storage releases to the tunnel conduit or the lower NF of Pacheco Creek. Without these rules and levels, it is impossible to assess claimed project benefits, or to determine to what extent the operation would harm the SCCCS.

A forecast plan would be necessary at the beginning of a water year to forecast releases to the NF and conduit tunnel, as well as inputs from San Luis Reservoir. One helpful specification would be to minimize delivery of cold-water pool water to the conduit tunnel, thus saving cold water for summer cold-water releases to the lower NF.

The applicant's Table 3-44 in the DEIR Alternatives Development and Project Description Appendix does not allow for a rigorous assessment of impacts of project operations on downstream fishery resources, such as juvenile steelhead emigration passage. The DEIR does not identify the frequency and volume of releases to the conduit, and thus it fails to provide assurances that water remaining in the reservoir would satisfy the flow or temperature criteria that have been proposed for maintenance of steelhead habitat.

B. CONTRIBUTION TO STEELHEAD RECOVERY UNCERTAIN

The DEIR concludes that the project's benefits to steelhead habitat in Pacheco Creek between miles 0 and 8 would increase productivity and facilitate recovery of the species within the South Central Coast California Steelhead - Distinct Population Segment (SCCCS DPS). However, bottlenecks to productivity can occur at any stage of the life cycle. Production potential is not additive, rather production potential is multiplicative. Just one zero bottleneck can lead to zero production. For example, poor rearing habitat in the estuary lagoon at the bottom of the watershed is known to be a major bottleneck to steelhead (SCCCS DPS Steelhead Recovery Plan – hereafter Recovery Plan). The DEIR fails to discuss or evaluate bottlenecks in the estuary lagoon at the bottom of the watershed that would likely undermine any proposed project benefits. Without this analysis, there is no scientific basis for the DEIR's conclusion that the project would facilitate recovery of SCCCS in the Pajaro River system.

C. PACHECO CREEK STEELHEAD – LIMITED CAPACITY FOR RECOVERY

Pacheco Creek, especially the NF, is a key watershed for the Recovery Plan's designated Core 1 population of SCCCS DPS. The designation of Core 1 implies numerous streams within Core 1 watersheds provide extensive habitat potential capable of supporting spawning and rearing large numbers of steelhead when water and other environmental conditions are suitable. The DEIR does not address how important the NF is among the watersheds of this Core 1 population and how its habitat potential relates to those of the other sub-watersheds (e.g., Uvas Creek), nor the dependencies among these populations.

Nor does the DEIR assess the intrinsic capacity of the habitats historically accessible to steelhead within the NF and other tributaries of the Pajaro Core 1 population unit. This issue should be addressed because there are other feasible and effective alternatives for augmenting the Core 1 population in the watershed that the proposed project should evaluate and include. Recovery might be better served if habitats of other Pajaro tributaries are protected or enhanced, rather than placing emphasis on the lower NF. This is especially critical, given that one bottleneck downstream from the project could lead to zero production.

D. IMPACTS ON DESIGNATED CRITICAL HABITAT OF STEELHEAD NOT DISCLOSED

The DEIR fails to analyze the negative effects of the proposed project and various project alternatives on the existing critical habitat designated in the NF. For example, the DEIR fails to analyze how much of the designated critical habitat would be lost or otherwise adversely affected; how impacts to critical habitat would affect the existing or potential future steelhead population; and how potentially significant impacts to critical habitat would be mitigated to less than significant levels. For example, the DEIR does not disclose what aspects of the critical habitat above the existing reservoir would be lost due to the proposed new reservoir. The DEIR fails to discuss why access to historical critical habitat above the proposed new reservoir is not provided by the proposed project. The DEIR fails to discuss how the existing dam and reservoir affects access to habitat by steelhead, and whether the historical habitat above the present dam was used by steelhead. How fish passage could allow access to this habitat is also omitted. This is important because the proposed reservoir would adversely affect existing designated critical habitat in the upper NF. The DEIR also fails to analyze how the proposed project would alter flow and water quality, and wood and gravel recruitment, from the designated critical habitat in the lower NF and lower watershed.

E. FACTORS LIMITING STEELHEAD IN THE PACHECO/PAJARO WATERSHED NOT IDENTIFIED

The applicant has failed to develop operating criteria that would ensure the pattern and magnitude of groundwater extractions, and water releases from the proposed new Pacheco Dam, would provide the essential habitat functions to support the life history and habitat requirements of adult and juvenile steelhead. For example, the applicant has failed to include modifications to existing fish passage impediments, that would allow: a) steelhead natural rates of migration to upstream spawning and rearing habitats, b) passage of smolts and kelts downstream to the estuary and ocean, and c) restoration of spawning gravel recruitment to the upper Pacheco Creek watershed.

The applicant has failed to address instream mining impacts to migration, spawning, and rearing habitat in Pacheco Creek. The applicant has failed to address the need to identify, protect, and where necessary, restore/protect estuarine-lagoon rearing habitat, including management of artificial sandbar breeching at the river's mouth. This is important because the DEIR assumes flow temperatures and volumes are the limiting factor to steelhead in Pacheco Creek, when in fact there could be more significant limiting factors (e.g., fish passage barriers) that would preclude the project from providing a measurable benefit to the steelhead population. Finally, the applicant has failed to justify the minimum instream flows and pulse flow magnitudes offered to provide the benefits claimed for steelhead recovery. Numerous documents and studies note the benefits to steelhead from higher flow rates (e.g., Micko and Smith 2020).

F. IMPACTS ON STEELHEAD RECOVERY PLAN NOT IDENTIFIED

The Recovery Plan promotes the restoration and maintenance of essential habitat functions for individual populations within the SCCC Steelhead Recovery Planning Area. The DEIR fails to identify all the essential habitat functions potentially affected directly or indirectly by the proposed project, each of which the SCCC steelhead population is dependent upon for its survival. Essential habitats include the lagoon at the estuary at the mouth of the Pajaro River, other tributaries where non-natal rearing may occur, winter-spring lower watershed floodplain rearing habitat, floodplain channels and stream passage bottlenecks such Miller Canal and San Felipe Lake, and potential dry-back stream reaches where flows go subsurface to meet groundwater demands.

G. CONSERVATION HATCHERY ALTERNATIVE NOT CONSIDERED

The DEIR fails to mention the role a conservation hatchery might have in meeting project mitigation and enhancement goals. A conservation hatchery program is suggested in the Recovery Plan to help achieve recovery in a reasonable time frame as well as to support recovery through critical periods of drought where project actions may not protect the steelhead population. A conservation hatchery may contribute to the recovery of the SCCCS DPS in a variety of ways, including: 1) providing a means to preserve local populations faced with immediate extirpation as a result of catastrophic events such as wildfires, toxic spills, dewatering of watercourses, or droughts; 2) preserving the remaining genotypic and phenotypic characteristics promoting life history variability though captive broodstock, supplementation, and gene-bank programs to reduce short-term risk of extinction; and 3) reintroduction of populations into restored watersheds if necessary. If adult steelhead reach the project area but conditions will not support their reproductive success for whatever reason, a conservation hatchery can save their contribution to the DPS. For example, if coldwater releases cannot be maintained through the summer, then eggs or naturally produced young can be maintained in a hatchery environment until conditions in the creek improve. Conditions under which rescue, reestablishment or supplementation could be used effectively in wild steelhead recovery must be evaluated. Such efforts have been undertaken elsewhere in the DPS (e.g., Uvas Creek; Micko and Smith 2020).

H. FUTURE STEELHEAD VIABILITY UNADDRESSED

The DEIR fails to assess the intrinsic potential of the population in an unimpaired condition, the population’s potential in meeting viability criteria for the SCCCS DPS, the current viability criteria of the population and SCCCS DPS, the current condition of the population, or the population’s ability to remain viable under present conditions or future conditions with or without the project. The Recovery Plan considers the populations of the Interior Coast Range (including the Pajaro) to be particularly important because in the past they appear to have produced the largest run sizes in the SCCCS DPS during years of high rainfall and run-off.

Existing habitat of the Pajaro merits high priority for immediate protection and restoration so populations and critical habitat do not decline further. Also worth noting is that any potential benefits of the proposed project could be negated by future degradation of critical habitat functions elsewhere in the watershed. As described earlier, the DEIR has not adequately defined the project's potential benefits in the context of the existing habitat conditions or functions. The DEIR does not provide any analysis on the likely negative impacts to the species' recovery from the project and its management of flows. Without further analysis on the population drivers within the DPS, those impacts could be significant negative forces on the population, or simply not provide any benefits to the recovery. Viability criteria changes in other watersheds of the DPS could affect the importance of the Pajaro component of the DPS, and visa-versa.

I. PROJECT EFFECT ON NF FLOWS UNCLEAR

The proposed project would release water to NF Pacheco Creek under a Variable Flow Schedule. Monthly baseflows and pulse flow targets would vary by water year type based on "unimpaired" inflow into the proposed reservoir. Because there is minimal hydrologic data available for the watershed and no baseline data for the NF, there is no ability to accurately estimate the "unimpaired inflow," and thus, the magnitude of flows needed to mimic the historic hydrograph.

To provide a more accurate estimate, the project must apply flow targets that are derived from a more complete watershed-wide hydrologic database. The monthly flow prescriptions in DEIR Table ES-2 are not reasonable given potential daily variability and thus should be daily average flow criteria that are readily achievable by the proposed project. If a pulse flow is achieved at a downstream gage, it is even more important a pulse flow occurs below the dam in the lower NF because SCCCS adults and juveniles in the NF also need the flow queues timed to overall watershed queues for such queues to be effective. Therefore, having no pulse release from the proposed reservoir if the South Fork (SF) provides the pulse is not protective if the goal is to provide the pulse for the benefit of lower NF fish and habitat. Finally, given the "flashy" hydrology of the entire Pajaro watershed, coordination of important hydrological events is necessary to a achieve the potential ecological benefits especially for anadromous fish such as steelhead dependent on short-term hydrological windows of opportunity.

J. PROJECT RESERVOIR OPERATIONAL RULES LACKING

Operational "rules" for the proposed reservoir are vague or non-existent. Proposed project operating rules (DEIR Section 3.12) specify release rates based on reservoir storage levels, by average water year type. The average reduction of flow in wet winter months is 21-23% (DEIR Table 3.12-14). In a wet year like 2019 that follows a dry year when the reservoir storage is low, the reduction in flow would be much higher (closer to 90% in February). That is because the new reservoir would have the capacity to store much of the upper NF tributary inflow and would release only the prescribed minimum flow of 8 cfs and no pulse flow (because the SF would supply the pulse at the downstream Dunneville gage). The negative effect of the proposed project operation on NF, the lower Pacheco, and Pajaro natural flow as well as steelhead production potential in 2019 would be significant. Even one year of such negative effects from high natural flow storage retention by the proposed project could have serious consequences to the Pajaro-Pacheco Core 1 steelhead population and recovery potential.

How the proposed reservoir is operated in conjunction with San Luis transfers is also important. For example, the DEIR states: "*When San Luis Reservoir total storage drops below 300,000 acre-feet, algae at the surface of the reservoir may be entrained into the San Felipe Division intake, reducing the quality of CVP water delivered through the Pacheco Conduit. To improve the quality of water conveyed to Valley Water during these times, referred to as low point events, Valley Water would generally reduce the amount of CVP water delivered from San Luis Reservoir and increase withdrawals from the expanded reservoir into the Pacheco Conduit*." (DEIR, p. 2-34).

In this case, use of the NF Pacheco Creek water in lieu of San Luis water to supply system water demands may put unreasonable risk on the cold-water pool supply needed to make cold-water releases through the warmer spring-fall months. Moreover, the DEIR does not prevent Valley Water from using low-quality CVP water to fill the proposed reservoir; the DEIR merely makes the vague statement that Valley Water would "generally reduce" the amount of CVP water delivered from San Luis Reservoir during low point events. The DEIR fails to analyze potentially significant environmental impacts associated with the delivery of low-quality CVP water to the proposed reservoir, or a more aggressive distribution of the proposed reservoir storage to the Pacheco Conduit for water supply demands that could adversely affect beneficial uses of water stored in the proposed reservoir.

The source of releases from the various outlets within the reservoir is also important. The DEIR (pp. 2-9 and -10) states: "*The inlet/outlet works included as part of the Proposed Project would consist of three adits on the upstream face of* *the hardfill dam installed at 480, 570, and 660 feet above msl; a bypass intake and pipeline; an intake tower built into the body of the dam; an outlet conduit cast through the bottom of the dam; and an outlet/bifurcation structure. Valves at the connection of the adits to the intake tower would allow for flow in and out of the reservoir at different elevations. To enhance dissolved oxygen levels in the deeper portion of the reservoir, when needed, a hypolimnetic aeration system would be located near the lowest adit inlet…. While the low-flow bypass pipeline could be operated separately from the outlet conduit, the interconnection in the outlet/bifurcation structure would provide additional operational flexibility and allow releases to the creek to be pulled from the low-flow bypass pipeline, or one of the adits as long as water was not being pumped into the reservoir".* The descriptions of the proposed dam's inlet and outlet infrastructure and their function are vague and difficult to relate to potential operations. For example: could either the "bypass" or "outlet conduit" allow water to be released to the creek from the reservoir at depths below the lower adit? This is critically important because of the disparate water temperatures that would occur at the different reservoir levels.

K. <u>INVASIVE FISH SPECIES INTRODUCTIONS TO NF AND EFFECTS ON EXISTING NATIVE ROACH AND HITCH UNADDRESSED</u>

It is not reasonable for the DIER to conclude that there are few native fish in the reservoir and NF under existing conditions, and thus project impacts on native fish "would not be substantial." Or, that some non-native invasive species are pre-existing, so invasive species introductions caused by the proposed project would be less than significant. Or, that changes to habitats will be less than significant, especially when DEIR Chapter 3.20 concludes that many water quality impacts will be significant and unavoidable.

The loss of miles of the NF designated as critical habitat for a threatened species to a new reservoir full of trans-basin water and the many non-native invasive fish species that come with it from the Sacramento San Joaquin Delta is significant. The DEIR fails to address impacts on this existing habitat. Existing watered sections or deeper pools of the upper NF may have native roach and hitch that would be wiped out by a new reservoir. The DEIR does not provide adequate baseline information regarding ecological conditions, nor a considered analysis of project impacts.

The new reservoir would not accommodate the existing reservoir's populations of roach and hitch, given the many non-native competitors and predators that would be brought in continuously from San Luis Reservoir. The roach and hitch likely depend on the existing reservoir population to repopulate the NF.

Therefore, there is no scientific basis for the DEIR's assumption that roach would be capable of colonizing the new reservoir, and thus, that eliminating the roach population in a new reservoir with San Luis transfers and its non-native constituents would not cause a significant impact to the species.

First, once the existing reservoir is drained, there would be no population to recolonize the new reservoir because there would be no source populations in the upper NF (because it would dry completely).

Second, even if there is a source population surviving in the upper NF or EF to colonize the new reservoir, the roach and hitch would not survive because of a new slate of non-native predators from San Luis Reservoir upon commencing operation. Based on a review of the literature (mainly Moyle 2002 and its references), the proposed new reservoir would likely accommodate San Luis non-native invaders and severely limit native roach and hitch. The DEIR fails to establish whether the upper NF is always dry or whether isolated pools sustaining fish are prevalent, and as a result, the DEIR fails to provide the information needed to assess the likelihood of source populations that could colonize the new reservoir. Valley Water also failed to conduct fish surveys to determine whether there are potential source populations of roach in the upper NF, or whether existing non-natives in the reservoir populate the NF below the existing reservoir.

L. POTENTIAL NEGATIVE IMPACTS ON STEELHEAD HABITAT IN PACHECO CREEK NOT DISCLOSED

Habitat conditions for the SCCC steelhead in Pacheco Creek are dictated by a suite of biotic and abiotic factors that may be affected by the project. The DEIR's argument that the project would improve habitat for steelhead is based on only three factors: (1) flow conditions, (2) water temperatures, and (3) physical habitat improvements to the lower NF. The proposed project would further starve the creek of sediment and attenuate the flood flows critical to maintenance of spawning and food-producing substrates. Valley Water has dismissed other project-related factors that may offset any beneficial effects on steelhead habitat. For example, the proposed project would lessen peak winter-spring pulse flows by storing water, thus potentially affecting upstream and downstream passage of steelhead to and from the NF, as well as other Pajaro watershed steelhead producing tributaries.

The DEIR ignores the fact that much of the new water released from the proposed reservoir would be Sacramento River and San Joaquin River water (and its many unnatural constituents) that has been in the Delta and various reservoirs for a year or more. The "enhanced flows" associated with the project could cause more steelhead to be diverted to the Pajaro/Pacheco watershed (and from other tributaries of the Pajaro) to spawn in lower NF Pacheco Creek. Existing natural NF flows would be reduced in winters of normal and wet years and would include a substantial proportion of San Luis water.

There is insufficient evidence in the DEIR that habitat in NF Pacheco Creek can accommodate such a new “influx” of spawners, or that added potential steelhead smolt production would have any greater chance than occurs presently of reaching the ocean. New eggs, fry, and smolts may also be subsequently consumed by predatory species that may benefit from the proposed project's releases, new larger reservoir, and new water from San Luis Reservoir. There is insufficient evidence provided in the DEIR that any increase in NF steelhead smolt production would benefit the SCCCS DPS.

The project may negatively impact steelhead habitat in Pacheco Creek through discharge of fine sediment, introduction of invasive species, and release of out-of-basin CVP water (which may affect imprinting and homing behavior). The proposed new reservoir would be very different than the existing reservoir in terms of warm water storage, algae production, and sedimentation, resuspension, and turbidity. Releases from the proposed new eutrophic reservoir would be very different than existing reservoir releases, even if they are colder and are of higher frequency and duration.

Because these and other negative effects are likely to occur if the project is implemented, they must be quantified and subtracted from the project's claimed ecosystem benefits to the steelhead population. For example, the DEIR claims invasive species would not have significant impacts on steelhead (and other sensitive species) because the cooler flows provided by the Project are less tolerated by potential invasives. That might be true for some invasive species, but not others.

Most of the fish species found in San Luis could readily survive in the proposed project’s two-story (warm surface and cold bottom water), eutrophic reservoir. The DEIR also ignores the fact that the project would create habitat for invasives by converting an intermittent stream into a perennial one. Under existing conditions, invasives are eliminated (or confined to perennial pools) when the creek runs dry, thus limiting their presence, abundance, and distribution in Pacheco Creek. There would be no such control mechanisms if the proposed project is implemented. None of the rationale used for the DEIR’s “less than significant” conclusion is supported by actual scientific data or analysis.

Specific Comments on DEIR Biological Resources – Fisheries

The following are my specific comments on Section 3.06 of the DEIR. The specific page and paragraph are noted below each heading.

1. **<u>Comment – PASSAGE TO THE NF DAM:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para1, p.3)

The DEIR assumes steelhead would be able to travel to the lower NF below the proposed dam. The Recovery Plan shows a natural barrier near the proposed dam location. The DEIR fails to explain why fish passage at the proposed dam was not considered. The following questions are left unanswered in the DEIR:

a. Would the new reservoir cover that barrier and could steelhead pass into the upper NF and East Fork (EF) with the barrier if passage past the dam is provided?
b. Were steelhead able to ascend into the upper NF and EF above the existing dam before its placement?
c. What consideration was given to use of the reservoir and upper watershed by steelhead?

2. **<u>Comment – POOR HABITAT AND LACK OF FLOW IN SUMMER-FALL IN LOWER PACHECO CREEK:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 5; p.3)

The DEIR states that lower Pacheco Creek below the confluence of the NF and SF is dry in summer-fall of most years. However, the specifics of the baseline that are critical to an understanding of the project impacts are missing. Is a commonly dry Pacheco Creek the natural state or the result of heavy surface and groundwater extraction that occurs at present and historically? Are there natural springs that could have sustained steelhead historically in the NF, SF, or in the lower Pacheco Creek below SF? How has the upper watershed been altered from its historical natural state that may have affected steelhead habitat? Would addressing any factor in the upper watershed outside of the project scope provide benefit to the steelhead population? Such “mitigation” should be considered in addressing project cumulative impacts as well as in the ESA section 7 mandate for enhancements that may improve the chances for recovery.

Is the historic presence of steelhead simply a consequence of the summer cold-water releases from the existing reservoir as implied in various documents associated with the proposed project (which contrasts with the portrayal in the SCCC Steelhead Recovery Plan that the intrinsic potential exists in the Core 1 Pacheco Creek population designation)? This question also relates to the historic condition of the lower watershed and whether its present or past state relates to the historic, present, or future state of the steelhead population. It also relates to a flawed conclusion that the proposed project would not affect the existing steelhead population, because a proposed project must help remedy any past impacts that contributed to listing of the species, as required under the federal and state endangered species acts. Without more detailed analysis it is unclear if even the purported project benefits exceed impacts, and if this location would have any beneficial impact on the population at all.

3. **<u>Comment – STEELHEAD IN THE UPPER PACHECO WATERSHED AND EFFECTS OF STREAMFLOW:</u>**

(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1; p.4)

As mentioned in DEIR, p. 4, para.1, critical factors in the Pacheco/Pajaro Core 1 Steelhead population's contribution to the South-Central Coast DPS (SCCC steelhead) include flow. However, other factors including water temperature, water quality, physical habitat, and passage are also important aspects of their life history and population viability. To receive a non-jeopardy Section 7 permit, the project must contribute in a real, positive, measurable way to the DPS's recovery.

The DEIR fails to describe all the negative effects or weigh them against the project's proposed benefits to steelhead. For example, the DEIR fails to analyze the negative effect of diverting much of the NF flow to the Pacheco Conduit compared to the existing condition, and weighing that effect against potential benefit of colder, higher summer flows to the NF from the new reservoir in summer-fall of some years. The former (NF natural inflow) represents a critical habitat function for the entire Core 1 population and its watershed-wide habitat, while the latter (coldwater releases from the proposed dam) is specific only to the short stretch of the NF below the proposed reservoir.

The DEIR is flawed in that it assumes that providing flows and cold water from the proposed dam will benefit the species, when there are many other critical factors (as mentioned above) that affect viability of the NF Pacheco-Pajaro population and overall DPS. These factors must be addressed by the federal/state agencies seeking ESA Section 7 permits for the proposed project. Simply maintaining, or perhaps improving the habitat in the NF in some areas and in some months of some years may or may not contribute measurably to recovery given all the stress factors. Bottlenecks to production may occur at any stage of the life cycle. Production potential is not additive, its multiplicative, because one zero bottleneck can lead to zero production.

A few bad years of population recruitment could lead to extirpation, as seems to be the present state (Micko and Smith 2020). The project's storage of natural flows in drier years and their release to the conduit system rather than Pacheco Creek could also be highly detrimental to the steelhead population.

For example: Figure A below presents the hydrograph for Pacheco Creek below the SF/NF confluence in the fall of critical dry year 2021. The proposed project would store much of this flow (i.e., all but the SF and Cedar Creek flows). The consequences to steelhead from the planned reservoir operation if flow pulse is the only natural hydrologic event could be adverse, given there would be minimal base flow or pulses in the lower NF below the project reservoir under the proposed operating criteria.

Figure B is an example for a wet year 2019 with a wet month, in an otherwise dry winter. The February Pacheco 2019 flows would be substantially reduced by the proposed reservoir if reservoir storage volume was low after a dry year and minimal spill were to occur. Again, such an impact could adversely affect steelhead production throughout the watershed, but especially in the NF.

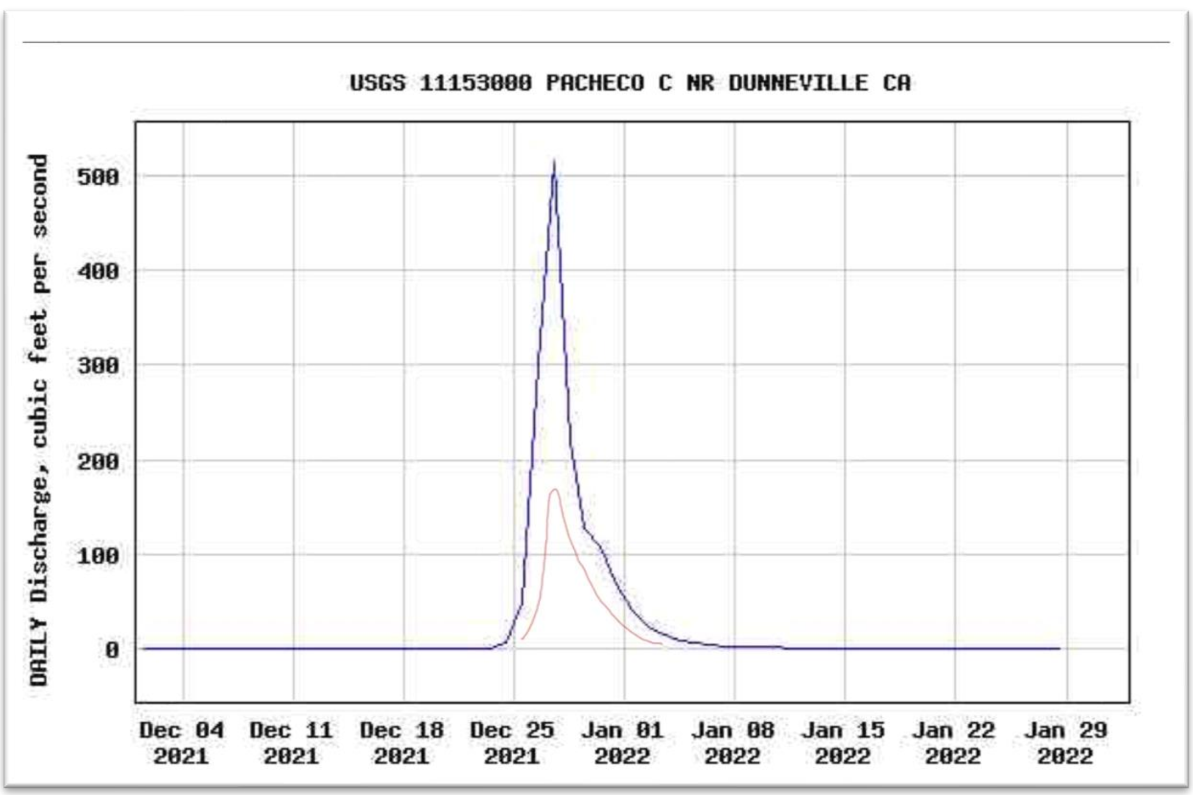


Figure A. December 2021 hydrology in Pacheco Creek at USGS Dunneville gage. Red line is flow that might be expected with proposed project assuming SF and Cedar Ck provide about one-third of flow. Note also that substantial NF flow was likely stored in the existing reservoir.

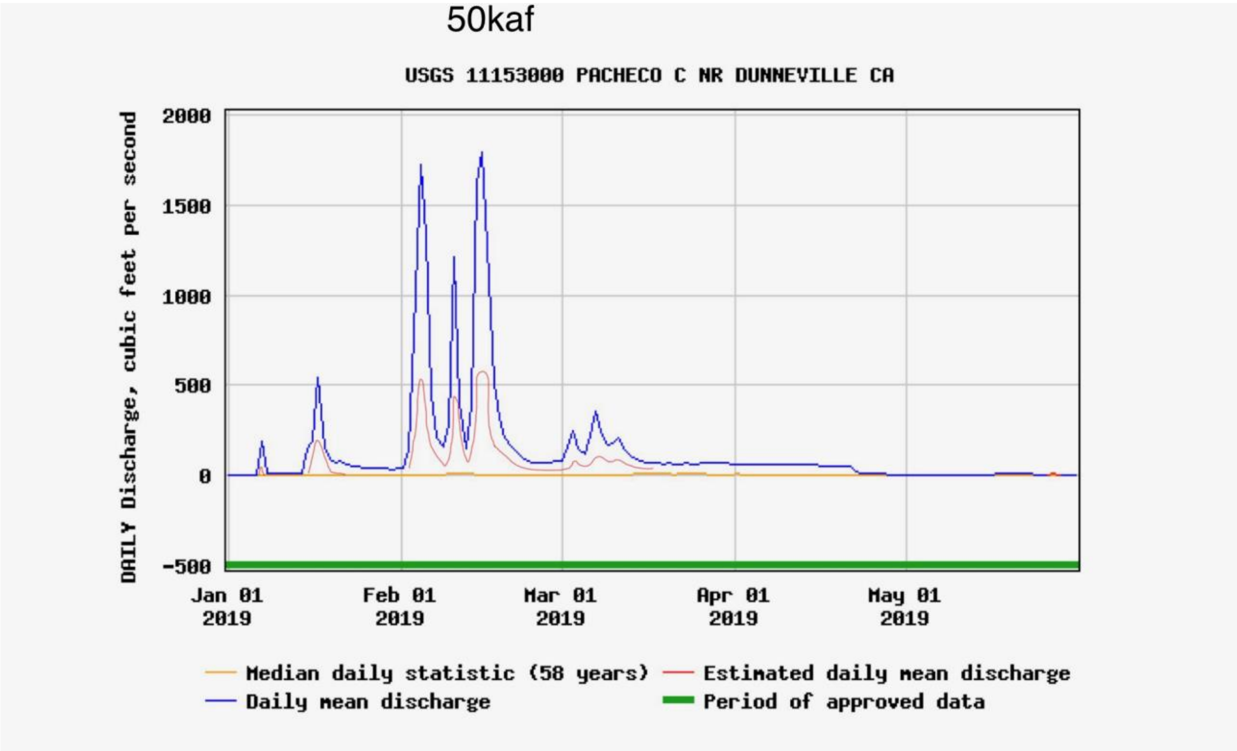


Figure B. Jan-May 2019 wet year hydrology in Pacheco Creek at USGS Dunneville gage. Red line is flow that might be expected with proposed project assuming the SF and Cedar Ck provide about one-third of flow. Note also that some NF flow was likely stored in the existing reservoir given 2018 was a dry year.

4. <u>Comment – STEELHEAD SPAWNING:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 3, p. 4)

This entire section fails to articulate what the issue is with this Core 1 steelhead population of the SCCCS DPS. Suitable flow exists to produce some steelhead in some years with wetter years having the greatest potential and greater use by adult steelhead immigrating from the ocean. The question that should be addressed is whether this project would increase potential steelhead reproduction, survival and smolt recruitment to the ocean? The DEIR claims it would and points to Valley Water's Habitat Model as evidence.

In my opinion, the project would not increase potential steelhead reproduction, survival and smolt recruitment to the ocean for reasons described in earlier and later comments, but mainly because of the dramatic impacts the project would have on the hydrology of the lower NF and lower mainstem described above in some wet and many drier years.

In the one dry and one wet year examples in Figures A and B above, there would be substantial reduction in winter flows through the entire watershed as water is stored for delivery to the Pacheco Conduit, thereby having negative consequences to steelhead production in the river/creek and the SCCCS DPS. The DEIR implies that this is OK if the applicants simply do not make things any worse than they are at present or in the foreseeable future. The potential benefits asserted by Valley Water may be real in specific cases, but must be contrasted with the project's negative impacts to the SCCCS DPS.

5. <u>Comment – WHAT IS WARM WATER?:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 3; p.4)

WARM WATER: "Juvenile steelhead grow quickly in warmer water." This vague statement implies the project enhanced habitat of the lower NF would have warmer water conducive to greater steelhead growth, when in fact the projects hypolimnetic flow releases would be cold (around 50F) under most summer-fall release conditions. Warmer water would occur further downstream especially below the confluence with the SF as the influence of the cold water releases from the reservoir wanes and flow declines as water percolates into the ground (p. 3.20-3). Optimal growth occurs at 52-54F, or slightly higher depending on many factors including predation, food, stress, dissolved oxygen, all of which are worse with warmer water, especially above 65F. The 'colder the better' (nearer 50F) is usually the best given all the factors, especially if proposed reservoir release are to extend rearing habitat as far downstream as possible for good growth/survival (<70F). Any unnatural factor contributing to warming the creek would be detrimental, which is why the project proponents have proposed a cold-water dam release and a shaded lower NF channel. Any factor that would minimize warming below the dam (e.g., shade) would be considered beneficial.

However, higher proposed minimum flows from the proposed reservoir in summer for water-supply benefitting lower Pacheco Creek groundwater recharge (p. 3.20-4) could lead to cold-water pool depletion. The complete loss of accessible reservoir cold-water pool supply in summer or fall would be highly detrimental to the Pacheco steelhead population. Partial loss and lower storage could lead to anoxic conditions in the cold-water hypolimnion and to harmful algal blooms toxic to fish below the reservoir (p. 3.30-10). If the proposed operation to provide storage to the Pacheco Conduit for system water supply distribution affects the cold-water-pool supply, then expressed benefits of the proposed project may not be realized. The farther downstream the coldwater habitat will extend the better it will be for the steelhead population. At some point downstream water temperature will just be a function of streamflow, groundwater influx, air temperature, and solar radiation. Some flow will allow the fish to move upstream to safer water if they would otherwise be trapped in isolated pools if the flow ramping is designed properly. According to the DEIR however, the proposed summer dam releases in some cases will be lower than existing dam releases in summer and thus would be a significant adverse effect on steelhead. Proposed monthly average summer flow targets (Table ES-2) are insufficient to maintain lower NF and mainstem below SF steelhead habitat especially in drought year dry-back operations.

6. <u>Comment – LACK OF EMIGRATION FLOWS:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 3; p.4)

"Offspring can remain in suitable upstream habitat more than one year if sufficient emigration (flow) conditions are not met." The DEIR's statement implies that juvenile steelhead in the NF may have to remain more than one year before emigrating because of poor growth from colder water, or lack of flow or excessively warm water downstream of the NF. In some situations, whether by choice or not, juvenile steelhead may remain in the NF for 2 or even 3 years before emigrating. This is important because the project may not be able to release :(1) sufficient pulsed flows to stimulate emigration and ensure its success in drier low-storage years in the winter-spring of drier years after drier years; and (2) sufficient base flows to sustain smolt steelhead in all years.

Although kelts, adults returning to the ocean after spawning, are not likely major contributors to production in the existing population state, they are potentially important in maintaining healthy populations. The DEIR acknowledges potential adverse effects on kelt survival from the proposed project. The SCCC steelhead are highly adapted, and spawn quickly and return quickly to the ocean if able. Any delays or shortening of their natural return window would be detrimental to the population. The project effect on winter flows described above (greater storage of NF water in terms of watershed natural pulsed inflows than the existing reservoir) would shorten the natural window for emigration of all tributary steelhead kelts in the Pajaro watershed.

7. **<u>Comment – UNIMPAIRED SF:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 4, p.4)

The DEIR describes the SF as once sustaining steelhead. The SF steelhead would benefit from NF habitat improvements and visa-versa. Improvements to the SF could eventually benefit young fish from NF generated by benefits in the NF and below the confluence. SF fish would benefit from any NF improvements. SF fish would also be adversely affected by greater storage of NF inflows in the new reservoir than the existing reservoir because of adverse effects on flow-related habitat below the confluence on both the NF and SF steelhead. The DEIR does not address this potentially adverse effect on SF steelhead potential recovery.

8. **<u>Comment – CEDAR CREEK STEELHEAD:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 4, p.5)

Cedar Creek steelhead may be adversely affected by reductions in the total magnitude of NF natural flows due to storage in the proposed new reservoir. Cedar Creek improvements by the proposed project are warranted to take further advantage of any NF project improvements to the mainstem Pacheco Creek habitat.

9. **<u>Comment – PACHECO CREEK CHINOOK:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.6)

The presence of Chinook in San Felipe Lake is indicative of the potential of stray steelhead spawning in Pacheco Creek, and even the future reestablishment of Central Valley hatchery steelhead in the Pacheco/Pajaro watershed because of San Luis Reservoir water transfers to the NF of Pacheco Creek. Such an effect would be a significant adverse impact on SCCC steelhead.

10. **<u>Comment – STEELHEAD SMOLT EMIGRATION:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.6)

The DEIR states that Steelhead smolt emigration would occur in winter-spring, the period for prescribed pulse flows. However, emigration is likely to begin with the first Oct-Feb rains, not just in late winter or spring. Pulse flows from the NF should occur when natural pulses occur from other tributaries. The high potential growth of young steelhead over the summer would allow fall-winter smolting and emigration with the first flow pulses.

11. <u>Comment – OTHER CURRENT AND FUTURE THREATS TO SCCC STEELHEAD:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 2, p.7)

While lower watershed existing habitat may not accommodate summer habitat use by juvenile steelhead, fall-spring rearing by "migrants" may be important for weeks to months. Habitat improvement in the lower watershed such as in San Felipe Lake may increase Pacheco steelhead smolt returns to the ocean and increase SCCCS DPS recovery, an objective of the proposed project Section 7 consultation. The proposed project cannot assume the benefits to steelhead without addressing lower watershed habitat suitability.

12. <u>Comment – PROPOSED PROJECT EFFECT FROM INCREASED DELTA DIVERSION:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 2 and 3, p.8)

Delta native fishes may be tolerant of salinity changes in the Delta as stated on DEIR p. 3.6-8, but their survival and productive capacity can be severely compromised by changes in the salinity distribution in time and space in the Delta. That distribution is affected by water demands from the South Delta that would be measurably increased by the proposed project. Any increased South Delta diversions resulting from the proposed project would be a significant cumulative impact to Central Valley fishes. The DEIR fails to disclose and analyze effects of the Proposed Project's new South-of-Delta storage on Delta exports nor the source of such new exports, as well as the potentially significant cumulative impact to Central Valley listed fishes. Neither does the DEIR describe the potential effects on San Luis Reservoir operation, or how it might affect the proposed Expanded San Luis Project under Cumulative Impacts of the proposed project. The DEIR concludes such a potential cumulative effect as less than significant, but that conclusion is not substantiated in the cumulative effects analysis of this DEIR.

13. <u>Comment – CENTRAL VALLEY LISTED FISH:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.9)

The list on page 9 fails to include listed CV steelhead. The proposed project would contribute to the significant cumulative impact on all these species. Potential straying of CV steelhead to the Pajaro watershed would be an additional potential impact of the proposed project to both the SCCCS DPS and CV Steelhead DPS.

14. **Comment – SCCC STEELHEAD:**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.10)

Like many populations in the SCCCS DPS, the Pacheco Creek population has considerable recovery potential as evident by its Core 1 designation in the NMFS Recovery Plan. This paragraph implies that the DPS's steelhead are favorably adaptable or at least tolerant of the typical harsh habitat conditions in SCCC streams like the Pacheco. The problem is that the high degree of harshness of the Pacheco system is mostly manmade and getting worse, causing conditions (not addressed by the proposed project) for which the species is not well adapted, thus leading to the present listed status of the species.

In my opinion, the proposed project would further hinder recovery of the SCCCS DPS by promoting the hypothesis that the NF habitat is the single-most factor limiting the SCCC steelhead element of the DPS, when other factors including fish passage, streamflow, predators, and water quality are underlying problems that must be solved before any benefits of the proposed project are realized.

15. **Comment – DRYBACK PROJECT OPERATION:**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.10)

The proposed project included summer dry-back operations (Table ES-2) that would greatly reduce steelhead production and survival benefits in drought years. There should be more than adequate storage in the proposed reservoir that could be carried over to minimize adverse dry-back conditions in droughts. The DEIR states that juvenile steelhead retreat to residual pools that offer enhanced growth and reduced competition. Drying pools would occur as the lower summer-fall reservoir releases would seep into the surface aquifer of the Pacheco Creek below the proposed reservoir.

Drying warming pools would not offer *enhanced growth* because fish would be under severe stress from potential overcrowding and less than optimal habitat. Juvenile steelhead do not favor zero streamflow velocity, nor do their invertebrate prey. Zero flow and minimum depths offer little cover or refuge from predators of all types. Competition may become intense from overcrowding. Water temperatures will rise with warmer summer air temperatures and result in lower dissolved oxygen which will be stressful if not at lethal levels to the fish.

Cannibalism of the eggs and fry of resident fish such as roach and hitch would increase. Drying pools may begin in spring and extend into the fall and winter of drought years, which could also limit winter spawning habitat. The project as proposed would continue the existing summer dryback period and result downstream residual pool stranding given the potential of minimum flows seeping into the ground. Minimum flows prescribed from late spring through early fall should be higher to sustain as much downstream flowing habitat as possible in the NF and mainstem below the SF confluence.

16. Comment – PROJECT TURBIDITY EFFECT ON STEELHEAD EGG-EMBRYO SURVIVAL:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 2, p.10)

Steelhead eggs and embryos are highly susceptible to suspended sediment suffocation while in the redd; this fact should be noted given the potential of the project producing high suspended sediment (turbidity) levels in the NF that would be stressful or even lethal levels during construction or operation. If the proposed reservoir is at minimum pool, its accumulated sediments will be exposed and susceptible to resuspension with winter rains and San Luis transfers at the most critical time for downstream spawning steelhead. The DEIR should address sediment deposition and resuspension in the reservoir and its effect on downstream turbidity during the winter steelhead spawning season.

17. Comment – STEELHEAD WATER TEMPERATURE TOLERANCE:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 3 and 4, p.10)

Steelhead are sensitive to water temperature at all life stages and are not tolerant to "warmer" temperatures that can occur in the watershed from spring through fall. The project can create a zone of cold-cool water in the reservoir hypolimnion which if released can cool a portion of the downstream NF from spring through fall that can sustain steelhead and other cool water fishes. This potential benefit depends on whether the cold-water pool can be sustained through at least the early fall and that dam releases are sustained at sufficient volume and temperature to sustain steelhead through the lower NF. As stated in the Water Quality chapter on p. 3.20-3, "*lowered streamflow can lead to relatively warm water temperatures and reduced natural stream aeration*".

Southern latitude steelhead like the Pacheco population may be slightly more tolerant of warmer waters than their northern cousins, but still have near the same preferences: spawning 53-56F, rearing 55-60F, and migrating <65F. Water temperatures would remain a severe limiting factor in much of watershed with or without the proposed project, because at low flows and high air temperatures water can warm to stressful (>65F) or even lethal levels (>75F).

Any project operations that could increase water temperature stresses would be considered adverse and any effects would be significant. Exhaustion of the new reservoir's accessible cold-water pool could occur in drier years if not carefully managed and regulated. (Note this has occurred in USBR's Shasta Reservoir on the Sacramento River in recent drought years leading to the near complete loss of annual winter run salmon production.)

Any water temperature limitations downstream of the project that could occur would limit any suggested project related benefits to steelhead. Summer water temperatures greater than 65F may be tolerated for short periods if flows, food, cover, predation, competition, and dissolved oxygen are not limiting. If these factors are not optimal in favor of the steelhead, growth and survival would suffer. The DEIR fails to address these potential limitations to or tradeoffs with the suggested project predicted benefits.

Valley Water is claiming the project would reduce temperatures compared to existing conditions. Yet the DEIR states in the Water Quality chapter (p. 3.20-7) that "*Limited measurements are available to characterize water temperature in the existing Pacheco Reservoir*". Those measurements in Figure 3.20-5 show that stressful water temperatures (65-75F) occur in the lower NF from May-October in drier years. Figure 3.20-4 shows lethal water temperatures (>75F) can occur in the surface waters of the existing in the summer of drier low-storage years.

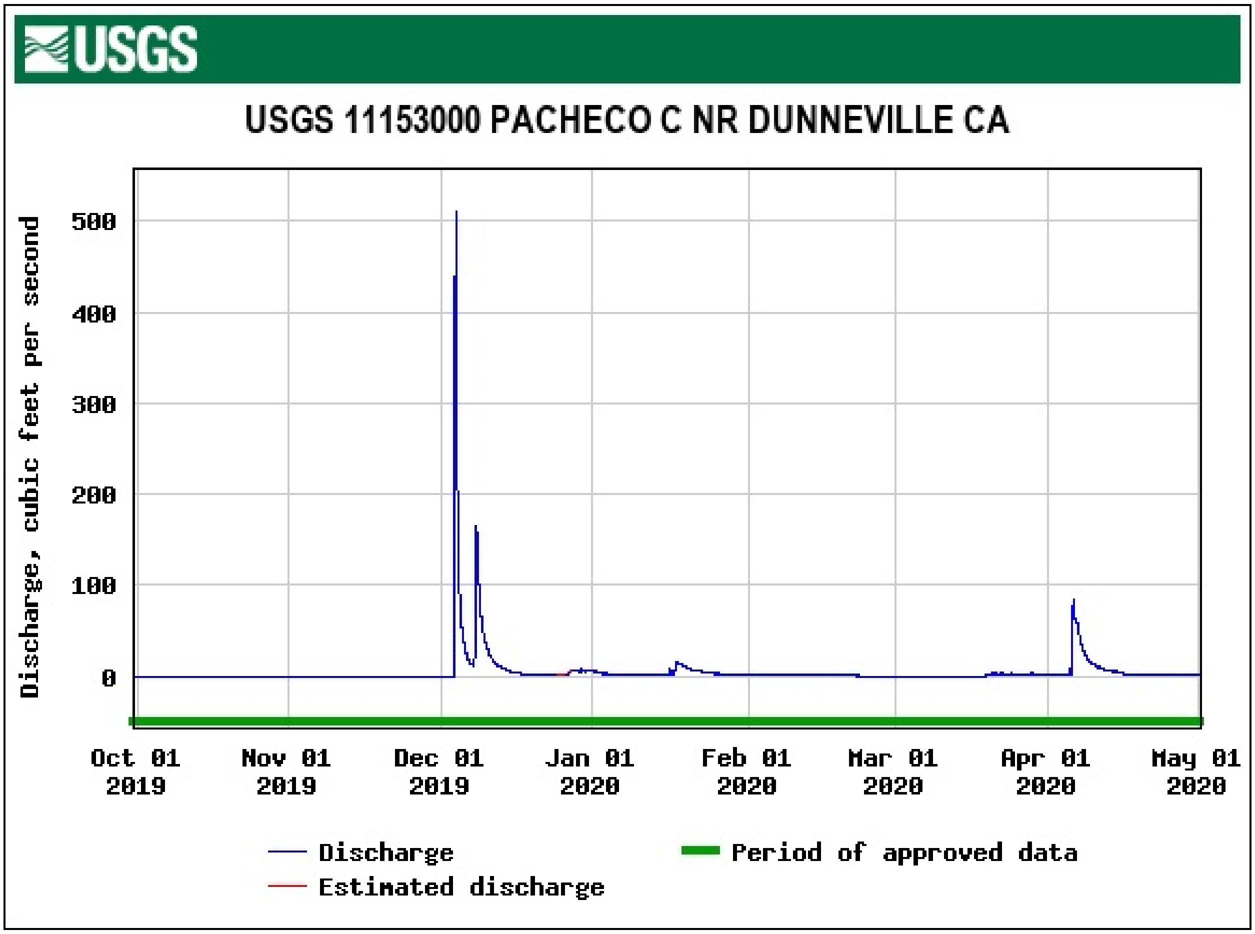
The proposed new reservoir would have a much larger surface area exposed to warm summer air temperature, causing potentially lethal water temperatures in its epilimnion (near surface layer). If sufficient storage is not maintained, such waters may be entrained into the proposed reservoir releases to the lower NF. Mean monthly model predictions averaged across year types show that stressful water temperatures would occur during construction in summer (DEIR, Figure 3.20-6, 3.20-7) and in the future with project operations (DEIR, Figures 3.20-10 to 18).

What these figures fail to show is daily afternoon temperature that may occur in warm dry years when the reservoir is depleted, and only bare minimum flows are maintained below the proposed new reservoir. Even at near dead-pool, the proposed reservoir would have substantial surface area to warm to lethal surface temperatures. If such conditions occur, there would be adverse effects on any steelhead in the lower NF. None of these potential dry year operational extreme model predictions were presented in the DEIR.

18. <u>Comment – STEELHEAD SPAWNING RUN:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.11)

Adult spawning migrations may occur from fall into spring when attraction and passage are provided by often-sporadic river outflow events. The DEIR states spawning occurs into March and incubation occurs into April. In colder wetter years with early spring storms, spawning could extend into April and incubation could extend into May or June (SCCCS Recovery Plan) especially if cold 50F water is being released from the new reservoir. Spawning can occur into April and emergence of fry from redds can extend into May or even June in wetter, cooler year types (SCCCS Recovery Plan).

The mean monthly flows do not accurately represent the daily flow windows steelhead would be faced with in individual years. For example: the figure below is for wet year 2019, after a dry 2018. Such windows of opportunity appear in most years, even in some of the driest drought years. The proposed project should accommodate these spawners under the worst water supply conditions to provide sufficient attraction flow to the NF when a depleted reservoir is storing NF stormwater inputs. Otherwise, adult steelhead leaving the ocean during the spate of flow will be attracted to other tributaries. Furthermore, the NF is part of or even a major contributor to the overall attraction for ocean steelhead to the Pajaro system. Substantial storage of the NF water (per the project proposal) portrayed in the figure below would have an adverse impact on the Pajaro/Pacheco core unit of the SCCCS DPS.



Pacheco Creek streamflow October 2019-April 2020 at USGS Dunneville Gage.

19. <u>Comment – DELAY IN STEELHEAD SPAWNING TO ANOTHER YEAR:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 fig 3.6-2, p.11)

The DEIR should mention that steelhead adults may wait to migrate and spawn another year. (Federal Register/Vol. 70, No. 170/Friday, September 2, 2005/Rules and Regulations). If adults are discouraged from attempting a spawning run and delayed a year or more because of storage of NF water in the proposed project, that would be considered an adverse impact to the Pajaro/Pacheco core unit of the SCCCS DPS.

20. <u>Comment – ADULT STEELHEAD STRAYING:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 4, p.12)

Some natural straying within the DPS may be acceptable, but whether it is "*desireable and natural*" as stated in the DEIR is questionable. NF-origin adult steelhead may stray into other forks and tributaries if NF attraction flows are diminished by the proposed project, which may be problematic if NF adult steelhead returns are inadequate or if habitat conditions in the other streams are inadequate compared to an enhanced NF.

The proposed project does not specifically provide attraction flows when other tributaries are doing so. To do so could substantially reduce the economic benefits predicted for the project.

Another concern is whether CV wild or hatchery steelhead would be attracted to CV water transferred to Pacheco Creek watershed by the projects transfer water from San Luis Reservoir, and whether that would have an adverse effect on the Creek's steelhead population. The trucking and barging described in the DEIR of CV hatchery fish applies mainly to salmon, not steelhead. Regardless, CV steelhead, especially those that are hatchery produced, could be attracted to the Pajaro/Pacheco watershed to spawn.

21. <u>Comment – LOW DISSOLVED OXYGEN EFFECTS ON STEELHEAD:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 4, p.12)

Low dissolved oxygen (DO) in a eutrophic reservoir should not be characterized as only being an "*extreme condition*". The potential for low DO in the hypolimnion even in winter of a eutrophic reservoir is real if not probable. Low DO may occur in dam release even with the proposed questionable aeration in the reservoir. Low DO may even occur during the winter-spring spawning season and could result in NF DO falling below 9 mg/l, which would be detrimental to steelhead eggs and embryos in redds where DO may be several mg/l lower than in incoming streamflow.[1] The DEIR should address the potential for low DO with a more complete analysis and assessment.

22. <u>Comment – CRITICAL HABITAT DESIGNATION:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.15)

The EIR should note that the NF and much of the Pajaro/Pacheco watershed are designated critical habitat of SCCC steelhead.

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1 https://calsport.org/fisheriesblog/?p=4012

23. Comment – RECOMMENDED RECOVERY ACTIONS:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 4, p.15)

The EIR should identify other critical recovery actions such as habitat features, not just flow. For flow, the EIR should be specific as to what flow features should be protected and provided to benefit steelhead. There has been no presentation of any preliminary Section 7 consultations by the applicant and NMFS concerning the proposed project and what flow criteria would be. Again, the DEIR does not mention the proposed project effect on winter attraction and migration flows.

24. Comment – FISHERIES IMPACTS AND MITIGATION:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 Table 3.6-2, p.24-27)

The Fish impacts listed number 1-4, 7-8, and 11 from all alternatives would be significant mainly because of the new reservoir (loss of designated critical stream habitat, reduction in winter storm flows, warm water summer releases), introduction of invasive predatory and competitive fish species, and water quality effects of the proposed reservoir (see detailed arguments in comments above and below). Fish impact 12 would be significant as an additive to cumulative impacts to CV fishes, furthermore any increase in Delta exports should be considered a significant adverse impact. The DEIR fails to provide sufficient argument that the above-mentioned project impacts should be classified as not significant as defined in Section 3.6.3.2: The DEIR makes the conclusory statement that these impacts would not be significant without any supporting evidence.

I have addressed these questions as follows:

- *Have substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the CDFW, NMFS, or USFWS been identified?*
    - The proposed project would have substantial impacts to steelhead, roach, and hitch, and the designated critical habitat of steelhead, as described in the above comments.

- *Would the Proposed Project interfere substantially with the movement of any native resident or migratory fish species*?

- The proposed project would have substantial impact on critical winter flow pulses through storage of NF water in the proposed new reservoir, pulses that are critical to adult steelhead attraction to the watershed, and adult and juvenile migration within the watershed. Mitigation provided in the form of base flow and pulse flow releases are inadequate to meet the above critical functions.

25. <u>Comment – IMPACTS OF OPERATIONS:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 2/3, p.29 and p30)

All 16 miles of upper NF habitat (as well as 2.5 miles of the lower SF and creek below the forks) would be subject to invasion of many native and nonnative fish species from San Luis Reservoir that presently do not occur in these reaches. Invasion would come from the introduction of San Luis Reservoir water into the proposed new reservoir. Such introductions would greatly alter and negatively affect the native fauna of the upper Pacheco Creek watershed.

Species that presently do not occur in the upper Pacheco Creek watershed and could invade include: goldfish, carp, brown bullhead, white catfish, smallmouth bass, striped bass, channel catfish, golden shiner, yellow perch, warmouth, black and white crappie, spotted bass, black bullhead, yellow bullhead, fathead minnow, red shiner, bigscale logperch, threadfin shad, rainwater killifish, Wakasagi, tule perch, various tilapia, redeye bass, various goby, molly, white bass, inland silverside, and pikeminnow. Any or all these invaders could expand in the proposed reservoir and into the upper Pacheco Creek watershed with potential negative consequences to native hitch, roach, and steelhead. Not all these invaders could develop sustaining populations but continued introduction from San Luis may occur. Some of the invasive species would be well adapted to the creek habitats, while others could be well adapted to the proposed new reservoir, or both.

From my review, I came to the following conclusions:

- There is high probability of San Luis transfer fish colonizing NF and reservoir, as well as the downstream watershed, which could lead to loss of special status species.
- Predation and competition could be much greater due to expanded reservoir.
- The proposed project would have a significant effect on the magnitude and duration of natural NF winter-spring flows by storing such flows in a large capacity reservoir and releasing only minimum base and pulse flows.

The DEIR's analysis is largely misdirected because it fails to consider the very real potential for new species invasions due to transfers of San Luis water. Also, it fails to acknowledge that many of the invasives below the dam are killed off by periodic droughts, which limits their abundance and spatial distribution. Finally, the DEIR fails to recognize that the large, proposed reservoir is more likely to sustain viable populations of invasive native and non-native species, and that such a reservoir would "push" invasives even further up the watershed (and into Henry Coe State Park and Romero Ranch), and even further down the watershed to San Felipe Lake and other tributaries.

26. Comment – CONSTRUCTION BARRIER:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 p.32)

The barrier would not function at higher flows nor protect spawning steelhead below the barrier from construction related effects such as construction-related high suspended sediments activated by storm runoff. Without the benefit of the existing NF reservoir providing minimum habitat conditions for part of the year, stresses on Pajaro/Pacheco native fishes will only worsen during the construction years.

27. Comment – MULTIYEAR CONSTRUCTION PERIOD EFFECTS:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 p.33)

Multiple years with no summer dam release during construction could have dire consequences to any steelhead production potential that may occur. These are all potential significant negative effects that require operational solutions and/or mitigation.

28. Comment – ADVERSE EFFECTS OF CVP TRANSFERS:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para1, p.34)

Spring water temperatures and algae would be adversely affected by CVP water introductions during the spring portion of water transfers. The effects from poor water quality and fish introductions are significant. The DEIR simply stated that non-native invasive fish already occur in the NF watershed and that water quality is already poor, plus transfers would only occur in winter when the proposed reservoir would be too cold to allow successful warm water fish introductions. Chapter 6 simply ignores the significant water quality effects predicted in Chapter 20.

29. <u>Comment – ADVERSE EFFECTS ON HABITAT</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para2-5, p.34)

Too low of minimum and pulsed flows, and poor water quality in the proposed reservoir would not provide high quality habitat, nor would the new reservoir sustain channel habitat, large woody debris, or gravel recruitment to the lower NF below the dam. A major concern would be maintaining adequate spring-fall steelhead habitat in the lower NF below the proposed dam.

Potential project benefits to steelhead are highly speculative given limitations in the lower watershed downstream to the ocean. Potential suspended sediment problems are likely a consequence of San Luis water transfers to proposed reservoir and are transfers of water sustaining algal blooms in San Luis Reservoir.

The claimed potential benefits to aquatic invertebrates from minimum storage releases are speculative given lack of upstream recruitment of natural minerals, large wood, sediment, or native aquatic invertebrates. The DEIR ignores the effects that attenuation of winter flood flows and a new reservoir would have on geomorphology (channel forming properties), LWD, and other essential components of steelhead habitat on the NF and downstream watershed.

30. <u>Comment – NON-NATIVE EFFECTS:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 2, p.35)

Many of the potential introduced fish (e.g., crappie) from San Luis transfers are pelagic at least for part of their life cycle and would readily be entrained in dam releases. These non-natives would populate the proposed new reservoir, the lower NF, and habitats further downstream (e.g., San Felipe Lake) at least on a temporary basis. These invasions could have significant impacts on special-status species and aquatic ecology that the DEIR does not address.

31. <u>Comment – NON-NATIVE INTRODUCTION EFFECTS:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 2 and 4, p.35)

Many of the potentially introduced fish can survive or even thrive in upper and lower NF as well as the new reservoir, and would increase predation and competition on roach, hitch, and steelhead. This impact would be significant.

32. <u>Comment – STRIPED BASS INTRODUCTION FROM SAN LUIS:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 3, p.35)

Striped bass could readily be introduced from San Luis Reservoir, and a transient population could occur in the new reservoir potentially affecting roach and hitch or expand downstream into the lower watershed lakes and stream, and estuary/lagoon habitats, potentially impacting roach, hitch, and steelhead production in the entire watershed. This impact is potentially significant.

33. <u>Comment – RESTORED SCOUR POOL BELOW DAM:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.36)

The DEIR fails to recognize that a scour pool would likely form below the proposed dam. It may be larger and more consequential than the present scour pool, and thus represent a significant feeding habitat for predatory fishes.

34. <u>Comment – WATER QUALITY IMPACTS:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 4-8, p.36)

The threat of water quality impacts is real and highly significant. Roach and hitch would likely be displaced, and steelhead production will be reduced from project construction and operation. Proposed “drybacks” may cause severe impacts to all three fish species and negate many of the project’s stated benefits. The DEIR promotes the benefits of the proposed drybacks but does not disclose or analyze the negative effects the drybacks would have on sensitive resources.

35. <u>Comment – SEDIMENT CONTROL PLAN:</u>
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.37)

The effects of the proposed project construction and operation would be insignificant only if flow, habitat, temperatures, wood, sediment-gravel, bugs (food), passage, and water quality (dissolved oxygen and turbidity) conditions improve, which they will not as proposed as outlined above. A more important question is whether existing fish populations would be sustained or improved from the proposed project and its related actions. Turbidity in the releases of the new reservoir could increase, given the large size of the reservoir, which would allow greater amounts of fine sediments to settle to the reservoir bottom than the existing reservoir. At low fall storage levels, inflows would activate stored sediment in reservoir and cause high downstream turbidity. If this occurred in winter spawning season (a likely probability) it would be highly detrimental to steelhead reproduction.

36. **<u>Comment – NET EFFECT ON STREAM FLOWS:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 table 3.6-4, p.45)

The DEIR states: "*The reduction in high flows would have a minimal effect on steelhead adult migration as there would still be an attraction flow provided.*" As discussed above with the accompanying figure, the reduction in flow magnitude and duration would significant. An 8 cfs baseflow or even a 30-50 cfs pulse flow would still represent a significant impact over existing conditions.

37. **<u>Comment – SUMMARY OF IMPACTS TABLE:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 table 3.6-4, p.49)

Impacts are outlined by topic in this table would all be significant (and potentially unavoidable), not less than significant (LTS). For example:

- Roach and Hitch – significant impacts from introduced fish species above and below the reservoir, and within the reservoir. Water quality changes to the reservoir and lower NF would be detrimental to roach and hitch.

- Steelhead and Lamprey – significant impacts from introduced fish species in lower watershed below dam. Turbidity/suspended sediment increases, seasonally lower flows, and lower dissolved oxygen would likely significantly reduce steelhead production downstream from dam in lower NF.

- All existing species would be significantly negatively affected during construction.

38. **<u>Comment – EFFECT OF PROPOSED PROJECT OPERATIONS:</u>**
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 1, p.60)

There would be changes to the reservoir limnology/ecology compared to existing reservoir in terms of volume, depth profiles, water quality profiles, and releases for water temperature, dissolved oxygen, turbidity, and algae production, as well as reservoir sediment dynamics (deposition and resuspension rates and composition). Most significantly there would be substantially more organic carbon (and biological oxygen demand) produced by the reservoir from much greater primary and secondary plankton and benthic algal production. Such changes would further impair water quality of Pacheco Creek and the Pajaro watershed, and potentially lead to significant effects on steelhead and other aquatic organisms and their critical habitats.

39. Comment – LIST OF POTENTIAL ALIEN FISH INVASIONS FROM SAN LUIS RESERVIOIR:
(DraftEIR_PachecoReservoirExpansionProject_Chapter3_Section3.06 para 4, p.60)

The list of alien species that could be established in the new reservoir is far greater than predicted in the DEIR based on limited information from Anderson Reservoir which is at the far end of the existing extensive transfer conduit system. The project would allow water, and introduced alien fish, to be transferred via the extension of the Pacheco conduit to the new reservoir.

Growth of the existing roach and hitch population in the new reservoir is unlikely given the different ecological conditions and would represent new unproven conditions under which a new and more alien fish community would be established. Roach and hitch, as well as steelhead populations, are not known for being resilient to new species invasions or habitat changes. The upper EF and NF natives would suffer from loss of stream habitat and hitch populations in the new reservoir in which they are unlikely to thrive given potential competition, predation, and changes in reservoir habitat.

Qualifications of Thomas C. Cannon

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EDUCATION:

University of Michigan
Fall 1965 – Summer 1969
School of Natural Resources
Major: Fisheries and Aquatic Ecology
B.S. in Fisheries

Northern Michigan University
Fall 1969 – Spring 1971
Biology Department
Majors: Biology and statistics.
M.A. in Biology

University of Michigan
Fall 1971 – Spring 1972
School of Public Health
Majors: Biostatistics and Environmental/Public Health
Masters of Public Health in Biostatistics

AFFILIATIONS:
American Fisheries Society (AFS)
CAL-NEVA Division of AFS
Fishery Foundation of California
California Sportfishing Protection Alliance

Relevant Experience:

- **Hudson River Power Plant NPDES Permit Projects – Hudson River Utilities New York (1972-1977)**

Early in my career I participated in some of the earliest projects developed under NEPA. Most notably, I participated in studies related to the continuing operations of Hudson River power plants as related to environmental impacts to Hudson River biota with emphasis on fish and water quality. I managed projects and staff, and designed and carried out studies, analyzed data, assessed impacts, and prepared reports and NPDES permits for all major power plant complexes on the Hudson River. I participated in the related NEPA process for licensing of the Indian Point Nuclear Power Plant for the Atomic Energy Commission and Federal Power Commission.

- **Great Lakes Power Plants NPDES Permits – Detroit Edison (1976-1977)**

I managed a project preparing NPDES permit applications for all of Detroit Edison's electric generating stations on the Great Lakes.

- **PG&E Delta Power Plant NPDES Permit Project – PG&E (1977-1980)**

I managed a project preparing NPDES permit applications for all of PG&E's steam-electric generating stations in California. The project included extensive surveys of the Bay-Delta and power plant impacts on the environment. Studies were coordinated closely with the DFG and federal agencies. Studies were coordinated with the NMFS (Tiburon Office), USFWS, and the Regional Water Quality Control Boards. One of my primary responsibilities was coordination with resource and regulatory agencies.

- **Striped Bass Project – SWRCB (1981-1982)**

I was a member of the State Board's Striped Bass Project team in the early 1980's investigating the failure of the water quality control plans in halting the precipitous decline in the striped bass and other fishes of the Bay-Delta. Our chief objective was to determine whether Delta and other diversions were directly causing loss of fish through entrainment or whether there was a fundamental shift in ecosystem productivity and habitat quality that was the cause of the declines in fish populations. We identified in our report to the State Board that regardless of the cause, the D-1485 Delta standards were inadequate to protect the Bay-Delta ecosystem and important fish populations including salmon and striped bass.

- **Importance of Bay-Delta as Nursery Area for Chinook Salmon – NMFS (1981-1982)**

As a consultant to the NMFS, I conducted a review of the importance of the Bay-Delta as a nursery area for Chinook salmon and other anadromous fishes including striped bass.

- **South Fork of the American River (SOFAR) Project (1981-1982)**

As a consultant to the project developer, my engineering firm was involved in the design of the SOFAR projects. My role included preliminary permitting and agency interaction.

- **Forest Management and Timber Harvest Plan – Hoopa Indian Reservation for BIA (1982)**

As a consultant to the BIA, I participated in the development of a Forestry Management Plan for the Hoopa Indian Reservation in northern California. I evaluated potential effects of all forest management activities on salmon and steelhead and their habitat in the Klamath and Trinity Rivers, and in tributaries to those rivers on tribal lands affected by forest management activities. I spent two weeks on the reservation with reservation and BIA staff observing potentially effected habitats and planned timber management activities. During that time I became acutely aware of the growing conflict between BIA managers and the tribes over control over reservation resources. I developed portions of the plan outlining protections to salmon and their habitat from forest management activities.

- A**laska Oilfields Environmental Studies – ARCO/USACE (1982-1986)**

As project manager of NEPA mandated environmental programs for oil companies and the Alaska District USACE, I coordinated environmental studies that addressed environmental impacts of oil field operation on the tundra and coastal river, estuarine, and marine ecosystems. Major focus was on effects to anadromous fish and their habitat from environmental impacts allowed under USACE permits. I worked closely under the direction of an interagency oversight team to evaluate impacts, conduct monitoring programs, and to define mitigation measures for North Slope oil operations. I also coordinated with North Slope native organizations from Point Barrow to the McKenzie River in Canada. I prepared for and presided over dozens of interagency and stakeholder meetings and technical workshops, and prepared reports and scientific papers.

- **Effects of Delta Pumping Plants on Bay-Delta Ecosystem – State Water Contractors and MWD – (1981-1987)**

As a consultant to the State Water Contractors and the Metropolitan Water District, I evaluated potential effects water projects in the Central Valley. My assignments included evaluating effects of CVP operations on the American River including review of early Instream Flow Incremental Methodology studies. I participated in many interagency reviews and worked closely with DWR and DFG staff working on a Draft Two-Agency Agreement for the State Water Project. I also worked with the USBR on testimony for the 1986 Water Quality Control Plan hearings with the State Water Resources Control Board.

- **Columbia River Data Development Project – BPA (1981-1984)**

As a consultant to the Bonneville Power Authority, I participated in a comprehensive study of the Columbia River estuary. My role was as an estuarine ecologist with emphasis on fish populations and the food chain. Working with agency and university biologists, our team developed baseline information on the Columbia River Estuary and its role in salmon ecology.

- **Susitna Hydroelectric Project – Alaska Power Authority (1984-1985)**

As a consultant to the Alaska Power Authority, I participated in the process of obtaining a FERC license for a hydroelectric dam on the Susitna River in south-central Alaska. Large scale changes in river flow, sediment and water temperature regimes, and geomorphology of the river from the proposed dam indicated to all involved that major impacts to the many salmon populations of the river could be expected if the dam were built. Eventually a lack of need for power killed the project. The project allowed me for to work with engineers, hydrologists, geomorphologists, groundwater, sediment, and water quality specialists to evaluate proposed effects of development on an ecosystem scale.

- **FERC Snake River Projects (1986-1989)**

As a consultant to Federal Energy Regulatory Commission (FERC), I participated in the NEPA process and preparation of federal EIS's relating to the licensing and relicensing of hydroelectric projects on the Snake River in Idaho. My role was to develop sections on aquatic species and habitats, and to coordinate Section 7 consultations with federal and state agencies review teams. Protected species at the time included bald eagles and several aquatic snail species. Rare and isolated populations of cutthroat trout were also addressed. I was responsible for addressing state and local land use laws and plans. Instream flow requirements for the Snake River were fundamental issues. This was one of several major FERC projects in which I was involved where state water law and the ESA were in direct conflict.

- **USFS/FERC Skagit-Nooksack Project (1988-1989)**

Working as a consultant to the US Forest Service, I participated in the NEPA process for multiple hydropower licensing and relicensing projects for the Forest Service and FERC. Actions evaluated included changes to flow and stream habitats. Effects considered included those on sockeye salmon and bull trout, as well as Coho and Chinook salmon and steelhead populations of the Skagit and Nooksack rivers.

- **FERC Elwha Project (1988-1990)**

I participated in the NEPA process relating to the relicensing or termination of FERC licenses for two dams on the Elwha River in Washington. I evaluated the potential impacts and benefits to salmon, steelhead, and bull trout populations from various alternatives including dam removal.

- **BPA Cowlitz Falls Project (1988-1990)**

I participated in the environmental documentation for the Cowlitz Falls Project of the City of Tacoma Washington for BPA. Actions included reintroduction of anadromous salmon and steelhead to the Cowlitz River and its tributaries above existing large hydroelectric project dams and reservoirs. Concepts and alternatives developed and evaluated including trucking adult salmon and trout above reservoirs and capturing young salmon and steelhead on their downstream migration before they reached the reservoirs, and transporting them below the lower dam on the Cowlitz River. The project is one of the most successful attempts at reintroducing anadromous fish to headwaters of dammed river.

- **FERC Salt Caves Project (1989-1991)**

As a consultant to FERC, I participated in the FERC licensing project for the Salt Caves Project on the Klamath River on the border of California and Oregon. I evaluated environmental effects of alternative hydropower generation facilities on resident trout, endangered suckers, and other aquatic life of the Klamath River. The evaluation included potential effects to anadromous salmon and steelhead of the project in the event that passage was restored past downstream dams (Irongate and Copco 1 and 2). I participated in Section 7 consultations relating to bald eagle and endangered suckers. I reviewed recovery plans and actions relating to the project that could impact or benefit these species. The primary laws and regulations governing potential project operations were those of the state of Oregon. The project was eventually not licensed by FERC because it failed to meet state water quality standards. I helped coordinate and conduct public meetings in Klamath Falls.

- **FERC Platte River Project (1990-1992)**

As a consultant to FERC, I participated in FERC licensing and related NEPA process for the Platte River Project in Nebraska. I evaluated potential effects to resident fishes, as well as special status species including paddlefish, sturgeon, whooping cranes, Arctic terns, and piping plovers - fish and birds that would be potentially affected by flow and habitat changes relating to the relicensing of the hydropower project. The Platte River Project supplied much of the agricultural water supply of central Nebraska. FERC jurisdiction and endangered species protection mandates brought project water supply objectives into direct conflict with ESA. On this and other FERC projects my team served as an extension of the FERC staff and often operated as “FERC staff” in coordinating with federal, state, and local entities, in conducting public meetings, and in preparing documentation. I presided over public meetings and technical coordinating meetings with federal, state, and local agencies, as well as stakeholders including environmental groups. Working with engineering staff I helped develop water supply and hydrology models of the Platte River. Key technical issues including land use, stream flows, and water supply were discussed and agreements worked out.

USACE Missouri River Master Manual Review (1991-1994)

As a consultant to the Missouri River Division of the USACE, I spent several years developing and evaluating alternatives and preparing an EIS on alternative Master Manual Operation regimes for the Missouri River dam-reservoir system from eastern Montana to the mouth of the Missouri River. My role focused on developing alternatives and assessing effects on environmental and cultural resources including special status species such as sturgeon and paddlefish. Effects considered were to reservoir water levels, stream flows, and related effects on water quality. The project included coordination with the many tribes along the Missouri River. Many of the tribes had keen interests in recreation, water supply, cultural, and water quality issues. I prepared for and presided over public meetings and technical workshops.

- **USACE/BPA Columbia/Snake Operations Review (1992-1994)**

I participated in the Columbia/Snake Operations Review for the USACE Walla Walla District, BPA, and USBR. I worked on elements of the EIS and potential effects to project alternatives to salmon and steelhead populations of the Columbia and Snake River systems.

- **BPA/Clearwater Indian Nation Clearwater River Study (1993-1994)**

I participated in IFIM and hydrology studies on the Clearwater River to evaluate changes in flow on salmon and steelhead and their habitat on the Clearwater River in southwestern Idaho. We worked through the tribes who received grants from BPA.

- **Bay/Delta Ecosystem Effects Studies – MWD (1994-1995); CUWA (1996)**

As a consultant to the Metropolitan Water District of Southern California and the California Urban Water Agencies, I was part of a team planning development of a multispecies habitat conservation plan for the State Water Project. I was also assigned to evaluate and help improve the IEP Monitoring Program in the Bay-Delta working closely with DFG, DWR, and USBR staff. I participated in many interagency review meetings and technical workshops on the operations of the state and federal water projects.

- **PG&E Delta Power Plants HCP and EA (1997-1999)**

As a third-party consultant funded by PG&E and representing the USFWS and NMFS, I participated in the preparation of an HCP and EA for a Section 10 application to take winter-run Chinook salmon and delta smelt at two Delta power plant complexes. I evaluated the long-term effects of the facilities and future operations on Delta and anadromous fish populations. I helped prepare the HCP and EA submitted by PG&E. I met with state and federal ESA agency staff on numerous occasions to discuss conservation measures and the effects of the facilities. I also evaluated potential conflicts between the NPDES and Section 10 permits for the facilities, as well as potential for greater diversions and higher temperature thermal plumes from the plants under the new ownership and ISO/IPO system being implemented by the California Energy Commission.

- **Delta Wetlands Project – BA and ER (1996-1998)**

As a third-party consultant funded by Delta Wetlands and representing the State Board and USACE, I participated in the development of alternatives and their environmental impact evaluations for the Delta Wetlands Project in the Sacramento-San Joaquin River Delta. I participated in the evaluation of potential effects of new water diversions on Delta outflow and evaluated implications to salmon, steelhead, and delta smelt populations. I also evaluated the potential to violate water quality criteria in the Delta from island storage releases. I participated in Section 7 consultations for the project with State and federal agencies while representing the applicant, the State Board, and USACE.

- **Montezuma Wetlands Project – BA and EIR/EIS (1996-1998)**

As part of a third-party consulting team funded by the applicant and representing Solano County and the USACE, I participated in the NEPA process related to the Montezuma Wetlands Project in Suisun Marsh near Collinsville. My roles included preparation of EIS sections on potential effects and benefits to fish and their habitat in the Bay-Delta, including winter run chinook salmon and delta smelt. Our team worked with the San Francisco District of the USACE and Solano County to ensure we met the needs of these permitting agencies.

- **Lower Butte Creek Study Program – Nature Conservancy and Ducks Unlimited (CVPIA program) (1997-1999)**

As a consultant to the Nature Conservancy and Ducks Unlimited, I participated in the Lower Butte Creek Study Program to evaluate potential means for improving salmon and steelhead passage through the Butte Creek system. My role was to evaluate potential fish passage problems and help to identify and promote solutions through working with local stakeholders. I identified passage solutions and previously unforeseen problems facing downstream salmon and steelhead juveniles migrating from spawning areas in the upper watershed. The Butte Creek system has tremendous obstacles to downstream migration of young salmonids particularly in drier years – most of these problems have yet to be resolved. My activities brought me in contact with local stakeholder groups, primarily farmers, but also federal and state refuge managers who also depend on water and land for their waterfowl and wetland programs.

- **Butte Creek Parrot-Phelan Dam Project – Butte County (1998-1999)**

As a consultant to Butte County, I evaluated the final facilities constructed to replace facilities lost at the Parrot-Phelan diversion site from devastating floods. The facilities were constructed under emergency authorities and Butte County asked me to review the project to ensure it was constructed appropriately under their laws and responsibilities. I noted that the screen and ladder were well designed and worked well. I noted potential problems with the flood flow bypass and associated problems for upstream passage under high flows.

- **CVPIA and CALFED EIR/EIS's – USBR/CALFED (1995-1999)**

I participated in the preparation of the EIR/EIS's for the CVPIA and CALFED programs for the USBR and CALFED. The EIS's covered many actions under the CVPIA and CALFED programs including alternatives development and evaluation. I worked on the water management strategies for both programs including the Environmental Water Account. I have worked extensively on all elements of the CALFED program and many elements of the CVPIA program. This experience has made me acutely aware of water management in the Central Valley. My previous experience with problems relating from D-1485 water quality standards, proposed D-1630 standards, and the 1995 Accord and Standards fits in well with my recent experiences dealing with conservation and recovery of fish populations in the Central Valley. I was also with the Anadromous Fish Restoration Program in the evaluation of the AFRP flow recommendations for the lower American River.

- **CALFED Ecosystem Restoration Program Plan – CALFED (1995-2000)**

As a consultant to CALFED, I was one of the original designers and authors of the Ecosystem Restoration Program Plan (ERPP). I prepared individual sections on actions to be considered for specific watersheds and resources including special status fish species. One of the major features of the ERPP is its links to other ecosystem restoration programs. I participated in various watershed reviews including the American River and was the author of the draft vision for the American River. I participated in the planning and conduct of many of the CALFED meetings and workshops.

- **CALFED Conservation Strategy - (1998-2000)**

I participated in the early design and development of the CALFED Conservation Strategy developed in consultation with a team of consulting scientists. I prepared early drafts of CALFED's Adaptive Management philosophy. I worked extensively on CALFED's Multi-Species Conservation Strategy. I was the principal author of appendix plans that included many prescriptions for conservation and recovery of all special status fish species in the Central Valley. I reviewed listing documents and recovery plans and incorporated elements into the conservation actions. I reviewed all salmon conservation and recovery actions for the Central Valley and Pacific Coast and made recommendations for modifying and adding to the overall recovery program. I also developed conservation schemes and measures for potential effects of each of the CALFED Program elements and associated actions that could affect special status fish species.

- **Delta Fish Facility Advisory and Technical Teams – CALFED/ CVP (1999-2001)**

I participated as a consultant to Delta fish facilities teams evaluating intake and fish protection facilities at the Delta Cross Channel, proposed Hood diversion, Clifton Court Forebay, and Tracy Fish Protection Facilities. As a consultant to the CALFED Delta Entrainment Effects Team, I helped in evaluating the potential effects of many options for water diversion from the Delta, including potential effects to salmon and steelhead. I prepared papers on factors affecting salvage numbers of salmon and steelhead at the state and federal pumping plants in the South Delta.

- **CVPIA Comprehensive Assessment and Monitoring Program (CAMP) – (1995-1996)**

I was an original member of the CAMP consulting team. We developed a monitoring and assessment program to evaluate whether objectives of the CVPIA would be met, particularly goals to double salmon and steelhead runs in the Central Valley. I promoted development of monitoring and assessment techniques to estimate production of wild smolts as well as adult escapement.

- **CALFED Water Management Strategy and Environmental Water Account – (1998-2001)**

I participated in CALFED's development of a water management strategy including the Environmental Water Account that would protect and enhance survival of salmon. The water management evaluation included detailed review of operations of the American River Project on flows of the American River and Delta inflow. I participated in the inter-agency gaming exercise to evaluate alternative operations of the water projects in combination with CVP and CALFED water accounts. During two years of extensive exercises, I became very familiar with water project operations in the Central Valley.

- **CALFED Delta Entrainment Effects Team – (1998-2000)**

I participated as an analyst on the CALFED DEFT team to evaluate the effects of water diversions on Bay-Delta fish populations.

- **CALFED DCC-TDF – (2000-2002)**

I participated in CALFED's Delta Cross Channel and Through Delta Facility team as an analyst to evaluate the benefits and adverse effects of different operations of the Delta Cross Channel and the proposed Through Delta Facility.

- **Water Forum/EBMUD – (1997-2000)**

As a consultant to the Water Forum (EBMUD) and SAFCA, I participated in the evaluation of the alternatives for American River flow and flood management and river restoration. I also helped prepare Lower American River Floodway Management Plan for SAFCA. I participated in numerous Lower American River Task Force meetings and other related meetings including the Lower American River Operations Group and Management Group. I participated in the preparation of the EIR for EBMUD's and Sacramento County's water diversion from the lower American River (since moved to Freeport on the Sacramento River). I worked on SAFCA restoration projects along the lower river and participated in temperature studies from Lake Natomas downstream through the river. As a consultant to the East Bay Municipal Utility District, I attended Water Forum public meetings and advised EBMUD on issues relating to water and habitat that would affect salmon and steelhead of the lower American River prior to the Water Forum Agreement of 2000. I participated in teams evaluating potential salmon habitat conservation and improvement projects for the lower American River. I was the principal author of SAFCA's fish habitat section of the Lower American River Floodway Management Plan. As part of that project I evaluated numerous options for conserving and improving salmon and steelhead habitat throughout the lower American River. I consulted with EBMUD to evaluate proposed conservation and habitat improvement measures of the Water Forum for the lower American. I prepared and submitted grant proposals to CALFED on behalf of SAFCA for specific habitat improvements to the lower American River. I evaluated effects of operations of USBR on the lower American River salmon and steelhead habitat and populations.

- **GCID Sacramento River Project – USACE (1999)**

I participated in the design of a monitoring program to evaluate the effectiveness of mitigation measures and project fish protection elements for the new GCID intake facility on the Sacramento River.

- **Battle Creek Hatchery Screening Project – USBR (2000)**

I participated in the design of a monitoring program to evaluate the effectiveness of new fish screens at the Battle Creek hatchery intake system on Battle Creek.

- **Yolo Bypass Ecosystem Restoration Strategy Development Project - Yolo Basin Foundation (1999)**

Working with the Yolo Basin Foundation, I prepared a grant application for local stakeholders to develop a restoration strategy to restore wildlife and fish habitat and improve salmon survival through the Yolo Bypass. I spent many hours in the bypass from the Fremont Weir in the North to the exit of the bypass on Cache Slough observing habitat conditions, land use patterns, and potential obstructions to salmon upstream and downstream passage. I identified many potential problems and opportunities to improve habitat and passage for Sacramento River salmonids. I met with individual stakeholders (including DWR and PG&E Properties) and helped obtain their support for the project. The project was funded and has begun.

- **Upper Yuba River Studies Program – CALFED (2000-2001)**

As a consultant to CALFED, I participated in the Upper Yuba River Studies Program. I prepared a monitoring program design to collect information necessary to determine if the upper watershed above Englebright Dam has habitats adequate for anadromous salmon and steelhead. I participated in CALFED workshops with participating stakeholders and the general public.

- **Lower Yuba River Studies Program – YRTWG (2000-2001)**

I have supported the Yuba River Technical Working Group in the preparation of grant applications to study fish passage problems in the lower Yuba River at Daguerre Dam. I supported the Working Group in reviewing the USACE preliminary study of Daguerre Dam. Options being evaluated are dam removal and ladder improvements.

- **Yuba River Watershed Assessment – Yuba Watershed Council, South Yuba River Citizens League (2000-2002)**

I have supported Yuba River watershed stakeholder groups in preparing grant applications for federal and state funding for watershed assessment and restoration activities. I have attended meetings with the Yuba Watershed Council and the South Yuba Citizens League. I have taken many field trips to the watershed and have identified problems including high sediment loads that threaten production of salmon and steelhead in the lower river.

- **Mokelumne River Watershed Assessment – Sierra Pacific Industries (2000-2001)**

As a consultant to Sierra Pacific Industries, I participated in the development of a watershed assessment for the upper Mokelumne River watershed properties of Sierra Pacific. The assessment focused on potential risks to water quality, sediment/erosion, and water supply from timber harvest in the watershed. We identified sub-watersheds that had the greatest potential impacts from timber harvest and identified measures to reduce environmental damage.

Recent Employment

- **Jones and Stokes Associates – Sacramento (1995-1999)**

At JSA, I participated in numerous local and regional projects including those identified above for this time period. I also received considerable management training as well as environmental training and classes on CEQA/NEPA and CESA/ESA. I managed JSA's contracts with CALFED and participated in CALFED's consulting team.

- **Foster Wheeler Environmental – Sacramento (1999-2002)**

At Foster Wheeler I as was primarily responsible for developing environmental business in northern California, Idaho, Washington, and Alaska, in addition to the pursuit of local projects identified above.

- **Fishery Foundation of California (2002-present)**

As the executive director (2002-2003) and principal investigator of the non-profit Fishery Foundation of California I helped conduct a striped bass tagging study, striped bass pen rearing program, and hatchery salmon acclimation program, and conducted a monitoring study of Delta fish habitat at Kimball Island near Antioch. I coordinated numerous activities with California Striped Bass Association and other sportfishing groups. I managed development and implementation of monitoring surveys of SAFCA habitat restoration projects in the LAR. I was the principal investigator of CVPIA monitoring surveys of the LAR that involved determining the habitat requirements of salmon and steelhead. I coordinated with stakeholder and agency groups and participated in workshops and projects including the Lower American River Corridor Management Plan. I have become intimately familiar with the river's hydrology, water temperature regime, salmon and steelhead populations, spawning and rearing habitat, and recreational fisheries. I was project manager and principal investigator on a grant from CVPIA to study water supply opportunities for the Cosumnes River. I was a consultant to Lake Wildwood Homeowners Association in proceedings with the Regional Water Quality Control Board and DFG Region 2 on water quality control plan violations in the Deer Creek watershed, a tributary to the lower Yuba River.

- **HDR Engineering – Folsom (2003-2004)**

At HDR I was primarily responsible for developing environmental business in northern and southern California, in addition to the pursuit of local projects identified above. I also participated in water resources projects in Alaska and Nebraska. I was project manager for regional indefinite deliverable contracts I helped procure for HDR with CALTRANS. I participated in many local and regional HDR projects working closely with the water resources engineering department.

- **Wildlands Inc. - Rocklin (2004-2010)**

As manager of aquatic programs at Wildlands during the past decade, I developed habitat restoration programs for Central Valley rivers under federal and state mitigation banking programs. I have worked closely with DFG, NMFS, USFWS, DWR, and SAFCA in defining opportunities for riparian and floodplain restoration. I have participated in Lower American River meetings and workshops. I have worked closely with NMFS in the development of a Conservation Banking Program in the Central Valley for listed salmonid fishes. I developed longfin smelt and Delta smelt conservation banks in the Delta and Suisun Marsh.

- **Consultant/CSPA Scientific Advisor (2010-present)**

Consultant on fishery ecosystem assessment programs relating to California resource management. Consultant to Karuk Tribe, Quartz Valley Indian Reservation, California Sportfishing Protection Alliance, Cal Trout, Klamath River Keeper, Westerveld Inc., Fishery Foundation of California, and others. Participate in various workgroups and committees of these planning entities. Subjects include ecosystem restoration, Yolo Bypass, fisheries enhancement, aquatic habitat assessment, water rights, water resources development, groundwater and surface water management - review, management, reports, assessments, and analyses. Advised CSPA on issues related to BDCP, water quality standards, water transfers, EcoRestore, biological opinions, and WaterFix. Contributed to CSPA Fisheries Blog.

EXHIBIT 3

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY **GAVIN NEWSOM,** *Governor*

DEPARTMENT OF WATER RESOURCES
P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

November 1, 2021

Mr. Christopher Hakes, Deputy Operating Officer
Dam Safety and Capital Delivery
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, California 95118

Pacheco Dam, Proposed
Santa Clara County

Dear Mr. Hakes:

This is the Division of Safety of Dams' (DSOD) response to the Santa Clara Valley Water District's (Valley Water) design concept submittals for the proposed Pacheco Dam. Valley Water's submittals, dated March 1, 2021, March 16, 2021, and August 25, 2021, sought DSOD's review and approval of the feasibility of constructing a "hardfill" dam at the preferred upper dam site. For the reasons set forth below, DSOD is unable to approve Valley Water's concept.

DSOD has completed its review of the submitted documents (list enclosed). These submittals define a hardfill dam as a symmetrical gravity dam constructed of cemented materials utilizing construction methods similar to Roller Compacted Concrete (RCC). Hardfill materials generally do not meet industry requirements for RCC mixtures, such as using lower quality aggregates with greater fines content (0.075 mm and smaller particles). According to the submittals, Pacheco Dam would be of similar design.

As proposed, Pacheco Dam would be the largest hardfill dam in the United States, standing at a height of 326-feet with 140,000 acre-feet of storage. A key aspect of DSOD's review has been the design, construction, and performance history of hardfill dams in the United States and elsewhere. However, given the short history (less than 20 years) and limited documentation for this type and size of dam, sufficient information is not readily available. With this limitation, DSOD cannot agree with Valley Water and its consultants that hardfill dams have proven adequate performance based on the lack of documented negative performance.

As discussed in a meeting with you and your staff on October 27, 2021, DSOD has identified major issues that lead us to reject the hardfill dam concept. A complete list of major comments is enclosed. The most critical issue, which was identified during your consultant's (AECOM) Probable Failure Mode (PFM) workshop, is the potential degradation of hardfill over time in the presence of water. This negative factor is identified numerous times in the screening of PFMs, but it was considered remote. However, a lack of research and limited performance history leave large uncertainties as to whether this factor is remote. This compounds the risk since the potential for water to interface with the hardfill cannot be fully mitigated, especially at the interface between the dam and foundation.

Although risk reduction measures could be incorporated into the design, the adequacy and longevity of any risk reduction measure would be unknown. The ability to monitor the dam's performance would be limited in areas such as at the contact between the dam and its foundation. As such, if deficiencies do manifest after significant progression, intervening actions may not be adequate to prevent a catastrophic failure of the dam.

Additionally, the lack of well-documented case histories, cohesive design standards, and independent research regarding hardfill dams and their long-term performance poses unacceptable risks for public safety. Finally, the suitability of the hardfill as a robust dam design cannot be accepted by DSOD based on these factors and assumptions that may prove incorrect in time as the performance of this dam type is better understood.

The upper dam site preferred by Valley Water remains a feasible site to construct a dam, such as an earthfill dam, but this site does have noted geologic issues that will need to be addressed for any dam type. The concern of site-specific fault rupture and the associated unknowns will remain until the foundation is excavated or fully explored via a trench. Additionally, the adverse bedding in the right abutment and potential for differential settlement between the adjacent geologic units will need to be further evaluated. Any dam constructed at this site will need to be designed to accommodate all uncertainties reliably to mitigate the risks associated with the extremely high downstream consequence associated with a dam of the proposed size.

If you have any further questions or comments, please contact Design Engineer Ashley Moran at (916) 565-7850 or Project Engineer Christopher Dorsey at (916) 565-7846.

Sincerely,

Sharon K. Tapia

Sharon K. Tapia, P.E.
Division Manager
Division of Safety of Dams

Enclosures

California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
DIVISION OF SAFETY OF DAMS
November 1, 2021

Enclosure 1

The list of documents submitted by Valley Water that DSOD reviewed for determining the acceptability of a hardfill dam at the proposed Pacheco Dam site follows:

1. Hardfill Dam Workplan Pacheco Reservoir Expansion Project, by AECOM, Inc., Stantec, and GEI Consultants, dated March 11, 2021.

2. Evaluation of Hardfill Dam Technical Memorandum Pacheco Reservoir Expansion Project, by AECOM, Inc., Stantec, and GEI Consultants, dated March 15, 2021.

3. Project Alternatives Assessment Technical Memorandum Pacheco Reservoir Expansion, by AECOM, Inc., Stantec, and GEI Consultants, dated March 2021.

4. DRAFT Assessment of Regional and Local Faulting, Pacheco Reservoir Expansion Project, Santa Clara County, California, by Lettis Consultants International, Inc., dated September 10, 2020.

5. Assessment of Local and Site-Specific Faulting, Pacheco Reservoir Expansion Project, Santa Clara County, California, by Lettis Consultants International, Inc. dated February 12, 2021.

6. Reservoir Rim Landslide Inventory Mapping near the Proposed Pacheco Reservoir Expansion Project, Santa Clara County, California, by Lettis Consultants International, Inc. dated March 2, 2021.

7. Pacheco Reservoir Expansion Project (PREP): Workshop materials from PFM workshop, by AECOM, Inc., Stantec, and GEI Consultants, dated August 25, 2021.

California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
DIVISION OF SAFETY OF DAMS
November 1, 2021

Enclosure 2

The following is DSOD's list of major comments with respect to the proposed hardfill dam at the Pacheco Dam site (upper or lower):

1. Long-term performance data for hardfill dams of the proposed size are not available to adequately support the proposition of a hardfill dam of such extreme consequence. The dynamic properties of hardfill are not well studied or known, and there are no records showing that the select hardfill dams of a similar or larger size have been subjected to dynamic loading close to their design loads. The documentation by AECOM regarding seismic history are based on estimates rather than direct measurements. The conclusion that hardfill dams have adequate performance because there has been no documentation of negative performance is potentially unconservative given the limited history (less than 20 years) for dams of this type and size under extreme loads.

2. In AECOM's review of potential failure modes (PFMs), a negative factor for many of the PFMs is the possibility that hardfill can degrade over time in the presence of water. We find this to be the most critical issue because water may be able to access the hardfill in multiple locations, and some locations may not be detectable. To date, thorough and complete research on this issue has not been performed, and it would take significant time to completely understand. However, this issue cannot be disregarded and is the crux of further issues below.

3. A grout curtain will not fully prevent seepage below or around the dam, and seepage is likely to permeate the dam at the foundation contacts and potentially cause hardfill degradation. The degradation of hardfill in existing dams is currently unknown and the appropriate research would need to be conducted to mitigate any potential risks.

4. The aggregates will be variable on site, which would increase the potential for hardfill to degrade over time if areas of concentrated seepage occur. While multiple mix designs will be developed, not every property of the hardfill will be understood, and the global variability may cause internal flaws or fractures that cannot be predicted or analyzed before construction. Additionally, adequate mixing will be a challenge with many aggregates exceeding 10-percent fines content. While a liner as proposed would protect the dam, we note that liners do degrade with time and environmental conditions (reservoir cycling, weather, etc.).

Enclosure 2

5. The potential for larger units of shales to abut sandstone units creates a potential for differential settlement below the dam. While structurally, the dam may be able to adequate bridge this condition, water would be more likely to access the interface reducing friction resistance, increasing uplift on the dam, and providing a pathway for seepage into and possible degradation of the hardfill or erosion of the foundation that may be undetectable.

6. Considering the adverse bedding and zones of open fractures in the proposed right abutment and the relatively narrow footprint of the hardfill dam, there is a risk of instability and seepage that could result in failure at that abutment. A dam with a larger footprint, like an earthfill dam, would better mitigate the risk of abutment failure by increasing seepage path lengths and improving the ability to capture and monitor for seepage.

7. The site-specific fault rupture evaluation does not adequately demonstrate absence of active faults in the dam foundation. Any planar, laterally continuous bedrock faults or shear zones exposed in the foundation during construction will be considered conditionally active and a possible rupture hazard if their attributes are reasonably consistent with the current tectonic regime. If a shear is encountered, conclusive proof of inactivity will be difficult to achieve given the apparent absence of Quaternary deposits greater than 35,000 years old.

<u>EXHIBIT 4</u>

San Luis Low Point Improvement Project

Draft Environmental Impact Statement/ Environmental Impact Report

Estimated NEPA Lead Agency Costs Associated with Developing and Producing this Draft EIS/EIR: $3,080,000

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

Santa Clara Valley Water District
San Jose, California

July 2019

San Luis Low Point Improvement Project Draft Environmental Impact Statement/ Environmental Impact Report

Public Draft

Estimated Lead Agency Total Costs Associated with Developing and Producing this EIS/EIR is $3,000,080

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

Santa Clara Valley Water District
San Jose, California

July 2019

Mission Statements

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

San Luis Low Point Improvement Project
Draft Environmental Impact Statement/Environmental Impact Report

Lead Agencies: U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and the Santa Clara Valley Water District (SCVWD)

State Clearning House #

ABSTRACT

Reclamation and SCVWD have made available for public review and comment the San Luis Low Point Improvement Project (SLLPIP) Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR). Investigations determined that several sections of B.F. Sisk Dam sit above liquefiable and soft soils. During the summer, high temperatures and declining water levels in San Luis Reservoir create conditions that foster algae growth. The water quality within the algal blooms is not suitable for municipal and industrial water users relying on existing water treatment facilities in Santa Clara County. The Draft EIS/EIR evaluates the potential impacts of alternatives to help maintain a high-quality, reliable, and cost-effective water supply for SCVWD and would ensure SCVWD receives its annual Central Valley Project contract allocations at the time and at the level of quality needed to meet its existing water supply commitments and avoid water supply interruptions. The alternatives evaluated in this EIS/EIR include construction of a new, lower San Felipe Intake, development of new technology retrofits at SCVWD's Santa Teresa Water Treatment Plant, the placement of additional fill material on the dam embankment to raise the dam crest to increase San Luis Reservoir storage capacity, and the development of an expanded Pacheco Reservoir and a new earthern dam and spillway constructed on the North Fork of Pacheco Creek.

This Draft EIS/EIR has been prepared according to requirements of the National Environmental Policy Act and the California Environmental Quality Act. Direct, indirect, and cumulative impacts resulting from the project alternatives on the environment of the region are addressed.

FOR FURTHER INFORMATION CONTACT:

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List of Acronyms

AADT	annual average daily traffic
AB	assembly bill
ABAG	Association of Bay Area Governments
ACHP	Advisory Council on Historic Preservation
ADA	Americans with Disabilities Act
AF	acre-feet
APE	area of potential effects
ATF	U.S. Bureau of Alcohol, Tobacco, Firearms, and Explosives
BAAQMD	Bay Area Air Quality Management District
Banks Pumping Plant	Harvey O. Banks Pumping Plant
BDCP	Bay Delta Conservation Plan
BMP	best management practice
BOs	Biological Opinions
CAAQS	California Ambient Air Quality Standards
CAL FIRE	California Department of Forestry and Fire Protection
CalSim II	California Simulation Model II
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
CEC	California Energy Commission
CEQ	Council of Environmental Quality
CEQA	California Environmental Quality Act
CCIC	Central California Information Center
CCR	California Code of Regulations
CDPR	California Department of Parks and Recreation
CDFW	California Department of Fish and Wildlife
CDL	commercial driver license
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
CH_4	methane
CHL	California Historical Landmark
CHRIS	California Historical Resources Information System
CHSRA	California High Speed Rail Authority
CNDDB	California Natural Diversity Database
CO_2	carbon dioxide
CRHR	California Register of Historical Resources

CRLF	California red-legged frog
VHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CWA	Clean Water Act
DSM2	Delta Simulation Model-2
dBA	A-weighted decibels
DBH	diameter at breast height
Delta	Sacramento-San Joaquin Delta
DMC	Delta-Mendota Canal
DO	dissolved oxygen
DOC	California Department of Conservation
DOF	California Department of Finance
DOGGR	Division of Oil, Gas, and Geothermal Resources
DOI	United States Department of Interior
DOSS	Delta Operations for Salmonids and Sturgeon
DOT	Department of Transportation
DPM	diesel particulate matter
DSOD	Division of Safety of Dams
DWR	California Department of Water Resources
EA	Environmental Assessment
EC	electrical conductivity
EIS/EIR	Environmental Impact Statement/ Environmental Impact Report
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GGERP	GHG Emissions Reduction Plan
GHG	greenhouse gas
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCP	Habitat Conservation Plan
hp	horsepower
I	Interstate
I-O	input-output
IAIR	Initial Alternatives Information Report
IMPLAN	Impact Planning and Analysis
ITA	Indian Trust Asset
ITP	incidental take permit
IRP	Integrated Resource Plan
Jones Pumping Plant	C.W. “Bill” Jones Pumping Plant

kV	kilovolt
kW	kilowatts
L_{eq}	unmitigated noise level
L_{dn}	day-night average level
LAFCO	Local Area Formation Commission
LOS	Level of Service
LOX	liquid oxygen
LSZ	low salinity zone
LUST	leaking underground storage tank
MAF	million acre-feet
M&I	municipal and industrial
$MTCO_2e/yr$	metric tons CO_2e per year
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAHC	Native American Heritage Commission
NCCP	Natural Communities Conservation Plan
NCP	Noise Control Plan
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOD	Notice of Determination
NOP	Notice to Proceed
NOTAM	Notices to Airmen
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWIC	Northwest Information Center
O&M	operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OES	Office of Emergency Services
OHP	Office of Historic Preservation
OHV	off-highway vehicle
OSHA	Federal Occupational Safety and Health Administration

PFR	Plant Formulation Report
PG&E	Pacific Gas and Electric
ppm	parts per million
PPV	peak particle velocity
PPWD	Pacheco Pass Water District
PR&Gs	Principles and Guidelines
PRC	Public Resources Code
PVWMA	Pajaro Valley Water Management Agency
PWRPA	Power and Water Resource Pooling Authority
PCDSCC	Resource Conservation District of Santa Cruz County
Reclamation	United States Department of the Interior, Bureau of Reclamation
REL	reference exposure level
RMP/GP	Resource Management Plan/ General Plan
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RV	recreational vehicle
RWQCB	Regional Water Quality Control Board
RWSP	Refuge Water Supply Program
SBA	South Bay Aqueduct
SBCWD	San Benito County Water District
SCCC	South-Central California Coast
SCVWD	Santa Clara Valley Water District
SDWA	Federal Safe Drinking Water Act
SFBAAB	San Francisco Bay Area Air Basin
SGMA	Sustainable Groundwater Management Act
SHPO	State Historic Preservation Officer
SJVAB	San Joaquin Valley Air Basin
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLDMWA	San Luis & Delta-Mendota Water Authority
SLLPIP	San Luis Low Point Improvement Project
SMS	Scenery Management System
SOD	Safety of Dams
SP	State Park
SR	State Route
SRA	State Recreation Area
SVS	south valley section
SWAP	Statewide Agricultural Production
SWP	State Water Project

SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TAC	toxic air contaminant
TAF	thousand acre-feet
TBM	Tunnel Boring Machine
UN	United Nations
U.S.	United States
U.S.C	United States Code
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USD	Unified School District
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	underground storage tank
VELB	Valley Elderberry Longhorn Beetle
VOC	volatile organic compound
VTA	Valley Transportation Authority
WAPA	Western Area Power Administration
WEAP	Water Evaluation and Planning
WSP	Water Shortage Policy
WTP	Water Treatment Plant
X2	low salinity zone

Executive Summary

ES.1 Purpose of this Environmental Impact Statement/Environmental Impact Report

The United States Department of the Interior, Bureau of Reclamation (Reclamation) and the Santa Clara Valley Water District (SCVWD) are proposing the San Luis Low Point Improvement Project (SLLPIP) to address water supply reliability and schedule certainty issues for SCVWD associated with low water levels in San Luis Reservoir. The SLLPIP alternatives would help to maintain a high quality, reliable, and cost-effective water supply for SCVWD, and would ensure that they receive their annual Central Valley Project (CVP) contract allocations at the time and at the level of quality needed to meet their existing water supply commitments.

Reclamation, the National Environmental Policy Act (NEPA) Lead Agency, and SCVWD, the California Environmental Quality Act (CEQA) Lead Agency have prepared this joint Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) to comply with NEPA and CEQA. This Draft EIS/EIR analyzes the direct, indirect, and cumulative effects of implementing the SLLPIP. Along with the environmental documentation process, Reclamation and SCVWD have completed a feasibility study to identify and analyze alternatives. The Feasibility Report documenting the study findings has been released for review concurrently with this Draft EIS/EIR.

ES.2 Project Background

Reclamation owns and jointly operates San Luis Reservoir with the California Department of Water Resources to provide seasonal storage for the CVP and the State Water Project (SWP). San Luis Reservoir is capable of receiving water from both the Delta-Mendota Canal (DMC) and the California Aqueduct. This enables the CVP and SWP to pump water into the reservoir during the wet season (October through March) and release water into the conveyance facilities during the dry season (April through September) when demands are higher. Deliveries from San Luis Reservoir to the San Felipe Division of the CVP, which includes SCVWD, flow west through Pacheco Pumping Plant and Conduit.

During the summer, high temperatures and declining water levels in San Luis Reservoir create conditions that foster algae growth. The thickness of the algae blooms vary, but typically average about 35 feet in depth. The water quality within the algal blooms is not suitable for municipal and industrial (M&I) water users relying on existing water treatment facilities in Santa Clara County.

Figure ES-1 shows the intake and outlet facilities associated with the reservoir. As water levels decline to the point that the algae is in the vicinity of the Upper Intake, that intake is no longer used. The low point problem occurs when the water levels decline to the point that the algae blooms are near the Lower Intake.

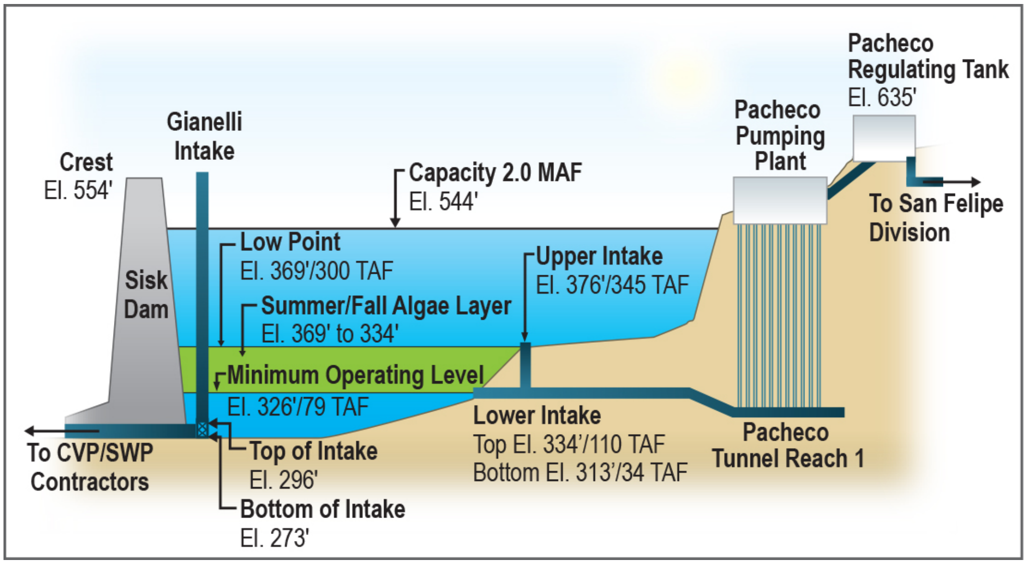

Figure ES-1. Reservoir Intake and Outlet Facilities

If water levels fall below an elevation of 369 feet above mean sea level (MSL) (300 thousand acre-feet [TAF]), SCVWD cannot withdraw water from San Luis Reservoir for M&I purposes because of water quality issues. San Luis Reservoir is the only delivery route for SCVWD's CVP supplies; therefore, SCVWD cannot access CVP supplies for M&I purposes during low-point events.

ES.3 Purpose and Need/Project Objectives

The Lead Agencies are proposing the SLLPIP for the purpose of optimizing the water supply benefit of San Luis Reservoir while reducing additional risks to water users by:

ES.3.1 Primary Objectives

- Avoiding supply interruptions when water is needed by increasing the certainty of meeting the requested delivery schedule throughout the year to South-of-Delta contractors, including SCVWD, dependent on San Luis Reservoir.

- Increasing the reliability and quantity of yearly allocations to South-of-Delta contractors, including SCVWD, dependent on San Luis Reservoir.

ES.3.2 Secondary Objective

- Provide opportunities for ecosystem restoration.

ES.4 Study Area

The study area for this EIS/EIR (Figure ES-2) includes San Luis Reservoir and its related water infrastructure (including the San Felipe Division's water intakes and associated infrastructure); Sacramento-San Joaquin River Delta (Delta); California Aqueduct; South-of-Delta CVP and SWP contractors; SCVWD service area, including the Santa Teresa Water Treatment Plant (WTP) in San Jose; and Pacheco Reservoir and the surrounding vicinity, Pacheco Creek, Pajaro River, San Felipe Lake and Miller Canal.

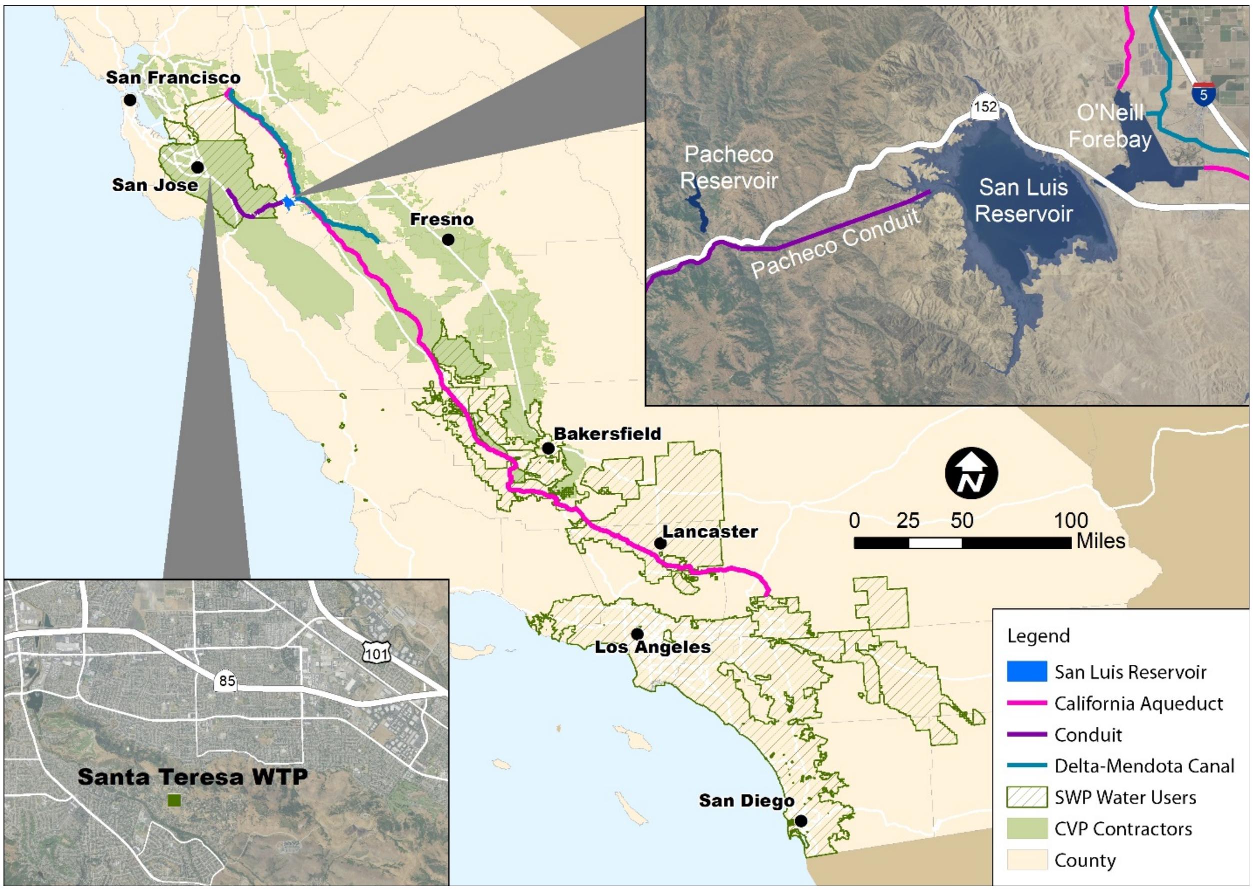

Figure ES-2. San Luis Low Point Improvement Project Study Area

ES.5 Alternatives Evaluated in this EIS/EIR

ES.5.1 Alternative 1 - No Action/No Project Alternative

Both NEPA and CEQA require the evaluation of a No Action or No Project Alternative, which presents the reasonably foreseeable future conditions in the absence of the proposed project. The purpose of the No Action or No Project Alternative is to allow decision makers to compare the impacts of approving the project to the impacts of not approving the project. The No Action/No Project Alternative would leave the current operations at San Luis Reservoir unchanged.

SCVWD would continue annual operations planning to anticipate curtailment of CVP supply, and would cope with its uses and sources of imported and local water supplies. CVP agricultural contractors would continue to rely on the current water supply allocation process.

ES.5.2 Alternative 2 - Lower San Felipe Intake Alternative

Alternative 2 includes construction of a new, lower San Felipe Intake to allow reservoir drawdown to its minimum operating level without algae reaching the San Felipe Intake. Moving the San Felipe Intake to an elevation equal to that of the Gianelli Intake would allow operation of San Luis Reservoir below the 300 TAF level without creating the potential for a water supply interruption to SCVWD. As part of this alternative, a new intake would be constructed and connected to the existing San Felipe Division Intake via approximately 20,000 feet of new pipeline or tunnel. The lower intake facility would allow the San Felipe Division to receive water from the lower reservoir levels that do not contain high concentrations of algae. A hypolimnetic aeration facility would also be constructed to increase dissolved oxygen levels in lower reservoir levels to prevent taste and odor issues.

ES.5.3 Alternative 3 - Treatment Alternative

Alternative 3 would implement technology retrofits at SCVWD's Santa Teresa WTP. The WTP is supplied with water from San Luis Reservoir, which during low point conditions can contain high concentrations of algae. Alternative 3 would develop new treatment technology at the WTP to address some of the negative impacts associated with increased algae during low point events. The proposed improvements evaluated under this alternative would add a raw water ozonation process to the Santa Teresa WTP. Implementation of a raw water ozonation process at the Santa Teresa WTP will require installation of a new ozone contactor, new ozone generation equipment housed in a new building, and new liquid oxygen storage facilities.

ES.5.4 Alternative 4 - San Luis Reservoir Expansion Alternative

Alternative 4 would be completed by placing additional fill material on the dam embankment to raise the dam crest to increase storage capacity. The alternative would build upon the dam embankment expansion and foundation modifications to address the seismic concerns. The seismic modifications to B.F. Sisk Dam under Reclamation's Safety of Dams (SOD) Act, as amended, that the San Luis Reservoir Expansion Alternative would build on are included in this alternative as connected actions as defined under NEPA. Alternative 4 would allocate the increased capacity to the CVP only. This expanded capacity would be operated in the same way as the current CVP portion of San Luis Reservoir, with the reservoir used for seasonal storage.

ES.5.5 Alternative 5 - Pacheco Reservoir Expansion Alternative

Alternative 5 includes construction and operation of a new dam and reservoir, pump station, conveyance facilities, and related miscellaneous infrastructure. The new dam and reservoir would be constructed on Pacheco Creek 0.5 mile upstream from the existing North Fork Dam and would inundate most of the existing Pacheco Reservoir. The proposed total storage for the new reservoir is 141,600 acre-feet (AF), with an active storage of 140,800 AF. The full pool elevation would be 694 feet and would inundate an additional 1,245 acres, for a total of 1,385 total acres inundated. Water would be collected in the new reservoir during the winter months from runoff from the local watershed area, and diversion of CVP supplies from the Pacheco Conduit. Alternative 5 would be operated by SCVWD to both improve habitat conditions for steelhead in Pacheco Creek and improve SCVWD water supply reliability, including during drought periods and emergencies. In addition, SCVWD will transfer 2,000 AF of its CVP water contract supplies (in below normal water years), directly or through transfer and exchanges, in perpetuity to Reclamation and U.S. Fish and Wildlife Services' Refuge Water Supply Program (RWSP), for use in the Incremental Level 4 water supply pool for wildlife refuges.

ES.6 Impact Summary

This section summarizes significant impacts generated by the action alternatives evaluated in this EIS/EIR and the mitigation measures identified to address those impacts. These significant impacts and mitigation measures are listed in Table ES-1 and described in further detail in Chapter 4 of the EIS/EIR. Areas of controversy and issues to be resolved (CEQA Guidelines Section 15123) are discussed in Chapter 6 of the EIS/EIR.

Table ES-1. Significance Effect Analysis Summary

Significance Criteria	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Water Quality				
Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on or off-site or provide substantial additional sources of polluted runoff.	2	Construction - S, LTS	WQ-1	Section 4.1.4
	3	Construction - S, LTS	WQ-1	Section 4.1.5
	4	Construction - S, LTS	WQ-1	Section 4.1.6
	5	Construction - S, LTS	WQ-1	Section 4.1.7
Conflict with or obstruct implementation of a water quality control plan.	2	S, LTS	WQ-1	Section 4.1.4
	3	S, LTS	WQ-1	Section 4.1.5
	4	S, LTS	WQ-1	Section 4.1.6
	5	S, LTS	WQ-1	Section 4.1.7
Result in effects on water quality related beneficial uses.	1	S, SU	--	Section 4.1.3
Surface Water Supply				
Substantially reduce the annual supply of water available to the CVP, SWP, or other water users.	1	S, SU	--	Section 4.2.3, Appendix B, Appendix N
	4	S, SU (Short-term, with shear key)	None	Section 4.2.6, Appendix B, Appendix N

Significance Criteria	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Geology and Soils				
Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature	2	S, LTS	PR-1	Section 4.5.4
	4	S, LTS	PR-1	Section 4.5.6
	5	S, LTS	PR-1	Section 4.5.7
Air Quality				
Conflict with or obstruct implementation of the applicable air quality plan	2	Tunnel Option Constr. - S, LTS Pipeline Option Constr. – S, LTS	Tunnel - AQ-1, AQ-2, AQ-3 Pipeline - AQ-1, AQ-2, AQ-3, AQ-4, AQ-5	Section 4.5.4 Appendix O
	4	Constr. – S, SU	AQ-1, AQ-2, AQ-6	Section 4.5.6 Appendix O
	5	Constr. – S, SU	AQ-1, AQ-2	Section 4.5.7 Appendix O
Greenhouse Gas				
Generate greenhouse gas emissions, either directly or indirectly, that could have a significant impact on the environment.	2	S, LTS	GHG- 1	Section 4.8.4 Appendix P
	4	S, LTS	GHG- 1	Section 4.8.6 Appendix P
	5	S, LTS	GHG- 1	Section 4.8.7 Appendix P
Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases.	2	S, LTS	GHG- 1	Section 4.8.4 Appendix P
	4	S, LTS	GHG- 1	Section 4.8.6 Appendix P
	5	S, LTS	GHG- 1 Carbon Offsets	Section 4.8.7 Appendix P
Visual Resources				
Have a substantial adverse effect on a scenic vista (areas with Scenic Attractiveness Class A or Class B classifications are considered scenic vistas)	2	Operation - S, LTS	VIS-1, VIS-3	Section 4.9.4
Substantially damage scenic resources within a State scenic highway corridor.	2	S, LTS	VIS-4	Section 4.9.4
	4	S, LTS	VIS-4	Section 4.9.6
Substantially degrade the existing visual character or quality of public views of the site and its surroundings or conflict with applicable regulations governing scenic quality.	2	S, LTS	VIS-2	Section 4.9.4
Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area.	2	S, LTS	VIS-1	Section 4.9.4
	4	S, LTS	VIS-1	Section 4.9.6
	5	S, LTS	VIS-1	Section 4.9.7

Significance Criteria	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Noise and Vibration				
Expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance.	4	Construction – S, SU	NOISE-1, NOISE-2, HAZ-5	Section 4.10.6 Appendix E1
	5	Construction – S, SU Operation – S, LTS	NOISE-1, NOISE-2, NOISE-3, HAZ-5	Section 4.10.7 Appendix E1
Cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	2	Tunnel Option – S, SU	NOISE-1	Section 4.10.4 Appendix E1
	3	S, LTS	NOISE-1	Section 4.10.5 Appendix E1
	4	S, SU	NOISE-1, NOISE-2, HAZ-5	Section 4.10.6 Appendix E1
	5	S, SU	NOISE-1	Section 4.10.7 Appendix E1
Traffic and Transportation				
Substantially increase traffic hazards due to a geometric design feature or incompatible use.	2	S, LTS	TR-1	Section 4.11.4
	3	S, LTS	TR-1	Section 4.11.5
	4	S, LTS	TR-1	Section 4.11.6
	5	S, LTS	TR-1	Section 4.11.7
Result in inadequate emergency access.	2	S, LTS	TR-1	Section 4.11.4
	3	S, LTS	TR-1	Section 4.11.5
	4	S, LTS	TR-1	Section 4.11.6
	5	S, LTS	TR-1	Section 4.11.7
Hazards and Hazardous Materials				
Increase the risk of exposure from hazardous materials to the public and construction workers during alternative construction onsite, during the transport, use or disposal of hazardous materials offsite, and during long-term operations and maintenance activities.	4	Construction – S, LTS	HAZ-5	Section 4.12.6
	5	Construction – S, LTS	HAZ-5	Section 4.12.7
Interfere with an active remediation site which could create a hazard to the public or the environment if contaminated soil and/or groundwater is encountered and released to the environment.	2	S, LTS	HAZ-1	Section 4.12.4
	4	S, LTS	HAZ-6	Section 4.12.6
Conflict with activities and operations at airports near or within the project area during construction, resulting in safety hazards for pilots or people working and residing in the area.	2	S, LTS	HAZ-3, HAZ-4	Section 4.12.4
	4	S, LTS	HAZ-3, HAZ-4	Section 4.12.6

Significance Criteria	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Temporarily interfere with an emergency response plan or emergency evacuation plan for the project vicinity as a result of construction traffic and traffic controls impacting local roads.	2	S, LTS	TR-1	Section 4.12.4
	4	S, LTS	TR-1	Section 4.12.6 Section 4.11.8
	5	S, LTS	TR-1	Section 4.12.7 Section 4.11.8
Increase the risk of wildfire within the vicinity of the project area through the use of mechanical equipment during construction	2	S, LTS	HAZ-2	Section 4.12.4
	4	S, LTS	HAZ-2	Section 4.12.6
	5	S, LTS	HAZ-2	Section 4.12.7
Aquatic Resources				
Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations	5	Construction – S, LTS Operation (Pacheco Creek/Pajaro River) – S, LTS	BIO-1, BIO-2	Section 4.13.7 Appendix L2
Terrestrial Resources				
Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as an endangered, threatened, candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW, NMFS, or USFWS	2	Construction – S, LTS	BIO-1, TERR-1 through TERR-15	Section 4.14.4
	3	Construction –S, LTS	BIO-1 TERR-6	Section 4.14.5
	4	Construction –S, LTS Operation – S, LTS	BIO-1, TERR-1 through TERR-15	Section 4.14.6
	5	Construction – S, LTS Operation – S, LTS	BIO-1, BIO-2 TERR-1 through TERR-15	Section 4.14.7
Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW, NMFS, or USFWS	2	S, LTS	TERR-1, TERR-3, TERR-4, TERR-14, TERR-15, TERR-16, TERR-17	Section 4.14.4
	4	S, LTS	TERR-1, TERR-3, TERR-4, TERR-14, TERR-15, TERR-16	Section 4.14.6
	5	S, LTS	TERR-1, TERR-16, TERR-18	Section 4.14.7
Have a substantial adverse effect on Federally or State protected wetlands (including, but not limited to, marsh, vernal pool, coast, etc.) through direct removal, filling, hydrological interruption, or other means	2	S, LTS	TERR-14, TERR-16	Section 4.14.4
	4	S, LTS	TERR-14, TERR-16	Section 4.14.6
	5	S, LTS	TERR-16	Section 4.14.7

Significance Criteria	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites	4	S, LTS	TERR-12, TERR-13, TERR-15	Section 4.14.6
	5	S, LTS	TERR-12, TERR-15	Section 4.14.7
Conflict with any local policies or ordinances protecting biological resources, or adopted HCP, NCCP, or other approved local, regional, or State conservation plan	2	S, LTS	TERR-1 through TERR-17	Section 4.14.4
	3	S, LTS	BIO-1, TERR-18	Section 4.14.5
	4	S, LTS	TERR-1 through TERR-14, TERR-17	Section 4.14.6
	5	S, LTS	TERR-1, TERR-18	Section 4.14.7
Land Use and Agricultural Resources				
Conflict with existing zoning for agricultural use or a Williamson Act contract	5	SU, LTS	LU-1	Section 4.12.7
Recreation				
Substantially reduce access to or close recreation areas as a result of project construction	2	S, LTS	REC-1	Section 4.17.4, Section 4.17.8
	4	S, LTS	REC-1	Section 4.17.6, Section 4.17.8
Reduce access to recreation uses through long-term operational changes to water levels in recreational water bodies	4	S, LTS (trail closures)	REC-2	Section 4.17.6, Section 4.17.8, Appendix N
Cultural Resources				
Result in adverse effects to historic properties listed or eligible for listing in the NRHP, and/or substantial adverse changes to historical resources, unique archaeological resources, or tribal cultural resources listed or eligible for listing in the CRHR or result in the disturbance of human remains	2	S, SU	CR-1, CR-2, CR-3	Section 4.20.4 Appendix K
	4	S, SU	CR-1, CR-2, CR-3	Section 4.20.6 Appendix K
	5	S, SU	CR-1, CR-2, CR-3	Section 4.20.7 Appendix K

Key: Alt = alternative; CDFW = California Department of Fish and Wildlife; CRHR = California Register of Historical Resources; HCP = Habitat Conservation Plan; LTS = less than significant; NCCP = Natural Communities Conservation Plan; NI = no impact; NMFS = National Marine Fisheries Service; NRHP = National Register of Historic Places; S = Significant; SU = significant and unavoidable; USFWS = United States Fish and Wildlife Service; W = with; WO = without

ES.6.1 Alternative 2 - Lower San Felipe Intake Alternative

Impacts across the study area associated with the development and long-term operation of a new, lower San Felipe Intake through either the pipeline or tunnel option would be generated during construction of the new intake infrastructure followed by long-term changes in the operation of

San Luis Reservoir with the avoidance of low point event water supply interruptions to SCVWD deliveries.

Construction of the new lower intake facility infrastructure would generate impacts on surface water quality resulting both from the disturbance of soils in construction and staging areas and the associated potential for increases in erosion along with subsurface construction activity in San Luis Reservoir and potential for increases in turbidity from reservoir floor disturbance. Construction activities would also result in air quality and greenhouse gas emissions with the potential to exceed significance thresholds. Implementation of mitigation including the installation of diesel oxidation catalysts on all off-road construction equipment, the selection of marine propulsion and auxiliary engines with selective catalytic reduction capable of achieving an 85 percent reduction in nitrogen oxides (NOx), and the purchase of carbon offsets would reduce these impacts to a less than significant level. Modifications to the study area's visual setting during the construction of Alternative 2 through the introduction of construction equipment and the disturbance of areas where construction is underway could generate impacts to visual resource experiences for visitors to the San Luis Recreation Area and viewers passing by the reservoir on nearby State Route (SR) 152. These impacts on visual setting would be mitigated to less than significant levels through the shielding of construction lighting used during nighttime construction, the strategic use of locations out of sight of major nearby viewing points including SR 152 for spoils storage and disposal, and design requirements for new infrastructure in the viewshed to minimize any new visual contrast or distraction they could generate. Noise generated by construction of the tunnel option under Alternative 2 would result in a significant and unavoidable impact, temporarily increasing the noise level on local roads. The use of area roadways by trucks and construction workers accessing the construction areas at San Luis Reservoir could cause temporary impacts to traffic safety on those roadways. This impact would be mitigated to a less than significant level with the installation of signage along impacted roadways warning motorists of slow-moving construction traffic and lane closures, and the use of traffic controls like flaggers or temporary traffic lights where construction equipment will be entering roadways. Construction activities could also generate significant impacts on sensitive terrestrial habitats including wetland and riparian vegetation communities, disturb terrestrial wildlife, nesting birds, adversely impact special status plant species and conflict with local policies or ordinances protecting biological resources. Mitigation measures including pre-construction surveys, establishment of buffers, construction monitoring, compensatory mitigation where impacts could not be avoided would reduce all of these potential impacts to a less than significant level. Finally, impacts to historic properties and/or historical resources associated with Alternative 2 could be significant given the area's rich cultural history. CEQA mitigation measures including avoidance of known resources, training of construction personnel on the cultural sensitivity in the area, monitoring for inadvertent discovery of new resources by a qualified archaeologist, and coordination with culturally associated Native American tribes would be implemented to reduce the potential for significant impacts. Under Section 106 of the National Historic Preservation Act (NHPA) for NEPA, adverse effects to historic properties will be resolved (i.e., avoided, minimized, or mitigated) through the completion of the Section 106 process and the execution of an agreement document (Memorandum of Agreement or Programmatic Agreement). No feasible measures have been identified to offset potential impacts to previously identified cultural resources in areas that will remain inundated during construction.

Once constructed, Alternative 2 would allow for the continued delivery of CVP water supplies from San Luis Reservoir to SCVWD in periods when the reservoir is drawn below the 300 TAF low point level by diverting the water from lower levels below the reservoir surface to depths that do not contain concentrations of algae. Alternative 2 would support the uninterrupted delivery of SCVWD CVP deliveries from San Luis Reservoir in all low point years.

ES.6.2 Alternative 3 - Treatment Alternative

Alternative 3 would implement new technology retrofits at SCVWD's Santa Teresa WTP. In comparison to Alternative 2, the construction actions required to implement Alternative 3 would result in fewer significant impacts requiring mitigation given the smaller construction area, implementation at the existing WTP at an area already disturbed, and shorter overall construction schedule.

Following the completion of construction, Alternative 3 would be similar to Alternative 2 by allowing for the continued delivery of CVP water supplies from San Luis Reservoir to SCVWD in periods when the reservoir is drawn below the 300 TAF low point level by making that water treatable the WTP and would support the uninterrupted delivery of SCVWD CVP deliveries from San Luis Reservoir in all low point years.

ES.6.3 Alternative 4 - San Luis Reservoir Expansion Alternative

Alternative 4 would complete major construction actions at San Luis Reservoir to raise the B.F. Sisk Dam embankment and increase storage capacity in the reservoir. The construction generated significant effects on water quality, paleontological resources, air quality, greenhouse gas emissions, visual resources, noise, traffic conditions, hazards, terrestrial resources, and cultural resources would be similar in type to those in Alternative 2 but given the longer construction schedule required for implementation of this alternative these impacts are larger in total magnitude over the full course of the alternative's development. The mitigation measures identified to address the impacts described above under Alternative 2 would also be implemented under Alternative 4 to help reduce the severity of these potential impacts.

By increasing total storage capacity in the reservoir and allowing it to fill above its current maximum operating level, Alternative 4 would support the delivery of additional water supply to SCVWD in some years with low point conditions when compared to the No Action/No Project Alternative, partially reducing SCVWD unmet demand in those years. Operation of the expanded San Luis Reservoir would not result in significant operational changes and would not require significant additional water diversions from the Delta.

ES.6.4 Alternative 5 - Pacheco Reservoir Expansion Alternative

Alternative 5 would, much like Alternative 2 and Alternative 4, implement a major construction action over multiple years, with similar significant water quality, paleontological resources, air quality, greenhouse gas emissions, visual resources, noise, traffic conditions, hazards, terrestrial resources, and cultural resources impacts. This project would also result in altered streamflow downstream of the dam along Pacheco Creek. Also, Alternative 5 would have a significant impact on land use and aquatic resources. Alternative 5 would also implement mitigation measures to help reduce the severity of those impacts.

Following the completion of construction, Alternative 5 would support the diverting of SCVWD's CVP supply in San Luis Reservoir earlier in the year prior to the summer months when the reservoir is typically drawn down to the 300 TAF level. CVP water stored in Pacheco Reservoir could then be released through the summer while supplies from San Luis Reservoir would be inaccessible to SCVWD. In addition, given the expanded Pacheco Reservoir's proposed size it would be able to support the storage of local inflow from the watershed that would further support the reservoir's use in support of downstream ecosystem benefits on Pacheco Creek and as an emergency supply for SCVWD to respond to potential CVP and SWP water supply interruptions.

ES.7 CEQA Proposed Project

For the purpose of CEQA, SCVWD has identified Alternative 5 as the Proposed Project. SCVWD's identification of a Proposed Project does not foreclose any alternatives or mitigation measures. All of the alternatives have been analyzed at a comparable level in this Draft EIS/EIR. Reclamation has not identified a preferred alternative in this Draft EIS/EIR for NEPA purposes. Consistent with Council of Environmental Quality (CEQ) Regulations 40 Code of Federal Regulations (CFR) Part 46.425, the Final EIS/EIR will identify a NEPA preferred alternative for implementation (or alternatives if more than one exists).

SCVWD and Reclamation are seeking input on the alternatives and their environmental effects during the public review of this Draft EIS/EIR. SCVWD and Reclamation will consider feedback received during the public review on the Draft EIS/EIR and the environmental impacts associated with each alternative when developing the Final EIS/EIR and selecting an alternative for implementation. Any alternative could be selected by the lead agencies following the conclusion of environmental review. SCVWD has identified Alternative 5 as the Proposed Project for CEQA because of the wide range of public and non-public benefits. Benefits identified include ecosystem improvements at Pacheco Creek and San Joaquin River watershed, flood control, emergency water supplies, groundwater recharge and M&I water supply, and M&I water quality (SCVWD 2017).

ES.8 Environmentally Preferable/Superior Alternative

CEQ Regulations Section 1505.2(b) require identification of an environmentally preferable alternative, and CEQA Guidelines Section 15126.6(e)(2) requires an EIR to identify an environmentally superior alternative. However, the CEQ regulations and CEQA Guidelines do not require adoption of the environmentally preferable/superior alternative as the preferred alternative for implementation. The identification of the preferred alternative is independent of the identification of the environmentally preferable/superior alternative, although the identification of both will be based on the information presented in this EIS/EIR.

Section 1505.2(b) of the CEQ Regulations requires the NEPA lead agency to identify the environmentally preferable alternative in a Record of Decision (ROD). The CEQ Regulations define the environmentally preferable alternative as "…the alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources."

This Draft EIS/EIR provides a substantive portion of the environmental information necessary for Reclamation to determine the environmentally preferable alternative and for SCVWD to determine the environmentally superior alternative. However, the public and other agencies reviewing a Draft EIS/EIR can assist the lead agency to develop and determine the environmentally preferable/superior alternative by providing their views in comments on the Draft EIS/EIR. In this Draft EIS/EIR, Reclamation and SCVWD have identified Alternative 5 as the environmentally preferable/environmentally superior alternative because of the ecosystem benefits to the Pacheco Creek and San Joaquin River watersheds it provides. Reclamation and SCVWD will consider feedback during the public review phase of the Draft EIS/EIR on the environmental benefits and impacts of each alternative when developing the Final EIS/EIR and ROD.

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Chapter 1
Introduction

The United States Department of the Interior, Bureau of Reclamation (Reclamation) and the Santa Clara Valley Water District (SCVWD) are proposing the San Luis Low Point Improvement Project (SLLPIP) to address water supply reliability and schedule certainty issues for SCVWD associated with low water levels in San Luis Reservoir. The SLLPIP alternatives analyzed in this joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) would help maintain a high-quality, reliable, and cost-effective water supply for SCVWD and would ensure SCVWD receives its annual Central Valley Project (CVP) contract allocations at the time and at the level of quality needed to meet its existing water supply commitments and avoid water supply interruptions.

Reclamation, the National Environmental Policy Act (NEPA) Lead Agency, and SCVWD, the California Environmental Quality Act (CEQA) Lead Agency, have prepared this joint EIS/EIR to comply with NEPA and CEQA. This EIS/EIR analyzes the direct, indirect, and cumulative effects of implementing the SLLPIP. Along with the environmental documentation process, Reclamation and SCVWD have completed a feasibility study to identify and analyze alternatives (Reclamation and SCVWD 2019).

1.1 Project Background

Reclamation owns and jointly operates San Luis Reservoir with the California Department of Water Resources to provide seasonal storage for the CVP and the State Water Project (SWP). San Luis Reservoir is capable of receiving water from both the Delta-Mendota Canal (DMC) and the California Aqueduct (see Figure 1-1). This enables the CVP and SWP to pump water into the reservoir during the wet season (November through April) and release water into the conveyance facilities during the dry season (April through October) when demands are higher. Deliveries from San Luis Reservoir also flow west through Pacheco Pumping Plant and Conduit to the San Felipe Division of the CVP, which includes SCVWD and the San Benito County Water District (SBCWD).

During the summer, high temperatures and declining water levels create conditions that foster algae growth. The thickness of the algae blooms vary, but typically average about 35 feet in depth. The water quality within the algal blooms is not suitable for municipal and industrial (M&I) water users relying on existing water treatment facilities in Santa Clara County.

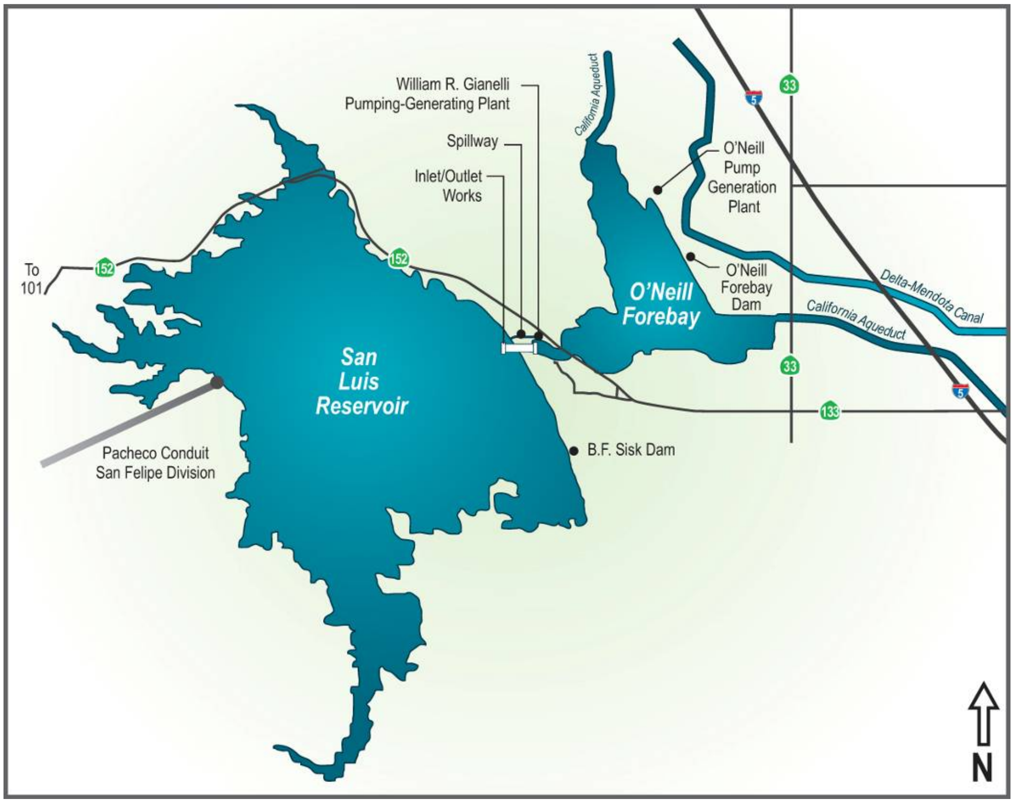


Figure 1-1. San Luis Reservoir and Associated Facilities

Figure 1-2 shows the intake and outlet facilities associated with the reservoir. As water levels decline to the point that the algae is in the vicinity of the Upper Intake, that intake is no longer used. The low point problem occurs when the water levels decline to the point that the algae blooms are near the Lower Intake. Typically, this point occurs when water levels reach an elevation of 369 feet above mean sea level (MSL) or at 300 thousand acre-feet (TAF) capacity in the reservoir, when the water is approximately 35 feet above the top of the Lower Intake (334 feet above MSL or 110 TAF). The reservoir’s minimum operating level is about 30 feet above the top of the Gianelli Intake; therefore, algae does not typically enter the Delta-Mendota Canal or California Aqueduct.

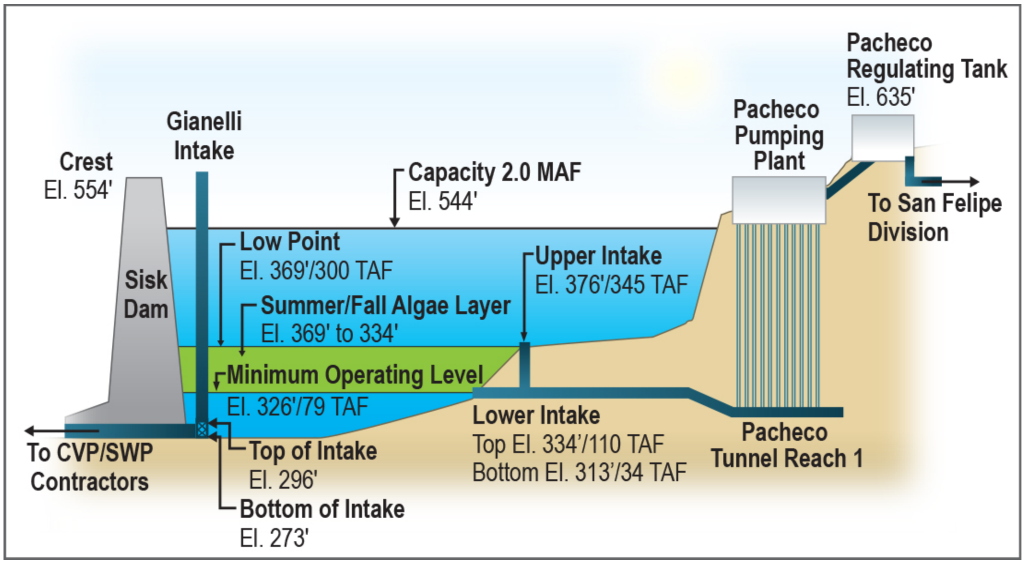


Figure 1-2. Reservoir Intake and Outlet Facilities

If water levels fall below 369 feet above MSL (300 TAF), SCVWD cannot receive water from San Luis Reservoir for M&I purposes because of water quality issues. San Luis Reservoir is the only delivery route for SCVWD's CVP supplies; therefore, SCVWD cannot access CVP supplies for M&I purposes during low-point events. The CVP operators allocate water based on the minimum operating level of 326 feet above MSL (79 TAF), and predict water levels below 369 feet above MSL (300 TAF) in most years. Even the prediction of a low point problem can cause water supply concerns for SCVWD because it must secure alternative water supplies in case disruptions occur, from sources including local groundwater supplies, District supplies stored in the Semitropic Water Storage District groundwater bank, and surface water transfers from willing sellers. In recent years, Reclamation has been implementing exchanges to deliver a portion of CVP supplies when there is a low point problem in San Luis Reservoir.

1.2 Purpose and Need/Project Objectives

The Lead Agencies are proposing the SLLPIP for the purpose of optimizing the water supply benefit of San Luis Reservoir while reducing additional risks to water users by:

- Avoiding supply interruptions when water is needed by increasing the certainty of meeting the requested delivery schedule throughout the year to South-of-Delta contractors, including SCVWD, dependent on San Luis Reservoir.
- Increasing the reliability and quantity of yearly allocations to South-of-Delta contractors, including SCVWD, dependent on San Luis Reservoir.

In addition to these primary objectives, the SLLPIP may also support a secondary objective to provide opportunities for ecosystem enhancement. The primary objectives distinguish between certainty of meeting delivery schedules and the reliability of supplies. More specifically, the first objective is related to predictably meeting contractors' delivery schedules throughout the year as opposed to the second objective, which strives to increase yearly allocations to more closely match the contractual terms.

The objectives for predictably meeting delivery schedules and increased annual allocations could lead to conflicts regarding San Luis Reservoir operations. These issues are relevant to South-of-Delta contractors dependent on San Luis Reservoir, including SCVWD. San Luis Reservoir serves as a storage facility to increase the annual reliability of deliveries to CVP and SWP contractors in the Central Valley. CVP contractors rely on both direct diversions from the Jones Pumping Plant and stored water from San Luis Reservoir to meet summer demands. Full exercise of the reservoir helps to maximize CVP supplies, but the low point constraint in the release of water from San Luis Reservoir could limit M&I supplies. The Jones Pumping Plant does not have enough pumping capacity to fully meet demands alone and CVP operators store additional water in San Luis Reservoir during the winter, when demands are low, to help meet summertime needs.

SCVWD is more impacted by conditions in San Luis Reservoir due to its position between the Sacramento-San Joaquin River Delta (Delta) and the San Felipe Unit. When SCVWD is unable to treat its CVP supply due to algae, then it must rely on other sources of water for M&I purposes which may not be reliable each year. In the future, increased demand and the potential for further regulatory constraints on availability of supplies may cause CVP and SWP contractors to maximize use of their water stored in San Luis Reservoir, increasing the frequency of the low point problem and the risk of supply interruptions to SCVWD.

SCVWD water supply interruptions have historically been avoided because SWP contractors have left water in storage, thus maintaining water levels in San Luis Reservoir above 300 TAF. However, in 2008 and again in 2016, San Luis Reservoir was drawn down below 300 TAF which created treatment performance issues at SCVWD water treatment plants (WTPs) and resulted in an interruption of deliveries from San Luis Reservoir (California Data Exchange Center [CDEC] 2018). Future CVP water supply reliability for SCVWD requires the full use of the CVP water from San Luis Reservoir; therefore, SCVWD desires a solution that resolves the low point problem in San Luis Reservoir that can impair the Districts ability to utilize contractual supplies.

1.3 Responsibilities of Lead and Cooperating Agencies

Reclamation and SCVWD are the NEPA/CEQA Lead Agencies in preparing this EIS/EIR. As the Lead Agencies, Reclamation and SCVWD will be responsible for finalizing the alternatives and selecting a reasonable range of alternatives for analysis in this EIS/EIR, completing the Draft and Final EIS/EIR documents, completing the Record of Decision/Notice of Determination (ROD/NOD) selecting an alternative for implementation, implementing the selected alternative, and ensuring all environmental commitments have been completed.

1.4 Public Involvement

1.4.1 Public Scoping

Public scoping is required by NEPA and CEQA for environmental documents that would have significant environmental impacts (EISs or EIRs). The purpose of public scoping is to obtain feedback from agencies, the public, and other interested parties on significant issues associated with a project. This information helps guide an agency's environmental review of a project. Reclamation and SCVWD considered scoping comments received as a part of both the alternatives formulation process and to support the evaluation of potential environmental effects (SCVWD 2002, Reclamation 2008).

In August 2002, the SCVWD conducted two public scoping meetings for the SLLPIP. The SCVWD prepared the "Low Point Improvement Project Scoping Summary Report" (dated October 2002), which summarized the comments received. The key areas of concern raised in the 2002 meetings and in comment letters submitted in response to SCVWD's Notice of Preparation (NOP) include:

- Potential impacts of the build alternatives on residential property, agriculture, and grazing lands in the project area if the build alternatives are implemented.
- Loss of wildlife habitat for sensitive and/or special-status species from new inundation.
- Safety issues related to flooding and earthquake hazards if new dams were constructed.
- Impacts to recreational and visual resources.

In August 2008, Reclamation issued a NEPA Notice of Intent (NOI) and SCVWD issued a CEQA NOP for the SLLPIP EIS/EIR. In September 2008, Reclamation and SCVWD held three public scoping meetings in San Jose, Sacramento, and Los Banos to provide information on the development of the SLLPIP EIS/EIR and to obtain feedback on significant issues. The results of these scoping meetings, including comments and concerns raised during the meetings and written comments received during the public comment period are presented in the *San Luis Low Point Improvement Project Environmental Scoping Report*, *December 2008*. Major issues raised the public meetings and in comment letters submitted in response to the NOI/NOP:

- Water supply effects of the alternatives;
- Clarifying the Federal interest in the project;
- The range of proposed alternatives; and
- Effects of the alternatives on power generation, water quality, fishing, and recreation in San Luis Reservoir.

1.4.2 Draft EIS/EIR Review

The Draft EIS/EIR will be released to the public for 60 days of review and comment, as required by NEPA and CEQA. Public meetings will be held for the Draft EIS/EIR and comments on the Draft EIS/EIR will be accepted at the meetings as well as throughout the public comment period.

1.4.3 Final EIS/EIR Development

Consistent with 40 Code of Federal Regulations (CFR) Part 46.425, the Final EIS/EIR will identify a preferred alternative (also known as the proposed project for CEQA) for implementation (or alternatives, if more than one exists). The preferred alternative will be identified in the Final EIS/EIR based on the information presented in this Draft EIS/EIR, in light of any potential revisions made in response to comments received on this Draft EIS/EIR. After the Final EIS/EIR is published, Reclamation and SCVWD will prepare a ROD/NOD to implement a selected alternative. Agencies with regulatory authority issuing permits or other types of approvals for the SLLPIP may adopt this EIS/EIR, consistent with their own policies and regulations, or use information included as the basis for their own environmental compliance.

Chapter 2
Project Description

This section summarizes the alternatives development process for the SLLPIP and describes the alternatives analyzed in this EIS/EIR.

2.1 Alternatives Formulation Process

The Lead Agencies used a comprehensive process to develop initial alternatives that included review of existing material, public input, and comparison and evaluation of initial alternatives using the Federal planning criteria and the purpose and need/project objectives. To meet the study objectives, the planning process follows the structured six-step planning approach outlined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*[1] (PR&Gs) (U.S. Water Resources Council 1983). The first step in the development of initial alternatives was the identification of potential management measures, which could include programs, projects, or policies, that would help achieve the project objectives. A total of 26 initial alternatives were developed from the management measures, which were screened down to 17 alternatives in the February 2008 *SLLPIP Initial Alternatives Information Report* (IAIR). These 17 alternatives were re-evaluated in the *SLLPIP Plan Formulation Report* (PFR), which screened out 14 of the 17 alternatives. Three alternatives, the Lower San Felipe Intake Alternative, the Combination Alternative and the Pacheco Reservoir Alternative, remained for further analysis in the Feasibility Report and EIS/EIR.

During the feasibility phase of the alternatives evaluation, the Lead Agencies reconsidered the alternatives recommended for consideration in the EIS/EIR. The PFR considered but eliminated the Treatment Alternatives; however, new treatment methods suggested during the feasibility phase resulted in this alternative being recommended for consideration in the EIS/EIR. The PFR also recommended consideration of the Combination Alternative; however, detailed review of the alternative by SCVWD during development of the Feasibility Report and this EIS/EIR identified issues with the feasibility of the alternative and it was eliminated from detailed consideration. Due to limitations associated with the reoperation of Anderson Reservoir and conflicts to operations of existing SCVWD wells, the Combination Alternative would be unable to adequately address low point generated water supply interruptions (SCVWD 2017a). The IAIR considered but eliminated the Expansion of San Luis Reservoir Alternative given its higher cost and similar benefits to the other storage alternatives that were identified in the IAIR.

[1] The SLLPIP Feasibility Study was initiated by Reclamation in 2004 and as such, has been developed consistent with the guidelines presented in the P&Gs. In 2015, the Department of the Interior released the *Department of Interior Agency Specific Procedures for implementing the Council on Environmental Quality's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (PR&G)* (United States Department of the Interior 2015). These new PR&Gs are being used to provide input on the SLLPIP Feasibility Study process but are not required.

However, results from the 2013 appraisal study indicated that inclusion of the Expansion of San Luis Reservoir Alternative in the SLLPIP Feasibility Report and EIS/EIR was warranted (Reclamation 2013). The Pacheco Reservoir Alternative was previously eliminated based on the acceptability and effectiveness criteria, because it had more potential for environmental effects and the greatest costs. However, in August 2017, SCVWD submitted an application for funding for the expansion of Pacheco Reservoir under the Water Storage Investment Program (WSIP). Based on the public and non-public benefits identified from the evaluation conducted for the WSIP application and the stakeholder support for the project, in response to SCVWD's request Reclamation has reevaluated the Pacheco Reservoir Expansion Alternative in the SLLPIP Feasibility Report and EIS/EIR. The feasibility report includes further evaluation of the completeness, effectiveness, acceptability, and efficiency of all the alternatives.

As was noted above, 26 initial alternatives were screened down to 17 in the IAIR of which 14 were screened out in the PFR. Table 2-1 displays the alternatives screened in the IAIR and PFR and the reason that they were screened.

Table 2-1. Alternative Screening Results

Category	IAIR Screening		PFR Screening		Feasibility Report
	Alternative	Screening Result	Alternative	Screening Result	
Institutional	Institutional Alternative	Retained	Institutional Alternative	Screened out as a standalone plan under the completeness criterion	
Source Water Quality Control	Algae Harvesting Alternative	Eliminated because it had similar benefits to algaecide and was economically infeasible when compared to algaecide			
	Algaecide Alternative	Retained	Algaecide Alternative	Screened out under the effectiveness and acceptability criteria given concerns over potential capacity to treat SLR algae and the difficulty permitting the application of algaecide on a drinking water reservoir at this scale	
	Managed Stratification Alternative	Eliminated because it had similar benefits to algaecide and was economically infeasible when compared to algaecide			

Table 2-1. Alternative Screening Results

<table>
<tr><th rowspan="2">Category</th><th colspan="2">IAIR Screening</th><th colspan="2">PFR Screening</th><th rowspan="2">Feasibility Report</th></tr>
<tr><th>Alternative</th><th>Screening Result</th><th>Alternative</th><th>Screening Result</th></tr>
<tr><td rowspan="3">Treatment</td><td>Treatment at San Felipe Intake Alternative</td><td>Retained</td><td>Treatment at San Felipe Intake Alternative</td><td rowspan="3">Screened out under the acceptability criterion given SCVWD's determination that DAF treatment is not an acceptable remedy to the low point issue because evaluation during previous WTP upgrades indicated DAF is less effective and more difficult to operate than current treatment methods</td><td></td></tr>
<tr><td>Treatment at WTPs Alternative</td><td>Retained</td><td>Treatment at WTPs Alternative</td><td>Treatment Alternative – carried forward following further analysis of developing Raw Water Ozonation at the Santa Teresa WTP.</td></tr>
<tr><td>Treatment at Pumping Plant Alternative</td><td>Retained</td><td>Treatment at Pumping Plant Alternative</td><td></td></tr>
<tr><td rowspan="4">Conveyance</td><td>Lower San Felipe Intake Alternative</td><td>Retained</td><td>Lower San Felipe Intake Alternative</td><td>Retained</td><td>Lower San Felipe Intake</td></tr>
<tr><td>Holladay Aqueduct Alternative</td><td>Eliminated because it had similar benefits to the Lower San Felipe Intake and Southerly Bypass Alternatives and was economically infeasible when compared to those options</td><td></td><td></td><td></td></tr>
<tr><td>Northerly Bypass Corridor Alternative</td><td>Eliminated because it had similar benefits to the Lower San Felipe Intake and Southerly Bypass Alternatives and was economically infeasible when compared to those options</td><td></td><td></td><td></td></tr>
<tr><td>Southerly Bypass Corridor Alternative</td><td>Retained</td><td>Southerly Bypass Corridor Alternative</td><td>Screened out under the efficiency criterion given the alternative's economic infeasibility when compared to the Lower San Felipe Intake Alternative</td><td></td></tr>
<tr><td rowspan="3">Storage</td><td>Anderson Reservoir Expansion Alternative</td><td>Retained</td><td>Anderson Reservoir Expansion Alternative</td><td>Screened out under the efficiency criterion given the alternative's economic infeasibility when compared to the Pacheco B Alternative</td><td></td></tr>
<tr><td>Chesbro Reservoir Expansion Alternative</td><td>Retained</td><td>Chesbro Reservoir Expansion Alternative</td><td rowspan="2">Screened out because additional engineering, geotechnical, geological and hydraulic analysis determined that an alternate site between the Pacheco A and Pacheco B locations was the most efficient storage site available</td><td></td></tr>
<tr><td>Lower Pacheco Reservoir Alternative</td><td>Retained</td><td>Lower Pacheco Reservoir Alternative</td><td></td></tr>
</table>

Table 2-1. Alternative Screening Results

Category	IAIR Screening		PFR Screening		Feasibility Report
	Alternative	Screening Result	Alternative	Screening Result	
	Pacheco A Reservoir Alternative	Retained	Pacheco A Reservoir Alternative	Retained as a single alternative with two storage capacity configurations and a final site to be determined during development of the Feasibility Report	Pacheco Reservoir Expansion Alternative
	Pacheco B Reservoir Alternative	Retained	Pacheco B Reservoir Alternative		
	San Benito Canyon Reservoir Alternative	Retained	San Benito Canyon Reservoir Alternative	Screened out because small size made reservoir less efficient than other options	
	San Luis Reservoir Expansion Alternative	Eliminated because it had similar benefits to the other storage alternatives and was economically infeasible when compared to those options			San Luis Reservoir Expansion Alternative - multiple configurations of a reservoir expansion alternative considered by analysis of the potential combination with the connected CAS action. The CVP only dedication of the expanded 120 TAF reservoir was selected to move forward in the feasibility process for further evaluation.
	Del Puerto Canyon Reservoir Alternative	Retained	Del Puerto Canyon Reservoir Alternative	Screened out under the efficiency criterion given the alternative's economic infeasibility when compared to the Pacheco Alternative	
	Ingram Canyon Reservoir Alternative	Retained	Ingram Canyon Reservoir Alternative		
	Quinto Creek Reservoir Alternative	Retained	Quinto Creek Reservoir Alternative		
Alternate Water Supplies	Monterey Bay Desalination Alternative	Eliminated because it was economically infeasible when compared to any of the other alternatives under consideration in the IAIR			
	San Francisco Bay Desalination Alternative	Eliminated because it was economically infeasible when compared to any of the other alternatives under consideration in the IAIR			
	Combined Desalination Alternative	Eliminated because it was economically infeasible when compared to any of the other alternatives under consideration in the IAIR			

Table 2-1. Alternative Screening Results

Category	IAIR Screening		PFR Screening		Feasibility Report
	Alternative	Screening Result	Alternative	Screening Result	
	Enlarged SBA/Los Vaqueros Expansion Alternative	Expansion of the SBA was screened out but enlarging Los Vaqueros Reservoir was retained	Los Vaqueros Expansion Alternative	Screened out under the completeness criterion given the ongoing development of the project in the Los Vaqueros Expansion Project Feasibility Study	
	Los Vaqueros Expansion Alternative	Retained			
Combination	Combination Alternative	Retained	Combination Alternative	Retained	Eliminated related to the acceptability criterion given the identification of issues with the feasibility of the Anderson Reservoir reoperation and groundwater components.

Key: CAS = Safety of Dams Corrective Action Study; DAF = Dissolved Air Floatation; IAIR = Initial Alternatives Information Report; PFR = Plan Formulation Report; SBA = South Bay Aqueduct; SCVWD = Santa Clara Valley Water District; SLR = San Luis Reservoir; WTP = water treatment plant

More detail on this process is included in Appendix A1, which details the alternatives screening criteria, initial alternatives identification and screening, plan formulation, scoping of alternative measures and pre-screening process, and additional alternatives considered and eliminated from further evaluation.

2.2 Project Alternatives

The SLLPIP alternatives are described below, including the No Action/No Project Alternative and four action alternatives. Appendix A2 includes more detail on each alternative.

2.2.1 Alternative 1 – No Action/No Project Alternative

Both NEPA and CEQA require the evaluation of a No Action/No Project Alternative, which presents the reasonably foreseeable future conditions in the absence of the proposed project. The purpose of the No Action/No Project Alternative is to allow decision-makers to compare the impacts of approving the project to the impacts of not approving the project. Under NEPA, the No Action Alternative also serves as the baseline to which action alternatives are compared to determine potential impacts. This differs from CEQA, where existing conditions serve as the baseline to determine potential impacts of the alternatives. The No Action/No Project Alternative may differ from the Affected Environment/Existing Conditions if there are actions that could occur in the project area that 1) currently do not exist and 2) do not rely on approval or implementation of the proposed project. However, because substantive changes in the area of analysis are not expected, the No Action Alternative would be the same as existing conditions/No Project Alternative. The No Action/No Project Alternative reflects existing and expected future conditions in the project area if no action is taken.

The No Action/No Project Alternative would leave the current operations at San Luis Reservoir unchanged. SCVWD would continue annual operations planning to anticipate curtailment of CVP supply and would manage its uses and sources of imported and local water supplies.

SCVWD relies upon a stable supply of CVP surface water as a part of its larger water supply portfolio that includes imported surface water supplies from the CVP and SWP, local groundwater, and local surface water supplies. Low point supply interruptions reduce the reliability of the CVP supply, which could jeopardize the short- and long-term reliability of other supplies intended for other uses. For instance, groundwater normally reserved for drought or emergency use may be relied upon during a low point event. A low point supply interruption—and even the threat of an interruption—can result in the immediate reduction of the amount of treated water available for delivery by the contractors, because it requires the re-operation of SCVWD's surface and groundwater systems and requires the use of alternative water supplies that would otherwise be dedicated to other uses. The effects resulting from delivery reductions and/or curtailments due to a low point would continue to pose a significant threat to the contractors' short- and long-term water supply reliability.

Under this alternative, water supply modeling results have predicted that there would be 17 years (out of the 82 modeled years)[2] where the San Luis Reservoir would be drawn below 300 TAF of storage, i.e. low point years.

2.2.2 Alternative 2 – Lower San Felipe Intake Alternative

Alternative 2, the Lower San Felipe Intake Alternative, includes construction of a new, lower San Felipe Intake to allow reservoir drawdown to its minimum operating level without algae reaching the San Felipe Intake. Moving the San Felipe Intake to an elevation equal to that of the Gianelli Intake would allow operation of San Luis Reservoir below the 300 TAF level without creating the potential for a water supply interruption to SCVWD.

As part of this alternative, a new intake (see Figure 2-1 for a schematic) would be constructed and connected to the existing San Felipe Division Intake via approximately 20,000 feet of new pipeline or tunnel. The top of the San Felipe Intake is currently at elevation 334 feet, and algae-laden water can reach the intake when reservoir levels reach approximately 369 feet (approximately 300 TAF in storage). Because the Gianelli Intake Facility is at elevation 296 feet (approximately 30 feet lower than the minimum operating pool), algae-laden water does not typically reach the Gianelli Intake. The new intake in this alternative would be at elevation 296 feet, the same elevation as the Gianelli Intake. The lower intake facility would allow the San Felipe Division to receive water from the lower reservoir levels that do not contain high concentrations of algae. A hypolimnetic aeration facility would also be constructed to increase dissolved oxygen levels in lower reservoir levels to prevent taste and odor issues.

[2] Appendix B presents in detail the modeling assumptions and methods used to estimate water supply effects from the No Action/No Project Alternative and the action alternatives.

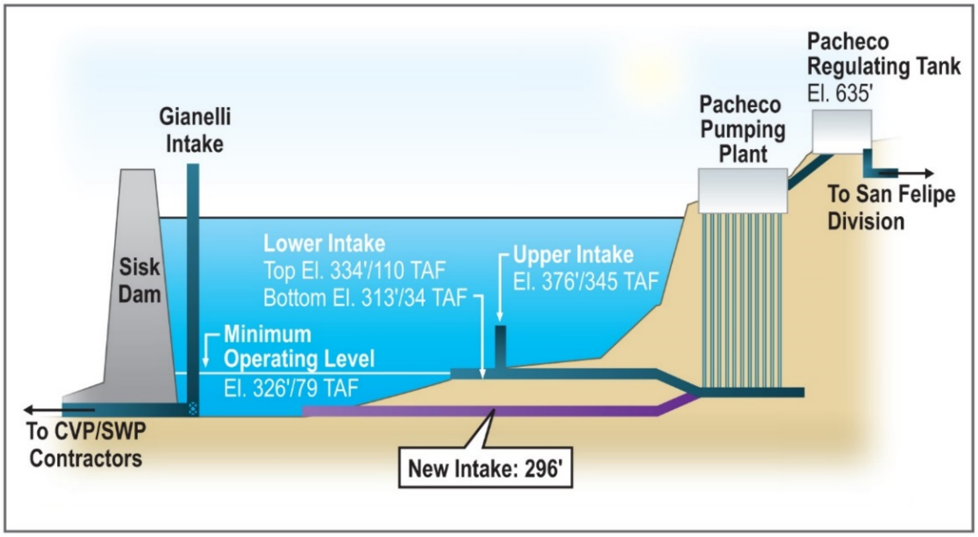


Figure 2-1. Lower San Felipe Intake Alternative

2.2.2.1 Project Facilities

Lowering the San Felipe Intake would also require an extension of the intake for the Pacheco Pumping Plant because the reservoir is higher on the west side than at the site of the Gianelli Intake. The conveyance structure from the new intake to the existing intake would be either a submerged pipeline along the bottom of the reservoir or a tunnel beneath the bottom of the reservoir. Two options, a tunnel option and a pipeline option, are being considered for the intake extension.

- **Tunnel Option –** This option would consist of a tunnel constructed beneath the reservoir floor. This option also includes a new vertical shaft on Gate Shaft Island to tie into the existing intake. The tunnel would be about 20,000 feet long and 15 feet in diameter, and the liner would have an inner diameter of 13 feet.

- **Pipeline Option –** Under this option, a new 13-foot diameter reinforced concrete cylinder pipe would be laid along the bottom of San Luis Reservoir. The pipeline would be about 20,000 feet. The pipe would have a constant slope upward from the new intake and tie into the invert of the existing lower intake at elevation 313 feet. An existing intake channel is graded along the bottom of the reservoir. To reduce the amount of dredging required, the pipeline's alignment would match the alignment of the existing intake channel.

2.2.2.2 Construction Methods and Equipment

The new intake structure would be constructed on shore in 10 foot segments. The segments would be transported to the permanent intake location on a barge, and then lowered into the reservoir using a crane. Intake segments would be stacked on top of each other to achieve the full intake height, and welded by divers to join and seal the segments. The tunnel option would be constructed using an Earth Pressure Balance Tunnel Boring Machine (TBM). Dewatering and blasting during construction would not be necessary and hazardous materials are not expected to be encountered. For the pipeline option, dredges would be used to modify the existing intake channel which would serve as a trench for the underwater pipeline. Pipe segments of 50 foot lengths would be transported by tug boats from the staging area to a barge, then lowered into the reservoir with a crane. Connection of pipe segments would be made by divers. Construction of the pipeline would not cause any changes to the CVP or SWP operations in the reservoir.

Construction of a new permanent access shaft on Gate Shaft Island would only be necessary for the tunnel option. Construction of temporary cofferdam structures is anticipated for both the tunnel and pipeline options in order to complete intake connections within the reservoir.

Equipment in the staging areas would include trailers, equipment to be used, and stockpiled materials. Construction staging and stockpile areas would include: (1) Dinosaur Point Use Area for both the tunnel and pipeline options. Dinosaur Point Use Area consists of 10 acres; (2) Basalt Use Area for the new intake structure construction. Basalt Use Area consists of 10 acres; (3) Area south of Gianelli Pumping Plant off of Gonzaga Road, for the transporting materials to the new intake location. The area proposed for use consists of 5 acres. Dinosaur Point and Basalt use areas would be needed for stockpiling materials and recreational use of these areas would be closed for the full construction duration.

The main staging area access route would be State Route (SR) 152 to Dinosaur Point Road. Most of the traffic to the site would come from the east. Improved road access from SR 152 to the Dinosaur Point and Basalt staging areas may be needed to accommodate the high volume of trucks and other heavy equipment anticipated during construction. Road reinforcement would be necessary at the intersections of SR 152 and the access roads to Dinosaur Point and Basalt use areas. Construction related traffic would likely begin 1 to 2 months after Notice to Proceed. Approximately 6 to 12 large deliveries per day could be expected, the transport and disposal of approximately 1,200 cubic yards of material to local landfills, along with the regular commuting of construction personnel.

The closest concrete batch plants are located in Los Banos, approximately 30 to 40 minutes driving time from reservoir access locations. Materials from local batch plants would be used for road improvement work and construction of the new intake structure. It is assumed that an on-site concrete batch plant would not be needed.

Since San Luis Reservoir is a drinking water source and specialized construction methods would be utilized for installation of the new intake and conduit, the following special safety measures would be implemented during construction within the reservoir: (1) Use of food grade oil for equipment lubricants; (2) Installation of turbidity curtains surrounding existing intakes, if operational; (3) Certified professional divers (for the pipeline option).

Equipment used in the reservoir for the tunnel option would include:

- 1 Barge
- 1-2 Boats
- 2 Water trucks
- 2 Graders
- 4 Cranes
- 1 Drill rig
- 2 Large excavators
- 2-3 Chiller plants
- 7 Portable Diesel Generators
- 2 Bulldozers
- 2 Loaders
- 1 Excavator
- 2 Concrete Pumpers
- 2 Dump trucks
- 1 Scraper
- 3 Flatbed Trucks
- Tunnel boring machine

Between 163,000 and 184,000 cubic yards of excavated material would be generated by the tunneling option. This quantity accounts for the expansion of excavated materials, and an increase due to soil conditioners used by a TBM. Excavated materials would be disposed of at Dinosaur Point and used to increase the boat ramp area.

For the pipeline option, anticipated equipment would include:

- 3-4 Boats
- Dump truck
- 2 Loaders
- 1 Concrete Pumper
- 3 Cranes
- Barge
- 1 Scraper
- Dredging barge or boat
- Loader
- 1 Excavator
- 2 Bulldozers
- 4 Portable Diesel Generators
- 2 Water Trucks
- 3 Flatbed Trucks
- 2 Graders

It is assumed for the purpose of this EIS/EIR, that construction would start in 2020. Construction of the tunnel option is expected to last approximately 47 months. The construction duration is based on 30-50 total anticipated workers on site, 12 of which would be working within the tunnel. Work would be performed 24 hours per day, 7 days a week. Construction of the pipeline option would last 33 months, and would focus on installing as much of the pipeline as possible during low water periods. Twenty workers are estimated to be on site for construction. Work would be performed for 10 hours per day from 7:00 a.m. to 5:00 p.m., 5 days a week.

2.2.2.3 Operations

The Lower San Felipe Intake Alternative would allow the San Felipe Division to draw water from San Luis Reservoir at the same elevation as the Gianelli Intake, which serves other CVP South-of-Delta contractors. This new lower intake would allow reservoir drawdown to its minimum operating level without algae reaching the San Felipe Intake. By allowing the delivery of imported CVP supply during low point periods, SCVWD would need to rely less heavily on locally stored surface and groundwater supplies.

2.2.3 Alternative 3 – Treatment Alternative

Alternative 3, the Treatment Alternative, would develop new technology retrofits at SCVWD’s Santa Teresa WTP. The WTP is supplied with water from San Luis Reservoir, which during low point conditions can contain high concentrations of algae.

2.2.3.1 Project Facilities

Alternative 3 would install new treatment technology at the SCVWD WTP to address some of the negative impacts associated with increased algae during low point events. The proposed improvements evaluated under this alternative would add a raw water ozonation process to the Santa Teresa WTP.

In a raw water ozonation process, ozone is added to the raw water entering the treatment plant before the water is treated by any other processes. Ozone oxidizes taste and odor causing compounds and other dissolved organic material released by algae. Ozone also improves clarification and filtration processes when used as a pre-oxidant. Implementation of a raw water ozonation process at the Santa Teresa WTP would require installation of a new ozone contactor, new ozone generation equipment housed in a new building, and new liquid oxygen storage facilities.

Figure 2-2 shows the conceptual site plan for the Santa Teresa WTP treatment technology upgrades.

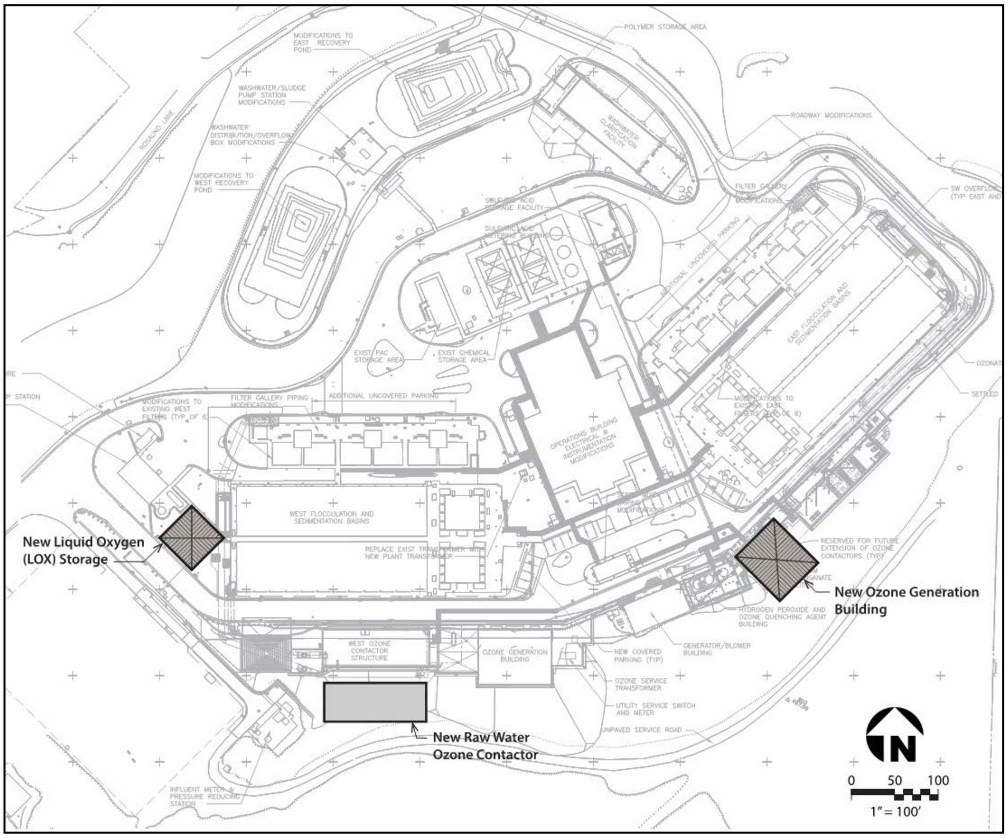


Figure 2-2. Santa Teresa WTP Conceptual Site Plan – Raw Water Ozonation

2.2.3.2 Construction Methods

Construction of the Treatment Alternative retrofits at the SCVWD WTP would be completed in compliance with existing SCVWD design standards. Replacement of the ozone generation equipment at the Santa Teresa WTP would require a plant shutdown. According to SCVWD staff, the plant can be shut down for up to 4 months. So, this work would need to be completed in a 4-month period. A plant shutdown would also be required for relocation of the existing duct bank. It is estimated that this work can be completed in a 1-month period. All other structures, equipment, and piping can be installed with the plant in operation. However, tie-in of all new piping, electrical feeders, and instrumentation and control system feeders would need to take place during the 4-month shutdown period described previously. Installation of the new equipment adjacent to existing facilities in operation would need to be closely coordinated with plant operations for safety purposes.

Equipment in the staging areas would include trailers and equipment to be used. Construction staging areas would be set up during the period of construction. It is anticipated that construction staging areas would be established at the WTP. The staging areas would be located on site and would not encroach on neighboring parcels. Construction equipment would include cranes, excavators, bulldozers, loaders, backhoes, ready mix concrete trucks, concrete pumpers, dump trucks, water trucks, flatbed trucks, and gravel, air compressors, concrete saw cutters, demolition equipment, and portable diesel generators. The Treatment Alternative would also require the transport and disposal of approximately 7,000 cubic yards of material at local landfills.

Construction work would be performed for 10 hours per day from 7:00 a.m. to 5:00 p.m., 5 days a week. The construction, testing and startup of the Treatment Alternative is anticipated to be approximately 3 years. It is assumed for the purpose of this EIS/EIR, that construction would start in 2020.

2.2.3.3 Operation of the Treatment Alternative

The Treatment Alternative would leave current SCVWD operations largely unchanged with the exception of periods with low point conditions in San Luis Reservoir (typically August and September) when SCVWD operators would be able to continue to take delivery of water supply from the reservoir while maintaining WTP performance. By allowing the delivery of imported CVP supply during these low point periods, SCVWD would be able to rely less heavily on locally stored surface and groundwater supplies.

2.2.4 Alternative 4 – San Luis Reservoir Expansion Alternative

Alternative 4, the San Luis Reservoir Expansion Alternative, would be completed by placing additional fill material on the dam embankment to raise the dam crest to increase storage capacity. The alternative would build upon the dam embankment expansion and foundation modifications to address the seismic concerns. The seismic modifications to B.F. Sisk Dam under Reclamation’s Safety of Dams (SOD) Act, as amended, that Alternative 4 would build on are included in this alternative as connected actions as defined under NEPA. The San Luis Reservoir Expansion Alternative would allocate the increased capacity to the CVP only. This expanded capacity would be operated in the same way as the current CVP portion of San Luis Reservoir, with the reservoir used for seasonal storage.

Alternative 4 would build on the physical SOD modifications currently under final design and raise the dam crest an additional 10 feet to a new crest elevation of 576 feet. This additional 10 feet in embankment height would support a new water surface elevation of 554 feet and an additional 120 TAF in storage capacity. In addition to the new embankment height added by the reservoir enlargement, the existing outlet works intake towers, access bridge, and spillway intake would need to be raised by 10 feet. Figure 2-3 shows the project footprint of Alternative 4, including the construction site boundary and change in reservoir water levels.

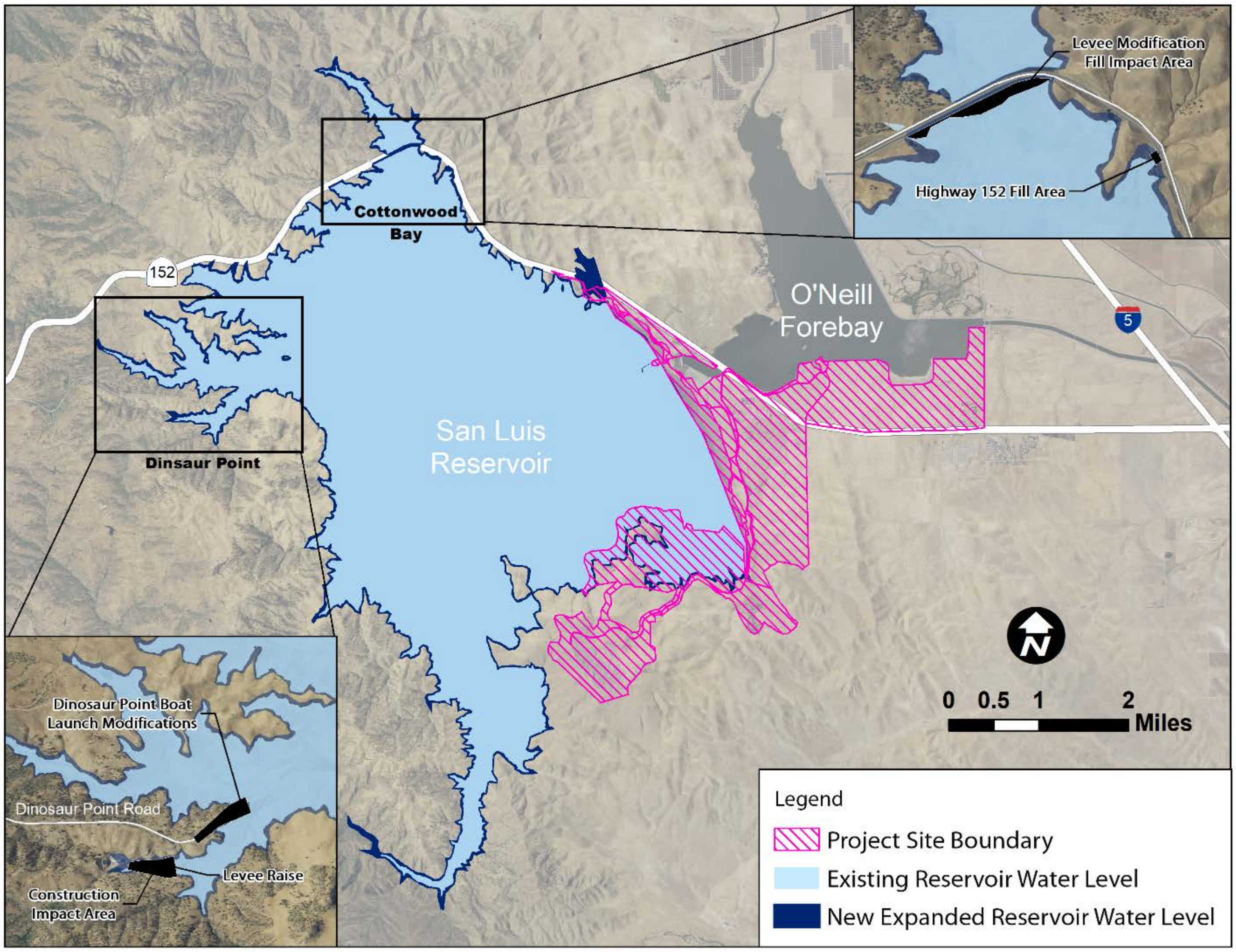


Figure 2-3. San Luis Reservoir Expansion Footprint

2.2.4.1 Project Facilities

As part of this alternative, the dam crest would be raised by adding additional embankment material (see Figure 2-4 for a schematic), and downstream stability berms and crack filters would be installed. The existing saddle dike, known as the East Dike, located approximately 1,300 feet north of the main embankment would be modified by adding a downstream filter. With increased reservoir surface elevations, modifications would be made at multiple locations along Highway 152 to prevent inundation of the roadway when the enlarged reservoir is filled to capacity, and modifications to the Dinosaur Point Boat Launch and the Goosehead Point Boat Launch would be made to increase the ramps operating elevation by 10 feet. The existing berm developed during construction of the Pacheco Pumping Plant would be reconstructed with a higher crest elevation to protect the plant at high storage levels (see Figure 2-5).

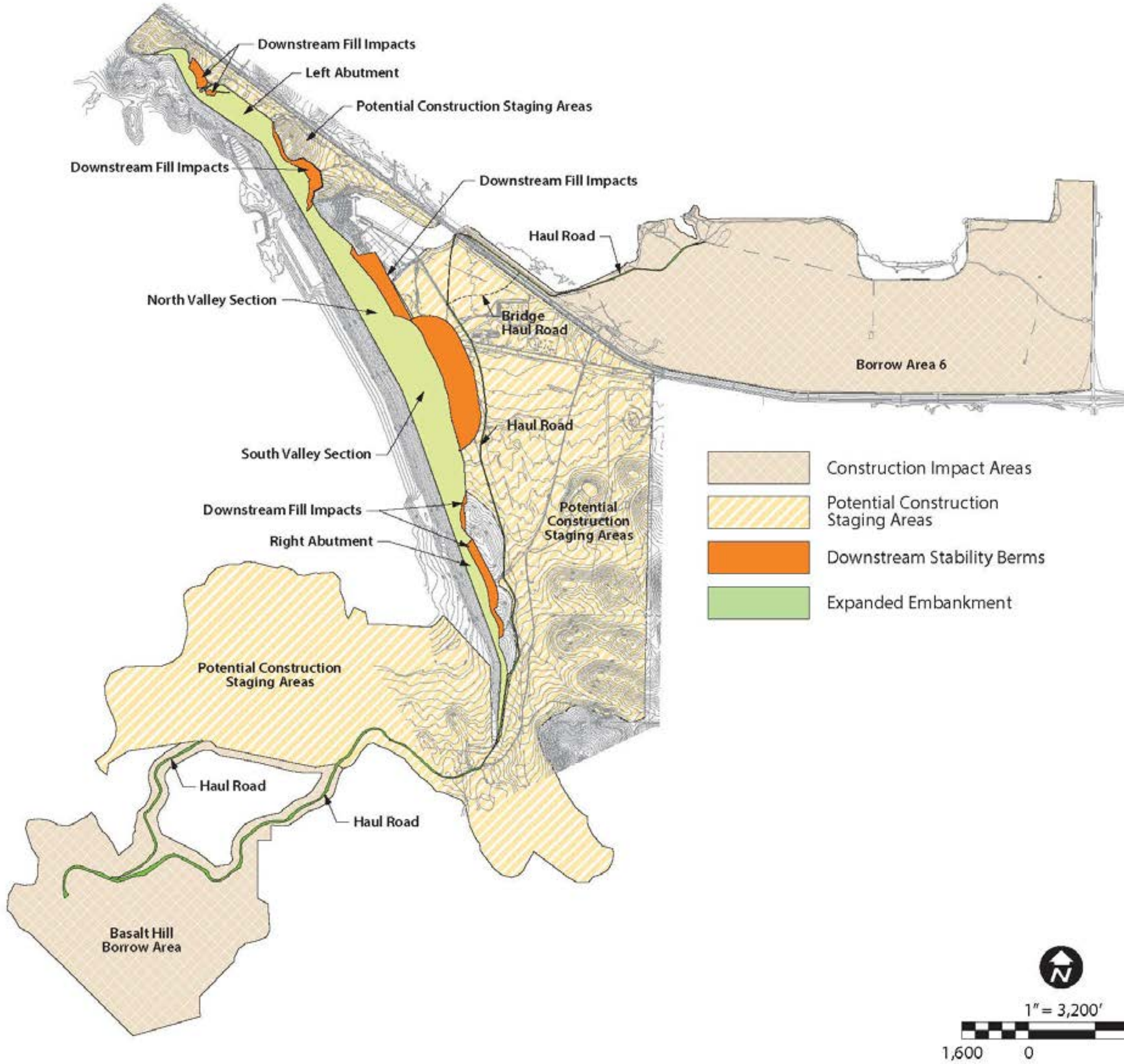


Figure 2-4. San Luis Reservoir Expansion Construction and Staging Areas

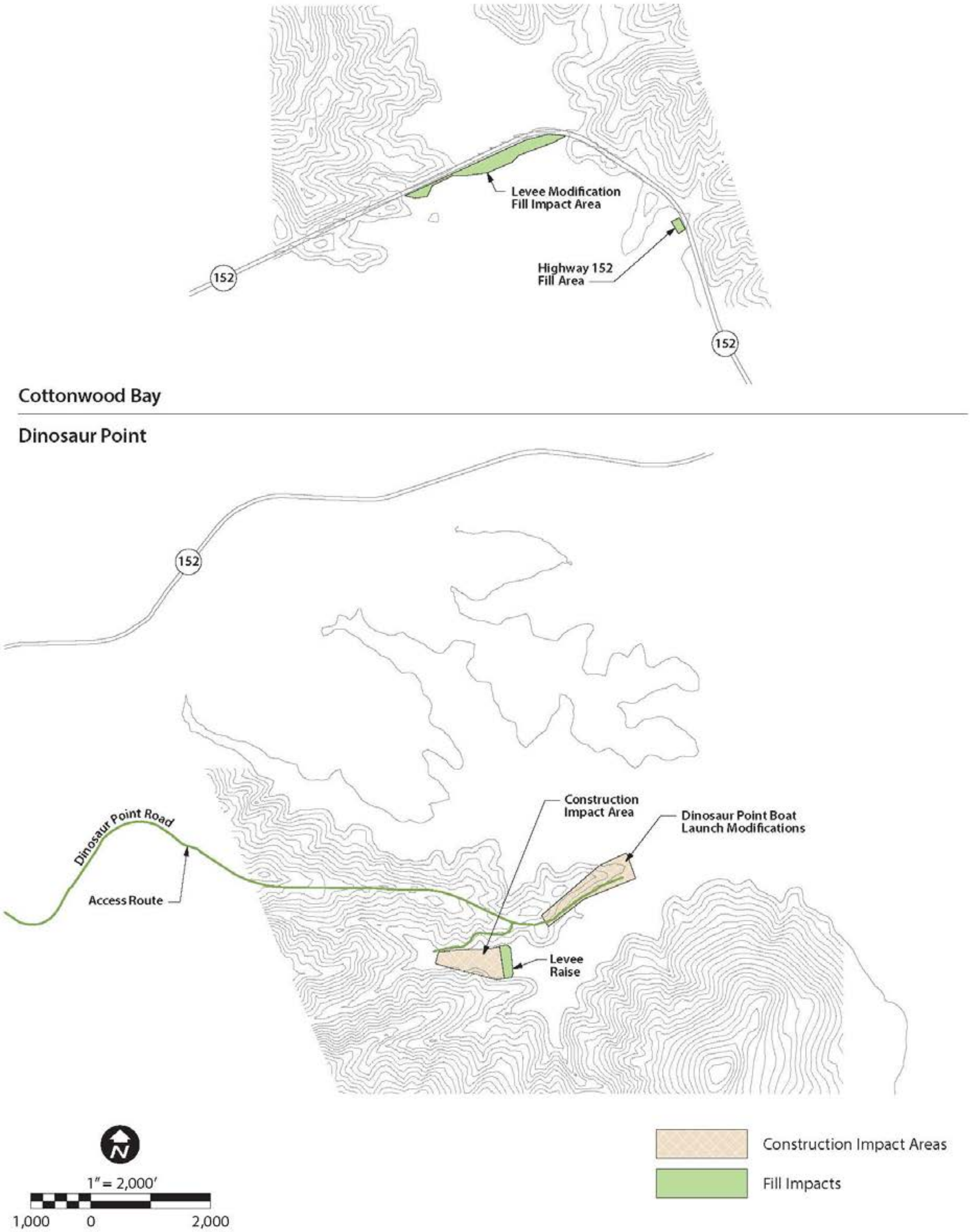


Figure 2-5. San Luis Reservoir Expansion Actions along Highway 152 and at Pacheco Pumping Plant

San Luis Reservoir seasonally operates in most years with an approximately 6-month period that CVP and SWP supplies are pumped into the reservoir followed by an approximately 6-month period where the reservoir is drawn down as those stored supplies are delivered to water users. Any work that would reduce the reservoir embankment strength, such as foundation or embankment excavation, would be timed seasonally and would occur during periods of the year when the reservoir is drawn down to lower elevations. As the reservoir is drawn down as a part of regular operations, construction would start after the reservoir is drawn below an elevation sufficient to ensure slope stability during any work that would impact embankment strength. This work would then be scheduled for completion prior to the subsequent refill of San Luis Reservoir back above that level to protect embankment stability, while allowing for uninterrupted water supply deliveries. Delays to refill could potentially occur if the construction schedule is delayed, but the division of specific modification actions scheduled to occur in one drawdown season would be structured to minimize this risk. In addition, contract requirements established by Reclamation and SCVWD would require use of the second construction shift on this particular component of the overall project in the event that work becomes delayed.

Implementation of the optional SVS shear key action would require limits on the maximum surface elevation in San Luis Reservoir for two fill and drawdown seasons, during the period that the berm foundation would be excavated. This reduction in surface elevation would reduce storage capacity in the reservoir and could limit CVP and SWP deliveries during this construction period. The shear key reservoir restriction would consist of a 55-foot reduction in the maximum water surface elevation of San Luis Reservoir from the current elevation of 544 feet to 489 feet. Excavation activities for the shear key would initiate when the reservoir is drawn down to 489 feet as a part of regular reservoir operations and would continue through two refill periods during which the reservoir would not be allowed to refill above that level. Reclamation and SCVWD would also target initiation of the shear key modification if possible, in a year where initial water supply forecasts are projecting dry or critically dry conditions to lessen the magnitude of this reservoir restriction’s impact in at least the first year of its two-year implementation window.

2.2.4.2 Construction

The shear keys and downstream stability berms would be constructed by first excavating the existing liquefiable and soft foundation soils. The rock blanket or slope protection would also be removed to the top elevation of the embankment and stockpiled downstream of the toe. Next, the existing toe drain would be removed by excavation. After completion of the excavations, the existing filters/drains located at the downstream toe would be re-established and a new toe drain seepage collection system would be installed, similar to the one currently in place. Stronger material would then be placed as backfill and compacted. At 480 feet, a two-stage downstream crack filter would be constructed. Above an elevation of 550 feet, the raised crest would be developed by simultaneously placing riprap and bedding, core, a two-stage chimney filter and the downstream shell. Materials used would be stockpiled downstream of the toe and in Borrow Area 6. After fill placement is completed, road base and paving of the dam crest complete the overlay raise.

Equipment in the staging areas would include trailers, equipment to be used, and stockpiled materials. Construction staging and stockpile areas would include area south of Gianelli

Pumping Plant off of Basalt Road, area north of Gianelli Pumping Plant off of Gonzaga Road, and Dinosaur Point. The access route to the two main staging areas would be SR 152 to Basalt Road. Temporary traffic signals would be installed at the current left turn crossing on SR 152 at Basalt Road and at the access road to Romero Visitor Center for the duration of the project. Up to 240 large deliveries or waste material transports offsite per day could be expected, the transport and disposal of material to local landfills, along with the regular commuting of construction personnel.

Aside from areas dedicated to construction staging and transportation, all remaining available space at the areas next to B.F. Sisk Dam would be needed for stockpiling materials. These areas around the dam would be used as a staging area of the full duration of construction. These areas would be returned to pre-construction condition after the project is completed. Equipment used to construct the alternative would include:

- 3 Excavators
- 4 Bulldozers
- 5 Cranes/Lifts
- 5 Compactors
- 1 Grader
- 2 Scrapers
- 13 Dump trucks
- 5 Water trucks
- 4 Flatbed Trucks
- 2 Wheel Trenchers
- 1 Barge
- 2 Concrete Pumpers
- 2 Concrete Saw Cutters
- 5 Loaders (2 small, 3 large)

Recreational activities would be suspended for safety reasons during the entire construction schedule at Basalt Use Area and Medeiros Use Area, and during active construction at Dinosaur Point Use Area (approximately 1 year). Recreational use for boating would be suspended for the full year that both the Basalt and Dinosaur Point use areas are closed and would be limited to areas away from B.F. Sisk Dam for the full construction schedule. The closed Basalt Campground would be utilized as a temporary camping area for construction workers.

Final design of the dam raise would include the development of a construction schedule that times the completion work in the direct path of potential flood flows or on infrastructure specifically designed to direct flood flows to occur in periods of the year when rain is unlikely and reservoir levels are lower. In addition, the contractor would be required to develop a health and safety plan that includes a response plan to flood forecasts that would require the suspension of construction activities and the movement of construction equipment to higher ground.

Construction is expected to last approximately 8 to 10 years. With the addition of the SVS shear key option, construction is expected to last approximately 10 to 12 years. Both with and without the SVS shear key option, construction duration is based on 130 anticipated workers on site during the day shift and 87 workers on site during the night shift. Work would be performed 24 hours per day, seven days per week, 12 months per year. The 24 hour work day would consist of two 10 hour work shifts, with a half hour for lunch each shift, plus a 3 hour maintenance period. Blasting operations at Basalt Hill would be limited to the hours between 6:00 a.m. to 6:00 p.m. It is assumed for the purpose of this EIS/EIR, that construction would start in 2020.

This 8 to 12 year construction schedule is based on the assumption of no funding constraints and is used to analyze the impacts in this EIS/EIR. However, with potential funding constraints, the construction schedule could extend up to 20 years. Impacts under an extended 20 year schedule would result in impacts equal to or potentially smaller in a single year of construction that cumulatively over the full 20 year schedule would be the same in total magnitude as the unconstrained schedule. An extended schedule would not change the impact determination of any of the resources analyzed in this EIS/EIR.

2.2.4.3 Operations

Increasing storage capacity in San Luis Reservoir would potentially increase the yield of the CVP in years that surplus supplies in excess of the reservoir's existing storage capacity are available. This increased yield could increase SCVWD's capacity to access their CVP supply prior to the reservoir being drawn below the 300 TAF level and allow the District to avoid the potential for a water supply interruption from low point conditions.

Alternative 4 would allocate the increased capacity to the CVP only. This expanded capacity would be operated in the same way as the current CVP portion of San Luis Reservoir, with the reservoir used for seasonal storage. The new capacity would fill after the existing capacity is filled, which would result in increased CVP yield during wetter years. Alternative 4 has the potential to decrease SWP deliveries by reducing SWP exports from the Delta through Banks Pumping Plant. Banks Pumping Plant exports can be reduced as compared to Alternative 1 because the additional CVP storage capacity under the alternative allows the CVP to export more of the water they are entitled to under the Coordinated Operations Agreement. Under Alternative 1, the SWP is able to export this water when the CVP portion of San Luis Reservoir fills and CVP South-of-Delta demands are being met.

2.2.5 Alternative 5 – Pacheco Reservoir Expansion Alternative

Alternative 5, the Pacheco Reservoir Expansion Alternative, includes the removal of the existing dam, development of a new reservoir, a new earthen dam and spillway, new pipelines and tunnels, a new pump station, and associated channel modifications, a new regulating tank at Pacheco Pumping Plant, and access improvements. The new dam and expanded reservoir would be constructed on the North Fork of Pacheco Creek 0.5 mile upstream from the existing North Fork Dam and would inundate most of the existing Pacheco Reservoir. The proposed total storage for the new reservoir is 141,600 acre-feet (AF), with an active storage of 140,800 AF. The full pool elevation would be 694 feet and would inundate a total of 1,385 total acres. Figure 2-6 shows the expanded Pacheco Reservoir footprint. Additional figures associated with Alternative 5 are included in Attachment A of Appendix A2 and show proposed project component layouts, borrow areas, and construction access and staging areas from SCVWD's application for funding under WSIP.

2.2.5.1 Project Facilities

The new embankment dam would be a zoned earthfill structure consisting of an impervious core, flanked by an outer shell of random fill. A system of filters and drains would be provided to control seepage through the dam and foundation. An uncontrolled side channel spillway with a trapezoidal cross section would be located adjacent to the right (west) abutment of the proposed dam. Alternative 5 would construct an inlet/outlet facility consisting of a sloping intake/outlet structure and a low-level inlet/outlet designed to provide deliveries to the reservoir from Pacheco Conduit and withdrawals from the reservoir to the conduit and the North Fork of Pacheco Creek. The Pacheco Reservoir Pump Station would serve as a two-way pump station that both delivers water to and withdraws water from the Pacheco Reservoir. A pipeline would be constructed to connect the new pump station located immediately downstream of the new dam and the existing Pacheco Conduit.

2.2.5.2 Construction

The North Fork Dam is currently being operated under the terms of a DWR Division of Safety of Dams order requiring that the upstream and downstream outlet controls be maintained in the fully open position to maximize releases and maintain the lowest possible surface elevation in Pacheco Reservoir given the current condition of its spillway (DWR 2018). Construction of the Pacheco Reservoir Expansion Alternative would initiate with demolition of the existing North Fork Dam. Removal of the existing dam would proceed from the top down to prevent steep slopes and to minimize the potential for slope failure. A temporary cofferdam would be constructed at the upstream toe of the new dam footprint with a crest elevation of 500 feet. The cofferdam would be developed with a bypass structure to ensure that flows in Pacheco Creek are maintained during construction. The cofferdam and bypass would be designed to regulate at a minimum, a 20-year flood event. Fill material for the new dam embankment would be sourced from six borrow areas. Embankment construction activities would include processing, excavating, loading, hauling, placing, and compacting of impervious core, adding earth fill, and draining and filtering of materials from borrow areas. Figure 2-7 shows the construction access and staging areas.

Alternative 5 would also require an upgrade to an existing 16-mile Pacific Gas and Electric (PG&E) transmission line in order to support the new reservoir pump station. Approximately 5.75 miles of 25 feet-wide haul road would be required to access the reservoir borrow areas upstream of the embankment location. Construction access roads totaling 4 miles and 25 feet wide would need to be constructed across the stream, downstream of the embankment, to access the spillway area.

Equipment used to construct the alternative would include:

- 2 Aerial Lifts
- 3 Boomtrucks
- 6 Bulldozer
- 1 Cement Mixer
- 4 Truck Mounted Drill Rig (Wells)
- 1 Excavator
- 3 Flatbed Trucks
- 2 Graders
- 12 Loaders
- 4 Portable Diesel Generators
- 2 Pressure Washers
- 5 Pumps
- 7 Rollers
- 1 Scraper
- 23 Maintenance Trucks
- 3 Skidders
- 10 Dump Trucks
- 12 Signal Boards
- 6 Water Trucks
- 4 Welders
- 7 Cranes

It is assumed for the purpose of this EIS/EIR, that construction would start in 2024. Construction is expected to last approximately 5 years. The construction duration is based on a maximum of 350 anticipated workers on site during the day shift and a maximum of 125 workers on site during the night shift. Work would be performed 24 hours per day, seven days per week, 12 months per year. Blasting would occur infrequently, and would only take place during daytime hours.

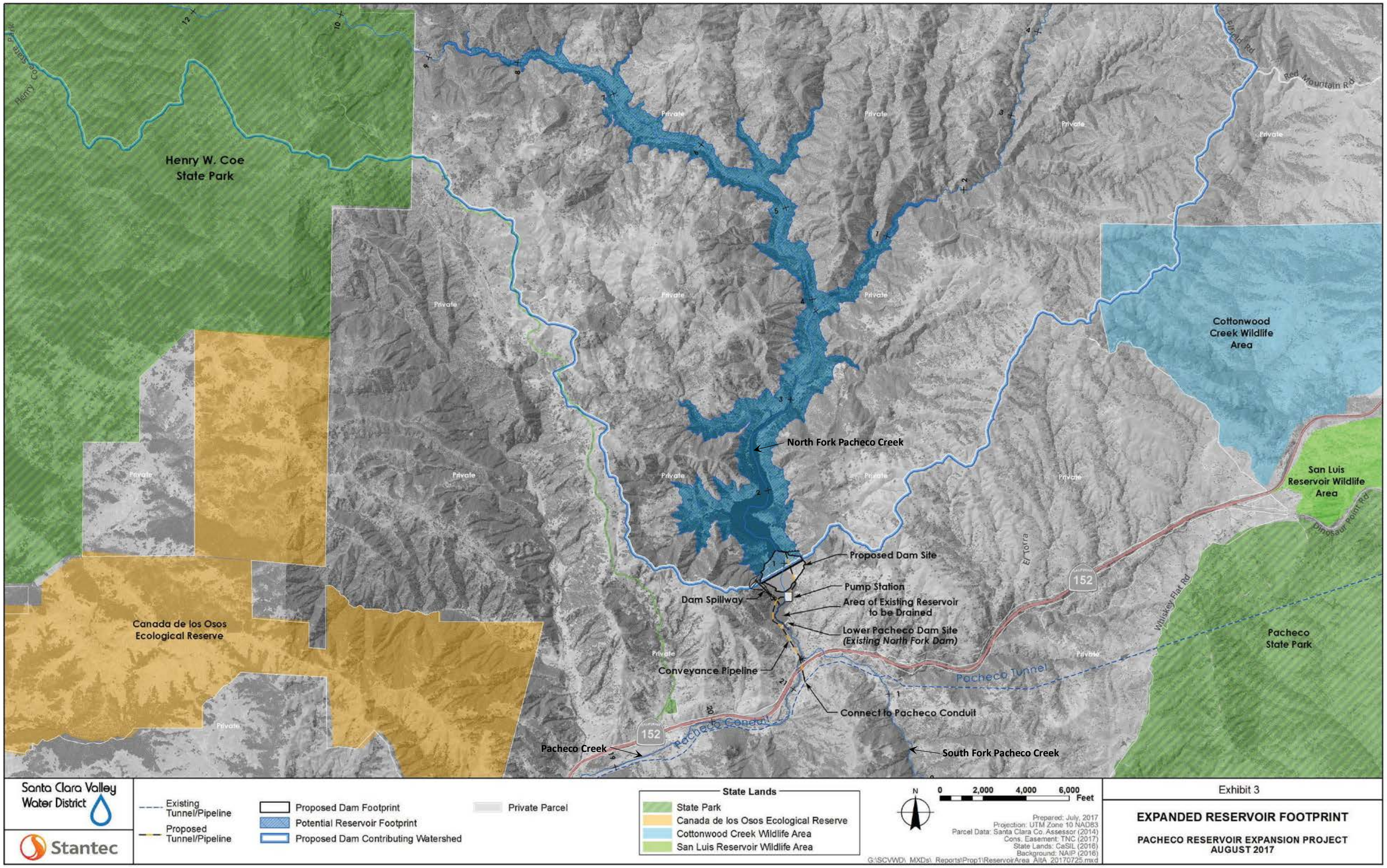


Figure 2-6. Pacheco Reservoir Expansion Footprint

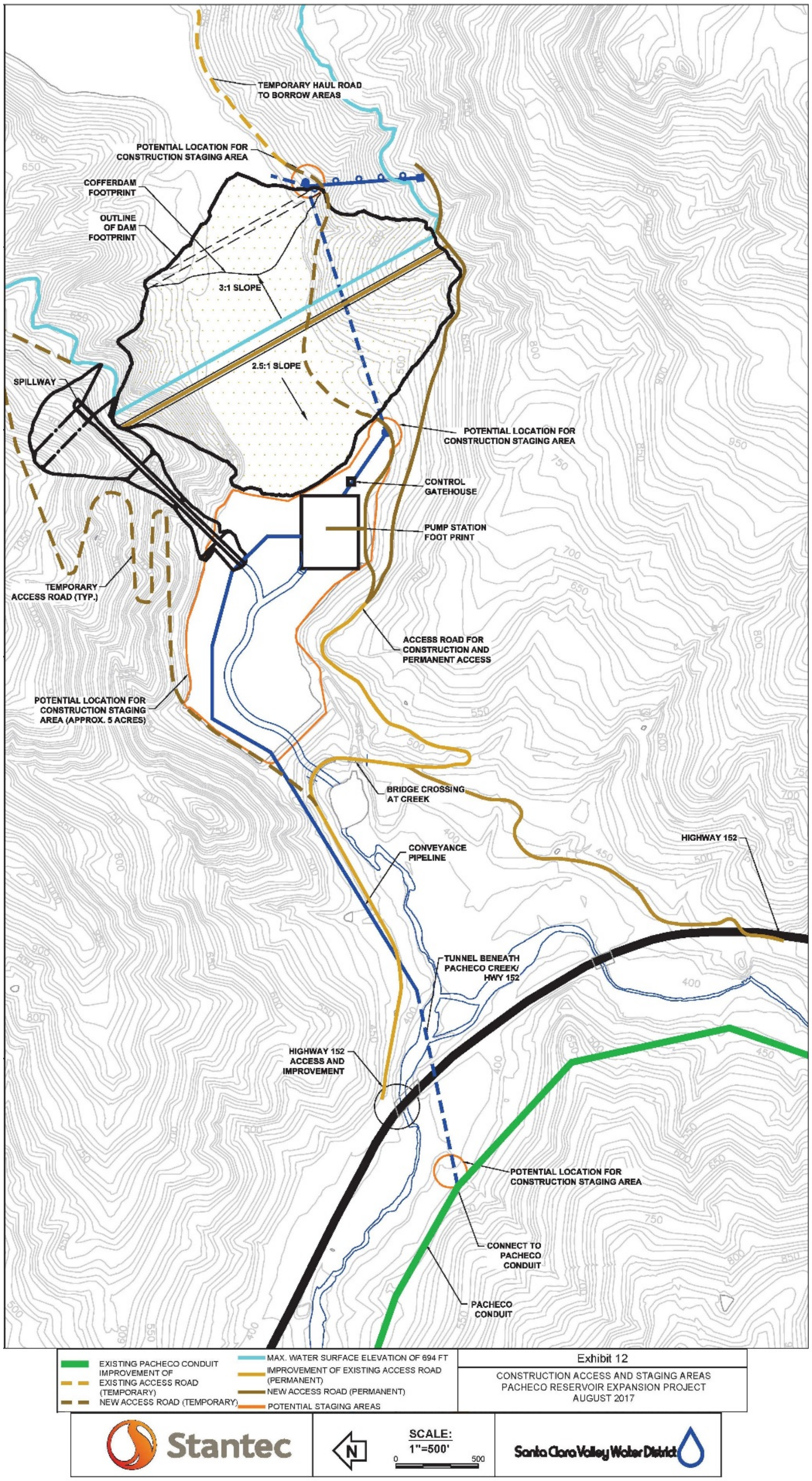


Figure 2-7. Pacheco Reservoir Construction Access and Staging Areas

2.2.5.3 Operations

The expanded Pacheco Reservoir would be primarily filled using natural inflows from the North and East Forks of Pacheco Creek. These inflows are typically realized from December through March. Supplemental flows to the expanded reservoir would arrive from SCVWD's share of contracted CVP pumped water from San Luis Reservoir. This would include allocated CVP water supplies that otherwise could not be delivered to or stored by SCVWD. This CVP water supply would be pumped from the Pacheco Conduit up to the expanded Pacheco Reservoir earlier in the year prior to the summer months when the San Luis Reservoir is typically drawn down to the 300 TAF level. The rate at which these transfers are made between San Luis Reservoir and Pacheco Reservoir would depend upon water rights, supply allocations, water demands, availability of other water supplies, and conveyance limitations of Pacheco Conduit. Conveyance and storage of these CVP supplies is anticipated to occur primarily in wet years. CVP water stored in Pacheco Reservoir could then be released through the summer while supplies from San Luis Reservoir would be inaccessible to SCVWD.

Alternative 5 would be operated by SCVWD to improve habitat conditions for steelhead in Pacheco Creek, improve SCVWD water supply reliability, including during drought periods and emergencies, and meet the groundwater recharge objectives of Pacheco Pass Water District (PPWD). Average monthly target flows ranging from 10 to 30 cubic feet per second (cfs) in Pacheco Creek would support the biological needs of South-Central California Coast (SCCC) steelhead, which are listed as threatened under the Federal Endangered Species Act (ESA), for higher flows for outmigration. The average monthly release targets are shown in Table 2-2[3]. During heavy precipitation events, releases from the expanded reservoir would be reduced to minimize flooding risks along Pacheco Creek and the Pajaro River. Winter releases of stored supply would be discontinued when it is estimated that there will be sufficient inflow passed through the reservoir downstream onto Pacheco Creek to provide for aquatic habitat going forward into the spring. The thresholds for discontinuing these winter releases are shown in Table 2-2. Operation of the expanded Pacheco Reservoir would not change the existing operations of the CVP.

To ensure that flows and water temperatures in Pacheco Creek are maintained in consecutive dry years, releases to Pacheco Conduit—to meet SCVWD water demands—would be discontinued in the event that reservoir storage volumes fall below 55,000 AF. This flow regime may however be altered in the event of an emergency declaration by SCVWD for health and safety purposes. These habitat flows would be secured by operations requirements expected in the biological opinion(s) that would be developed for the expanded Pacheco Reservoir, as well as the contract between California Department of Water Resources (DWR) and SCVWD for the provision of grant funding through the WSIP, and in the contract between and DWR and SCVWD for the provision of grant funding through the WSIP, and in the multi-agency operations agreement between Reclamation and SCVWD for Pacheco Reservoir that would be developed during the pre-construction design phase for this alternative if it is selected for implementation.

[3] These average monthly release targets shown in Table 2-2 incorporate the biological needs of the SCCC steelhead and include a 15-day pulse flow of 30 cfs, followed by a 15-day release schedule of 10 cfs. This pulse flow is anticipated to occur in March and April for outmigration.

Table 2-2. Average Monthly Release Targets to Pacheco Creek from Expanded Pacheco Reservoir

Month	Average Monthly Release Targets to Pacheco Creek (cfs)[1]	Inflow into Pacheco Reservoir Needed to Discontinue Winter Releases (cfs)
January	10	11.2
February	10	11.2
March	20	22.4
April	20	22.4
May	12	13.4
June	13	NA
July	14	NA
August	14	NA
September	14	NA
October	14	NA
November	10	11.2
December	10	11.2

Notes:
[1] Releases from Pacheco Reservoir are reduced during high flows in the south fork of Pacheco Creek.
Key: CFS = cubic feet per second

In addition, SCVWD would transfer 2,000 AF of its CVP water contract allocation (in below normal water years), directly or through transfer and exchanges, in perpetuity to Reclamation and U.S. Fish and Wildlife Services' Refuge Water Supply Program (RWSP), for use in the Incremental Level 4 water supply pool for wildlife refuges. This long-term voluntary reallocation of CVP yield by SCVWD would be secured by an agreement between the U.S. Fish and Wildlife Service (USFWS) and SCVWD detailing the mechanisms and timing for delivery of this supply, a contract between DWR and SCVWD for the provision of grant funding through the WSIP specific to this refuge water supply that would require the provision of these supplies in perpetuity, and a multi-agency operations agreement between Reclamation and SCVWD for Pacheco Reservoir to deliver and store SCVWD's CVP supply in this new facility that would also include the requirements for this transfer.

2.3 CEQA Proposed Project

For the purpose of CEQA, SCVWD has identified Alternative 5 as the Proposed Project. SCVWD's identification of a Proposed Project does not foreclose any alternatives or mitigation measures. All of the alternatives have been analyzed at a comparable level in this Draft EIS/EIR. Reclamation has not identified a preferred alternative in this Draft EIS/EIR for NEPA purposes. Consistent with Council on Environmental Quality (CEQ) Regulations 40 Code of Federal Regulations (CFR) Part 46.425, the Final EIS/EIR will identify a NEPA preferred alternative for implementation (or alternatives if more than one exists).

SCVWD and Reclamation are seeking input on the alternatives and their environmental effects during the public review of this Draft EIS/EIR. SCVWD and Reclamation will consider feedback received during the public review on the Draft EIS/EIR and the environmental impacts associated with each alternative when developing the Final EIS/EIR and selecting an alternative for implementation. Any alternative could be selected by the lead agencies following the conclusion of environmental review.

SCVWD has identified Alternative 5 as the Proposed Project for CEQA because of the wide range of public and non-public benefits. Benefits identified include ecosystem enhancements at Pacheco Creek and San Joaquin River watersheds, flood control, emergency water supplies, groundwater recharge and M&I water supply, and M&I water quality (SCVWD 2017b).

2.4 Environmentally Preferable/Superior Alternative

CEQ Regulations Section 1505.2(b) require identification of an environmentally preferable alternative, and CEQA Guidelines Section 15126.6(e)(2) requires an EIR to identify an environmentally superior alternative. However, the CEQ regulations and CEQA Guidelines do not require adoption of the environmentally preferable/superior alternative as the preferred alternative for implementation. The identification of the preferred alternative is independent of the identification of the environmentally preferable/superior alternative, although the identification of both will be based on the information presented in this EIS/EIR.

Section 1505.2(b) of the CEQ Regulations requires the NEPA lead agency to identify the environmentally preferable alternative in a Record of Decision (ROD). The CEQ Regulations define the environmentally preferable alternative as "…the alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources."

This Draft EIS/EIR provides a substantive portion of the environmental information necessary for Reclamation to determine the environmentally preferable alternative and for SCVWD to determine the environmentally superior alternative. However, the public and other agencies reviewing a Draft EIS/EIR can assist the lead agency to develop and determine the environmentally preferable/superior alternative by providing their views in comments on the Draft EIS/EIR. In this Draft EIS/EIR, Reclamation and SCVWD have identified Alternative 5 as the environmentally preferable/environmentally superior alternative because of the ecosystem benefits to the Pacheco Creek and San Joaquin River watersheds it provides. Reclamation and SCVWD will consider feedback during the public review phase of the Draft EIS/EIR on the environmental benefits and impacts of each alternative when developing the Final EIS/EIR and ROD.

2.5 Uses of this Document

In addition to the decision described above, Reclamation and SCVWD will use this EIS/EIR to obtain required environmental permits and approvals and use alongside the Feasibility Report to obtain funding.

Table 2-3 indicates the permits or approvals anticipated for the construction and operation of the SLLPIP Alternatives. This EIS/EIR has been developed to cover the environmental review and consultation requirements required by federal, state, regional or local laws, regulations, or policies listed in Table 2-3, as required by CEQA Guidelines Section 15124(d)(1). This coverage will allow the agencies responsible for implementing these permits or approval to rely on information in this EIS/EIR during the permitting or approval process.

Table 2-3. Permits or Approvals Required for SLLPIP Implementation

Permit or Approval	Applying Agency	Permitting or Approval Agency(s)
Federal Endangered Species Act Section 7 Compliance	Reclamation	USFWS and NMFS
Clean Water Act Section 401 Certification	Reclamation/SCVWD	SFRWQCB, CVRWQCB
Clean Water Act Section 404 Permit	Reclamation	USACE
California Endangered Species Act Section 2081 Permit	Reclamation/SCVWD	CDFW
California Fish and Game Code section 1602 Lake and Streambed Alteration Agreement	Reclamation/SCVWD	CDFW
NHPA Section 106 Compliance	Reclamation	SHPO and/or ACHP
NPDES Permit for General Construction	Reclamation/SCVWD	SFRWQCB, CVRWQCB
NPDES/WDR Individual Permit for Discharge	Reclamation/SCVWD	SFRWQCB, CVRWQCB
Petition to change CVP and SWP water rights	Reclamation/DWR	SWRCB
Clean Air Conformity	Reclamation/SCVWD	USEPA
Clean Air Act Fugitive Dust Control Plan & Indirect Source Review Air Impact Assessment	Reclamation/SCVWD	SJVAPCD
Clean Air Act Authority to Construct/Permit to Operate	Reclamation/SCVWD	BAAQMD
Encroachment Permit	Reclamation/DWR/SCVWD	California Department of Parks and Recreation, Santa Clara County, City of San Jose
Pacheco Reservoir Operation Agreement for the Reallocation of CVP Water Supply	SCVWD	USFWS
Pacheco Reservoir Multi-Agency Operations Agreement	SCVWD	Reclamation
WSIP Grant Funding Contract	SCVWD	DWR

Key: ACHP= Advisory Council on Historic Preservation; BAAQMD= Bay Area Air Quality Management District; CDFW= California Department of Fish and Wildlife; CVRWQCB= Central Valley Regional Water Quality Control Board; NHPA= National Historic Preservation Act; NMFS= National Marine Fisheries Service; NPDES= National Pollutant Discharge Elimination System; SFRWQCB= San Francisco Bay Regional Water Quality Control Board; SHPO=State Historic Preservation Office; SJVAPCD= San Joaquin Valley Air Pollution Control District; SWRCB= State Water Resources Control Board; USACE= United States Army Corps of Engineers; USEPA = United States

Chapter 3
Affected Environment / Environmental Setting

This chapter presents an overview of the affected environment for the SLLPIP EIS/EIR. Appendix C presents the Federal, State, and local laws, regulations, policies, and plans that are relevant and applicable to the affected environment, area of analysis, and analysis of impacts. The study area for this EIS/EIR (Figure 3-1) includes San Luis Reservoir and its related water infrastructure (including the San Felipe Division's water intakes and associated infrastructure); Sacramento-San Joaquin River Delta; California Aqueduct; South Bay Aqueduct (SBA); South-of-Delta CVP and SWP contractors; SCVWD service area, including the Santa Teresa WTP in San Jose; and Pacheco Reservoir and the surrounding vicinity, Pacheco Creek, Pajaro River, San Felipe Lake and Miller Canal. Regional and local environmental settings are described in the below sections.

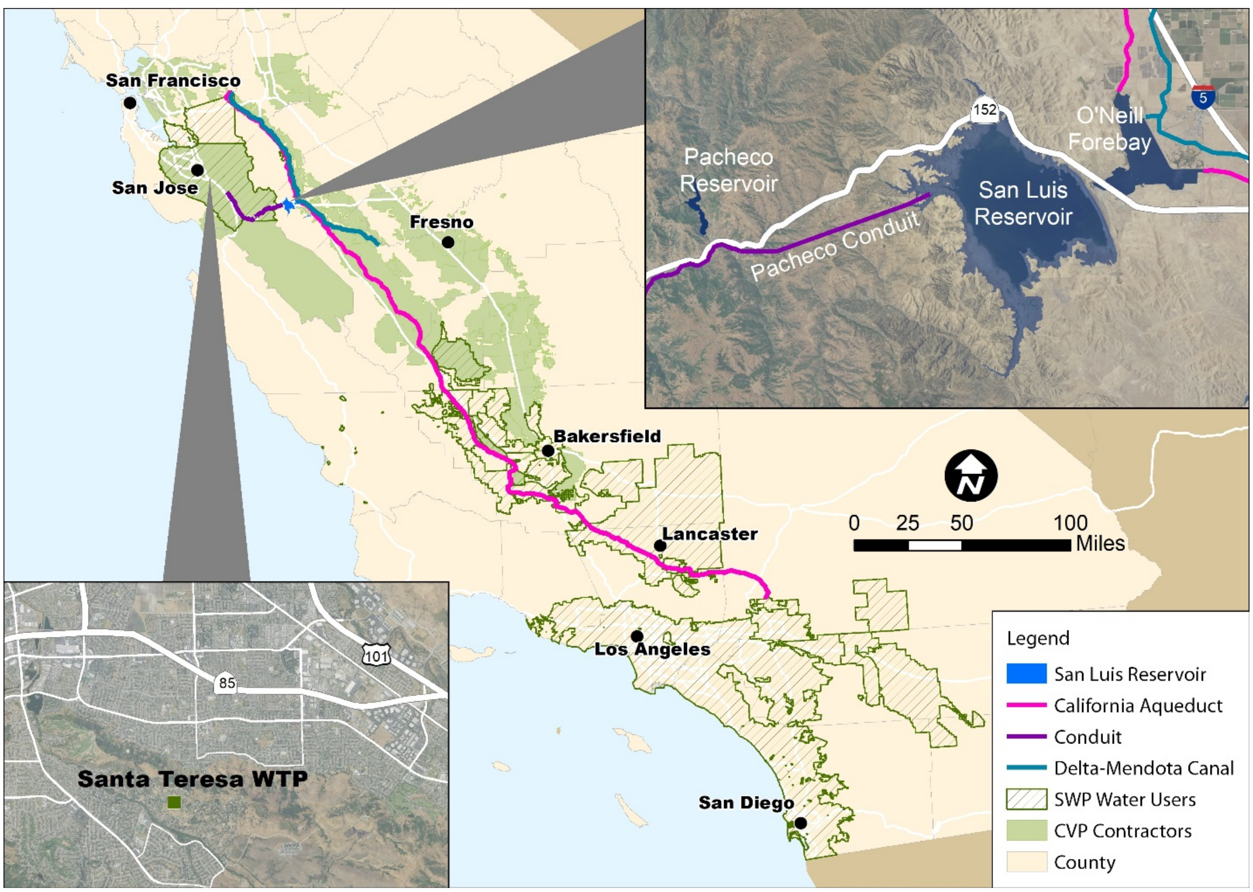


Figure 3-1. San Luis Low Point Improvement Project Study Area

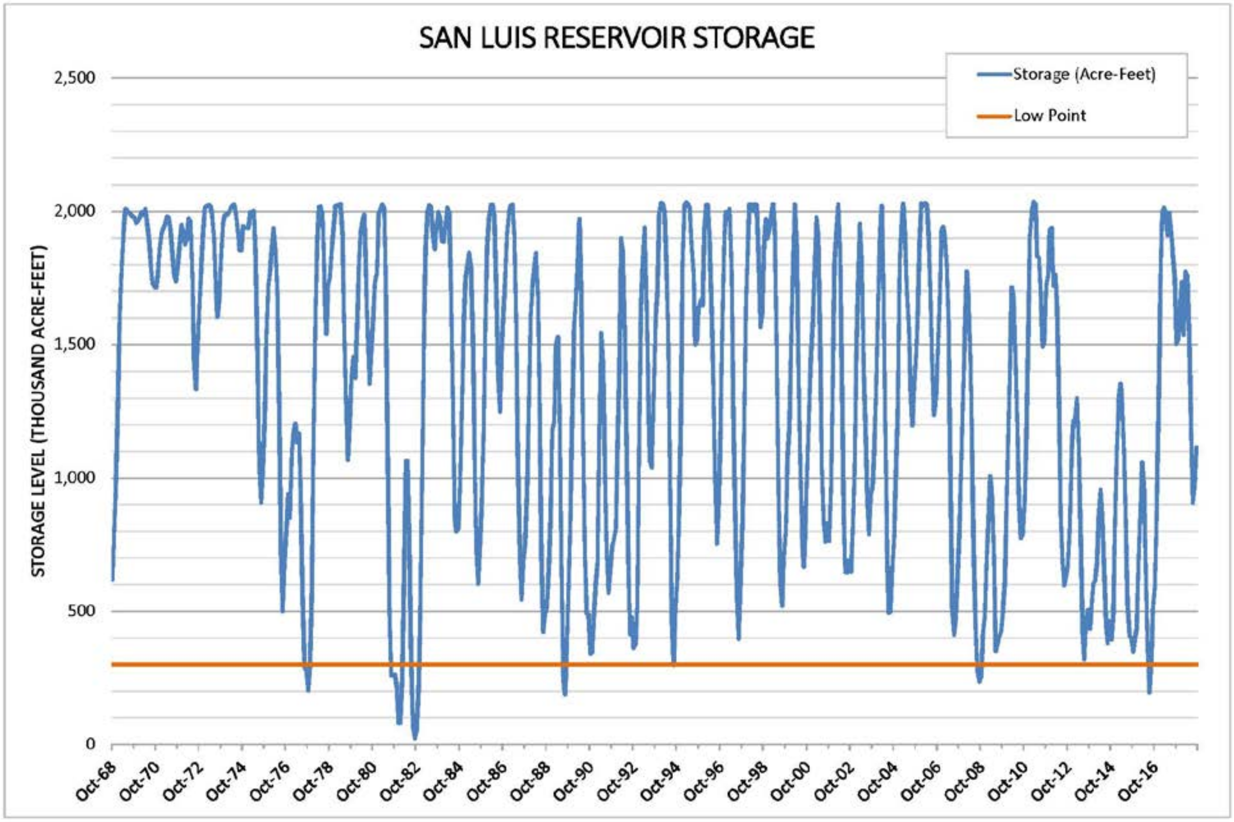
3.1 San Luis Reservoir

San Luis Reservoir is an off-stream storage reservoir in Merced County. Reclamation owns and jointly operates San Luis Reservoir with DWR to provide seasonal storage for the CVP and the SWP. San Luis Reservoir is capable of receiving water from both the DMC and the California Aqueduct, which enables the CVP and SWP to pump water into the reservoir during the wet season (October through March) and release water into the conveyance facilities during the dry season (April through September) when demands are higher. Deliveries from San Luis Reservoir also flow west through Pacheco Pumping Plant and Conduit to the San Felipe Division of the CVP. The CVP contractors that receive water from San Luis Reservoir include the San Felipe Division and the Central Valley Region CVP Contractors.

San Luis Reservoir and the surrounding area tend to be windy and are characterized by wet, cool winters and warm, dry summers. During the summer months, when water levels are low, water quality in the San Luis Reservoir deteriorates due to a combination of higher warmer temperatures, wind-induced nutrient mixing, and algal blooms near the reservoir surface. Presently, when San Luis Reservoir approaches its late summer/early fall low point, algae growth may begin to degrade water quality for contractors that utilize the water. If the algal layer is significantly thick, when the lake storage volume is reduced to approximately 300,000 AF, algae may begin to enter the Lower San Felipe Intake. The water quality within the algal blooms results in clogging issues for agricultural water users with drip irrigation systems in San Benito County or for M&I water users relying on existing water treatment facilities in Santa Clara County. Increasing water demands in the future will increase pressure to fully utilize all available storage in the reservoir (SCVWD 2005).

Appendix D provides detailed information about constituents of concern listed in the Clean Water Act (CWA) and beneficial uses of California waters defined in the California Water Code. The appendix also discusses water quality in the Delta, and general water quality characteristics of reservoirs. Water quality samples are routinely collected through automated monitoring at O’Neill Forebay at Gianelli Pumping Plant. Electrical conductivity (EC), dissolved oxygen (DO) and dissolved nitrate data from this sampling location are presented in Appendix D. Historic algae count data collected at Pacheco Pumping Plant indicate greatest algae cell counts during mid- to late-summer months, peaking in some years above 70,000 algae cell counts. DO is often lowest in the late summer and fall following excessive algae growth. Nitrate levels drop beginning in late spring as algae begins to form and depletes nitrate levels through late fall. In addition, San Luis Reservoir and O’Neill Forebay were designated in 2010 on the California 303(d) List for mercury impairment. Potential sources of the impairment are listed as unknown.

Figure 3-2 shows monthly storage in San Luis Reservoir from 1968 through early 2018. Storage is highly variable throughout the year as the reservoir refills in the fall and winter months and releases water in spring and summer to meet CVP and SWP demands. In most years, the storage level in San Luis Reservoir has remained above 300 TAF. As Figure 3-2 shows, San Luis Reservoir was drawn down in 1981 and 1982 to a storage level of 79 TAF to facilitate repairs. During the drought periods of 1976–1977, 1988–1992, and 2007–2008, the reservoir was drawn down to below 300 TAF. San Luis Reservoir also fell below 300 TAF in the summer of 2016 (Reclamation 2016a).



Source: CDEC 2018

Figure 3-2. Monthly Storage in San Luis Reservoir from 1968 to 2018

Several special districts, including community service districts, water districts, and sanitary districts provide sanitary sewer service within the unincorporated communities in Merced County. Unincorporated communities that lack sanitary sewer infrastructure are serviced by septic systems (Merced County 2013). There are two active solid waste disposal and landfill facilities in the county—the Highway 59 Landfill located in Merced, and the Billy Wright Landfill located in Los Banos. Electric services in the county are provided by PG&E and the Merced and Turlock Irrigation Districts. PG&E provides natural gas within the county (Merced County 2013).

Certain water supply facilities in the reservoir area use power to transport water and generate power. Gianelli Pumping Plant is a joint Federal/State facility that lifts water from O'Neill Forebay to San Luis Reservoir. During the irrigation season, water released from San Luis Reservoir through B.F. Sisk Dam generates energy as it flows back through the pump turbines to the forebay. Each of the eight pumping-generating units has a 63,000-horsepower (hp) motor and a capacity of 53,000 kilowatts (kW) as a generator, for a total installed capacity of 424,000 kW (Reclamation 2011a). At the Pacheco Pumping Plant, water from San Luis Reservoir is lifted through the San Felipe Intake to be transported to the San Felipe Division facilities. The Pacheco Pumping Plant has 12 pumps, with a total of 24,000 hp, approximately 300 feet in lift, and a total capacity of 600 cfs of flow.

San Luis Reservoir is in the Panoche-San Luis Reservoir watershed, part of the San Joaquin River Basin. San Luis Reservoir is drained by San Luis Creek, a tributary to the San Joaquin River. Natural runoff is captured by canals, reservoirs, and pumping facilities, and directed into a complex network of water supply infrastructure for SWP and CVP beneficial uses (Reclamation and California Department of Parks and Recreation [CDPR] 2013). There is no current streamflow monitoring at any of these inlets into the reservoir.

The area surrounding San Luis Reservoir is designated on the Federal Emergency Management Agency (FEMA) current Flood Insurance Rate Maps (FIRMs) as within Zones D, X, and A (FEMA 2016). Low-lying areas along creeks and the banks of San Luis Reservoir are susceptible to flooding. The San Joaquin County and City of Los Banos San Luis Reservoir dam failure inundation maps describe flood waters flowing in a northeast direction from the reservoir through Los Banos toward the San Joaquin River which could impact communities extending downstream and upstream along the river through Merced and Stanislaus Counties and portions of San Joaquin County (San Joaquin County Office of Emergency Services [OES] 2003, City of Los Banos 2003). Reclamation conducted an evaluation of the dam at San Luis Reservoir and concluded that during a severe earthquake, failure of the dam could occur, leading to overtopping as a result of embankment sloughing and/or seiche-generated wave action. Modifications to address seismic concerns under Reclamation’s SOD Act, as amended, are currently under final design.

The vast majority of land within Merced County is designated as Agricultural and Foothill Pasture Land and lies outside of existing cities (Merced County 2013). County land surrounding the reservoir includes a variety of uses. The unincorporated community of Santa Nella, located northeast of O’Neill Forebay, includes residential and commercial uses (Reclamation and CDPR 2013). Other land use in the area surrounding the reservoir is primarily grazing land. Lands to the southeast of the reservoir include privately owned ranchlands, agricultural lands, public utility uses, and other scattered nonresidential uses (Reclamation and CDPR 2013). There is no land surrounding San Luis Reservoir designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance or land enrolled in Williamson Act contracts.

The San Luis Reservoir State Recreation Area (SRA) spans approximately 27,000 acres and includes major facilities such as the San Luis Reservoir, O'Neill Forebay, and Los Banos Reservoir, as well as several other Federal and State owned lands and facilities (Reclamation and CDPR 2013). The San Luis Reservoir SRA Resource Management Plan/General Plan (RMP/GP) defines distinct geographic divisions, or management zones, within the SRA based on physical, social, and management characteristics (Reclamation and CDPR 2013). The management zones include Administrative and Operations Zone (for staff, operations, and maintenance activities), Frontcountry Zone (for the majority of visitor facilities, camping, and concessions), and Backcountry Zone (for less intensive recreation and with limited camping and trails).

The San Luis Reservoir SRA contains five use areas (areas designated as major public recreational facilities)—Basalt, Dinosaur Point, Los Banos Creek, Medeiros, and San Luis Creek—and one minor use area for off-highway vehicle (OHV) use. There are two additional areas designated for wildlife; both allow for hunting and primitive hiking, along with nature study activities. The primary activities at each use area vary but, collectively, the San Luis Reservoir SRA provides opportunities for boating, swimming, windsurfing, camping, and fishing

(Reclamation and CDPR 2013). Boating and other water sports, such as jet skiing and windsurfing, are allowed from sunrise to sunset on San Luis Reservoir, O'Neill Forebay, and Los Banos Creek Reservoir (CDPR 2003). There are boat ramps at all five use areas; however, the boat ramp at the Medeiros Use Area is currently closed due to safety concerns (Reclamation and CDPR 2013). The San Luis Reservoir SRA also provides over 640 campsites for visitor use. The San Luis Reservoir SRA consists of two developed campgrounds, at the Basalt and San Luis Creek use areas and undeveloped campgrounds at the Medeiros and Los Banos Creek use areas.

Pacheco State Park (SP) lies directly west of the San Luis Reservoir SRA. The park is only partially open to the public for day use recreation such as hiking and bicycling. The Pacheco SP offers an approximately 25-mile-long trail system, including 15 designated trails. The remainder of the park is used for equestrian activities and cattle grazing, in addition to a wind turbine farm that generates clean energy for 3,500 homes. The only campground facilities available at Pacheco SP consist of primitive horse campgrounds; however, tent camping is available for corporate events and is permitted upon request (CDPR 2004, CDPR 2011).

Public utilities serving San Luis Reservoir SRA include sewage and water treatment, water storage facilities, power transmission and distribution lines, and propane. There is no formal stormwater system at the San Luis Reservoir. Runoff from the campgrounds, parking grounds, and boat ramps flows overland into area water bodies or percolates into the groundwater.

The area surrounding San Luis Reservoir is dominated by agricultural land uses and publicly owned parkland and wildlife areas, which are relatively quiet. Motor boats are the main source of noise in the vicinity of the San Luis Reservoir at the O’Neill Forebay Recreational Boating area. Motor boats are the main source of noise at O’Neill Forebay. Several campgrounds and day-use picnic areas present along the shores of the reservoir and forebay are relatively close to areas where construction activities would take place under some project alternatives, including San Luis Creek Use Area. The residences nearest potential construction sites at San Luis Reservoir include a subdivision off SR 152 and a residence on Harper Lane. Figure E1-2 in Appendix E1 depicts these noise-sensitive land uses around San Luis Reservoir. At these sensitive receptors, the estimated noise level is a Day-night average level (L_{dn}) of 40 A-weighted decibels (dBA), based on the United States Environmental Protection Agency (USEPA) *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (USEPA 1974).

This environmental assessment relied on the United States Department of Agriculture (USDA), Forest Service Scenery Management System (SMS) to classify the visual resources in the project area. Because visual sensitivity as well as judgments of visual quality and viewer response is dependent on a number of conditions, they tend to be subjective in nature. The SMS uses scenic attractiveness and Landscape Visibility to develop a meaningful measurement of the relative importance and sensitivity or what is seen and perceived in the landscape. Overall, the area around San Luis Reservoir offers open scenic vistas of undeveloped land and open water. These scenic qualities are enhanced by the surrounding undeveloped landscape consisting of “open grassland, expansive vistas of the rolling terrain and the adjacent Diablo range” (Reclamation and CDPR 2013). Utilizing the USDA SMS, San Luis Reservoir is considered a Class A resource, and O’Neill Forebay has elements that are Class A and Class B (USDA Forest Service

1995). State designated scenic highways include SR 152 from the Santa Clara County line to the junction with Interstate (I)- 5.

San Luis Reservoir and O'Neill Forebay are near the boundary of the Great Valley (San Joaquin Valley portion) and the Coast Ranges geomorphic provinces (California Geological Survey [CGS] 2002). As mapped by the county, the eastern portion of San Luis Reservoir including O'Neill Forebay is in a low potential landslide zone while the western portion of the reservoir is in a medium potential landslide zone (Merced County 1990). Surface soil texture surrounding San Luis Reservoir is generally characterized as silt loam on the eastern portion, and loam and sandy loam on the western portion (USDA, Natural Resources Conservation Service [NRCS] 2016a). The silt loam soils have moderate erodibility while the sandy loam soils have a high erodibility (USDA, NRCS 2016b). Shrink-swell potential surrounding San Luis Reservoir can be characterized as low to moderate (USDA, NRCS 2016c).

San Luis Reservoir is in a seismically active area and is close to several faults and fault systems. The Ortigalita fault passes under the reservoir in two locations, one is along the western shore of the reservoir crossing over Lone Oak Bay to the east and the other runs from Cottonwood Bay close to the eastern shore of the reservoir on the eastern side of Basalt Hill (Reclamation and CDPR 2013, USGS 2011). The statewide map of aggregate availability shows the location of aggregate mines in Merced County; however, none are located in the vicinity of San Luis Reservoir. The general location of the mine(s) is southwest of Los Banos on the east side of Highway 5 (Kohler 2006). The California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOC, DOGGR) identified one dry hole well near the eastern edge of the O'Neill Forebay near the connection to the California Aqueduct. This well was abandoned in 1937 (California DOC, DOGGR 2010). There is one mine in the vicinity of San Luis Reservoir and three mines located near Los Banos SRA (California DOC, Office of Mine Reclamation 2012).

San Luis Reservoir is not located within 2 miles of a public or private land-based airport. However, the San Luis Reservoir Sea Plane Base, owned by the CDPR, allows water landings of planes on the reservoir. Approximately 25 aircraft operations per year take place at the reservoir. No overnight mooring of seaplanes is allowed and landing must be at least 500 feet from shore. Notices to Airmen (NOTAMs) are provided as needed from the seaplane base (Airport-Data 2017). The SRA is surrounded by wildlands and the potential for a wildfire in this area does exist which could affect neighboring urbanized areas of Santa Nella. Much of the area surrounding San Luis Reservoir SRA is designated within a moderate or high fire severity zone and is within the State Responsibility Area, which is protected by the California Department of Forestry and Fire Protection (CAL FIRE). Merced County Fire Department provides primary response services to urban fires in unincorporated Merced County Local Responsibility Areas (Merced County 2013). The closest school to San Luis Reservoir SRA is Romero Elementary School on West Luis Road in Santa Nella approximately 1.5 miles east of O'Neill Forebay (Gustine Unified School District [USD] 2013).

One active hazardous materials site was discovered within the San Luis Reservoir SRA consisting of soil and groundwater contamination from a leaking underground storage tank (LUST) containing gasoline. The status of the site is open and remediation of soil and groundwater occurred under the supervision of Merced County until September 2009. Central

Valley Regional Water Quality Control Board (RWQCB) has issued a request to California Department of General Services to continue with monitoring and the installation of additional monitoring wells to assess the extent of soil and groundwater contamination still present (Central Valley RWQCB 2016). Three open hazardous materials sites are within the vicinity of the San Luis Reservoir SRA. The Anderson's Pea Soup LUST cleanup site on SR 33 is contaminated with diesel and gasoline. The Anderson's Pea Soup site is open with a completed site assessment and interim remedial action. Santa Nella Parcel 41, formerly known as Central Valley Pipelines, is located on Santa Nella Road. Santa Nella Parcel 41 is open and currently under remediation for crude oil contamination. The Forebay Chevron site located on Gonzaga Road and is open with a completed site assessment. Emergency evacuation routes within the study area include I-5, SR 33, and SR 152.

Figure F-1 in Appendix F exhibits the road network surrounding the proposed construction sites in the San Luis Reservoir Area. Table 3-1 provides the existing (2016) operating conditions of highway segments located in the vicinity of the project site. Table 3-2 summarizes the daily traffic along the three local access routes. At a junction a highway segment is divided into upstream and downstream and will have two different annual average daily traffic volumes (AADT) values. For conservative purposes, the higher value was used for analysis.

Table 3-1. Existing Highway Operations – San Luis Reservoir Area

Highway	Junction	Jurisdiction	Lanes	Road Type	2016 AADT[1]	Highest LOS
I-5	SR 152	Merced County	4	Rural Freeway	32,000	B
US 101	SR 152 North Junction	Santa Clara County	6	Rural Freeway	110,000	B[2]
SR 152	SR 156 Junction	Santa Clara County	4	Rural Freeway	39,500	B[2]
SR 152	I-5	Merced County	4	Rural Freeway	30,700	B
SR 152	SR 33	Merced County	4	Rural Freeway	29,100	B
SR 33	I-5 West Junction	Merced County	2	Rural Non-Freeway Isolated Stops	14,200	F

AADT – Annual Average Daily Traffic Volumes, LOS – Level of Service
Notes: [1] Source: Caltrans 2016 ; [2] Source: VTA 2014

Table 3-2. Existing Local Roadway Operations – San Luis Reservoir Area

Parameter	Fifield Road/ Dinosaur Point Road	Basalt Road
Road Type	Rural Non-Freeway Isolated Stops	Rural Non-Freeway Isolated Stops
Number of Lanes	2	2
Average Maximum Daily Trips	137	191
Level of Service	B	B

Source: Reclamation and CDPR 2013

All work on Alternative 2 and Alternative 4 would occur at San Luis Reservoir in Merced County. Table 3-3 below presents the 2016 population and housing characteristics for the communities nearest to San Luis Reservoir that would be expected to supply local workers and provide housing for non-local workers.

Table 3-3. Population and Housing for Communities near San Luis Reservoir (Estimated 2012-2016)

Population and Housing	Los Banos	Newman	Gilroy	Gustine	Santa Nella	Total
2016 Population	37,012	10,808	52,576	5,684	1,965	**108,045**
Total Housing Units	11,272	3,403	15,802	2,129	630	**33,236**
Total Occupied	10,698	3,195	15,386	1,960	606	**31,845**
Total Vacant	574	208	416	169	24	**1,391**
Vacant: For Rent	199	164	96	0	0	**459**
Vacant: For Sale	53	0	43	0	6	**102**

Source: U.S. Census Bureau 2016a.

Demographic data from the 2016 American Community Survey 5-Year Estimates by the U.S. Census Bureau show that Merced County is considered a minority affected area, as the county exhibits a total minority proportion exceeding 50 percent; it is at 70.5 percent (U.S. Census Bureau 2016b). Economic data from the U.S. Census Bureau show that Merced County is not considered a low-income affected area. Merced County has a higher proportion of low-income residents than the State (21.4 percent); however, the county does not surpass the identified 24.6 percent poverty level threshold (U.S. Census Bureau 2016b). Identified census tracts within the San Luis Reservoir Region include the communities of Gustine, Ingomar and Volta (Census Tract 20); San Luis Reservoir SRA and Santa Nella (Census Tract 21); and Los Banos (Census Tracts 22.01, 22.02, 23.01, and 23.02). Demographic data show that all the census tracts have total minority proportions exceeding 50 percent, with the largest minority population located within Census Tract 22.02 at 81.5 percent (U.S. Census Bureau 2016a). Economic data identified Census Tract 22.01 as the only tract in the San Luis Reservoir region that is considered a low-income affected area (U.S. Census Bureau 2016c).

3.2 Sacramento-San Joaquin River Delta

San Luis Reservoir provides off-stream storage, with a majority of water supplied to the reservoir by Delta exports. Water quality in the Delta Region is governed in part by Delta hydrodynamics, which are highly complex. The principal factors affecting Delta hydrodynamic conditions are (1) river inflows from the San Joaquin and Sacramento River systems, (2) daily tidal inflows and outflows through the San Francisco Bay, and (3) export pumping from the south Delta through the Harvey O. Banks Pumping Plant (Banks Pumping Plant) and C.W. "Bill" Jones Pumping Plant (Jones Pumping Plant). These Delta hydrodynamic conditions are primarily measured using the parameters of the Sacramento River flow, Delta outflow, Delta inflow, low salinity zone, Old and Middle River flows, and Delta exports. Of these parameters, the transition area between saline waters and fresh water, frequently referred to as the low salinity zone[1] (LSZ), typically located within Suisun Bay and the western Delta and commonly associated with the position of the low salinity zone (X2), is directly controlled by the others—Delta inflow, Old and Middle River flows, and Delta exports. Given this connection, changes in the position of the LSZ and X2 can be used to characterize likely changes in the other parameters.

The existing water quality constituents of concern in the Delta can be categorized broadly as metals, pesticides, nutrient enrichment and associated eutrophication, constituents associated with suspended sediments and turbidity, salinity, bromide, and organic carbon. The relative concentrations of these constituents over time is closely related to the hydrodynamic conditions, including the position of X2, described above. Other physical parameters (including pH, temperature, and EC), monitored daily at Clifton Court Forebay (see Appendix D), can provide a demonstration of how change in these hydrodynamic conditions can affect water quality conditions in the Delta over time.

3.2.1 South-of-Delta CVP Contractors and Facilities

Reclamation operates the CVP, which diverts water from the Delta through Jones Pumping Plant at the southern end of the Delta and lifts the water into the DMC. This canal delivers water to CVP contractors and exchange contractors on the San Joaquin River and to water rights contractors on the Mendota Pool. The CVP water is also conveyed to the San Luis Reservoir for deliveries to CVP contractors through the San Luis Canal. Water from the San Luis Reservoir is also conveyed through the Pacheco Tunnel to CVP contractors in Santa Clara and San Benito Counties (Reclamation 2017).

The San Luis & Delta-Mendota Water Authority (SLDMWA) agencies hold contracts for approximately 3 million acre-feet (MAF) of CVP water annually. Approximately 2.5 MAF of the water is used to irrigate 1.2 million acres of agricultural lands in the Central Valley and Santa Clara and San Benito Counties, while 150,000 to 250,000 AF is used for M&I purposes and 250,000 to 300,000 AF is used for environmental purposes, including wildlife habitat management in the San Joaquin Valley (SLDMWA 2016).

The CVP has only delivered 100 percent of the contracted water to agricultural and M&I contractors in the SLDMWA service area four times since 1990, and the SWP has only delivered 100 percent of the contracted amount twice since 1990. Because of groundwater overdraft conditions throughout the SLDMWA region, groundwater supplies are declining. This has further reduced water supplies for the SLDMWA agencies. In 2014, only 45 percent of the maximum contract volume were delivered to South-of-Delta CVP contractors (Reclamation 2015), and in 2015, South-of-Delta CVP M&I allocations were 25 percent of the contract total (Reclamation 2016b). In 2016, South-of-Delta CVP M&I allocations increased to 55 percent of the contract total (Reclamation 2016b), in 2017 the allocation was 100% (Reclamation 2018a) and in 2018 the allocation was 50% (Reclamation 2019). The San Felipe Division of the CVP and SCVWD are discussed below in more detail.

[1] The LSZ is often referenced by X2, which is the distance upstream, in kilometers, from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand. X2 is largely determined by Delta outflow (Kimmerer 2004).

3.2.2 South-of-Delta SWP Contractors and Facilities

The DWR operates the SWP, which diverts water from the Delta through the Banks Pumping Plant into Bethany Reservoir. The California Aqueduct is 444 miles long and delivers water from Bethany Reservoir south to the Central Valley and Southern California. The California Aqueduct flows south 60 miles to O'Neill Forebay at San Luis Reservoir (DWR 2015). At O'Neill Forebay, the California Aqueduct becomes the San Luis Canal, which is managed jointly by Reclamation and DWR and serves both the CVP and the SWP. The San Luis Canal is Federally-built and extends 103 miles from O'Neil Forebay southeast to just past Kettleman City (Reclamation 2011a). At this point it becomes the California Aqueduct again, an SWP facility that delivers water over the Tehachapi Mountains to Southern California.

The SBA was constructed by the SWP in the 1960s to provide water to the south San Francisco Bay area in Alameda and Santa Clara Counties. The South Bay Pumping Plant lifts water 566 feet into the aqueduct (DWR 2001). Water then flows to a junction and a portion is pumped into Lake Del Valle. The SBA conveys water from the Delta through a combination of more than 40 miles of pipelines and canals to the SCVWD, among other water providers. Maximum Table A SWP allocations conveyed by the SBA includes the delivery of 80,000 AF to the Alameda County Flood Control and Water Conservation District (Zone 7), 42,000 AF to Alameda County Water District, and 100,000 AF to SCVWD (DWR 2016a). The SBA ends in a 160-foot diameter Santa Clara Terminal Tank in San Jose at the Penitencia WTP (DWR 2001).

The SWP delivers water to 29 public water agencies in Northern, Central and Southern California that hold long-term contracts for surface water deliveries. The agencies deliver water for both urban use and agricultural use, representing over 25 million municipal water users and 750,000 acres of irrigated farmland. Five of the agencies use the SWP water primarily for agricultural uses, and the remaining 24 use the SWP water primarily for municipal use. As noted above, Alameda County Flood Control and Water Conservation District (Zone 7), Alameda County Water District, and SCVWD all receive their SWP supplies through the SBA.

Water supplies for the agencies include imported SWP water, groundwater, local surface water, and, for some agencies, other imported supplies. The agencies collectively have received deliveries ranging from approximately 1.4 MAF in dry water years to approximately 4 MAF in wet years.

Similar to CVP South-of-Delta deliveries, SWP exports from the Delta, and the corresponding South-of-Delta deliveries have decreased over time. Implementation of the 2008 and 2009 U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Biological Opinions for the Long-Term Operations of the SWP and CVP resulted in substantial changes in South-of-Delta SWP deliveries. In the period between 2005 and 2013, average annual SWP exports have fallen by 12 percent (DWR 2015).

The affected environment for socioeconomics includes counties where CVP and SWP water service contractors could be affected by the SLLPIP alternatives. The CVP water service contractors have service areas in the San Joaquin Valley ranging from the Delta south to Kern County and in the Bay Area region. The SWP water service contractors have services areas in the Bay Area region, San Joaquin Valley region in Kern and Tulare Counties, and in Southern

California. Table 3-4 presents the regional economy for all counties potentially affected by the alternatives. Regional economic data are presented at a county level, with data from the U.S. Census Bureau and Impact Planning and Analysis (IMPLAN) 2014 data (see Appendix G for a description of IMPLAN). IMPLAN data files are compiled annually from a variety of sources, the U.S. Bureau of Economic Analysis, U.S. Bureau of Labor, and U.S. Census Bureau. Output represents the dollar value of industry production. Labor income is the dollar value of total payroll (including benefits) for each industry plus income received by self-employed individuals.

Table 3-4. Regional Economy by Region and County, 2014

County	Employment (Jobs)	Output (Million $)	Labor Income (Million $)
San Joaquin Valley Region Total	1,824,909	$302,817.6	$96,359.9
Fresno	470,293	$70,994.1	$23,897.1
Kern	415,280	$76,664.5	$23,899.8
Kings	58,269	$13,220.8	$3,627.1
Madera	63,301	$10,171.3	$3,314.8
Merced	101,718	$17,576.2	$5,405.6
San Joaquin	292,108	$45,653.5	$14,867.7
Stanislaus	230,322	$38,336.4	$11,847.3
Tulare	193,616	$30,201.0	$9,500.6
Bay Area Region	**2,830,602**	**$687,275.6**	**$242,696.9**
Alameda	965,630	$179,704.3	$67,638.5
Contra Costa	524,255	$135,972.5	$34,342.2
San Benito	23,672	$3,861.4	$1,124.3
Santa Clara	1,317,045	$367,737.4	$139,592.2
Southern California Region	12,823,418	$2,137,945.0	$757,102.0
Los Angeles	6,082,843	$1,052,751.2	$369,535.2
Orange	2,052,670	$366,579.0	$129,830.8
Riverside	926,353	$123,121.4	$41,561.5
San Bernardino	907,976	$130,158.4	$44,286.0
San Diego	1,981,064	$332,070.8	$124,801.5
San Luis Obispo	163,580	$22,968.6	$7,633.3
Santa Barbara	269,245	$39,491.2	$15,105.5
Ventura	439,686	$70,804.4	$24,348.4

Source: 2014 IMPLAN data; MIG 2016

3.3 San Felipe Division

The San Felipe Division of the CVP was authorized in 1960 and currently delivers water to agriculture and M&I users in Santa Clara County and the northern portion of San Benito County (Reclamation 2011a). The three agencies that make up the San Felipe Division are SCVWD, SBCWD, and Pajaro Valley Water Management Agency (PVWMA). Table 3-5 shows the CVP contract allocations for each of the San Felipe Division agencies. The PVWMA currently does not have a connection to the CVP system or San Luis Reservoir and is therefore not discussed further in this water supply section.

Table 3-5. Contract Allocations for the San Felipe Division

San Felipe Division Members	Contract Type		Source of CVP Water
	Agriculture (AF)	M&I (AF)	
SCVWD[1]	33,100	119,400	San Luis Reservoir
SBCWD	38,244	5,556	San Luis Reservoir
PVWMA[2]	6,260	0	None (See Note 2)

Source: Reclamation 2016c

AF = Acre-Feet

[1] The SCVWD CVP water is used throughout Santa Clara County.

[2] Currently, the PVWMA does not have a connection to the CVP system. However, the PVWMA plans to construct a connection in the future. PVWMA has a contract reservation for an additional 19,900 AF per year which is not under contract until provisions of the Central Valley Project Improvement Act are fulfilled

SCVWD and SBCWD receive water directly from San Luis Reservoir through the San Felipe Division facilities. Water for the San Felipe Division is released from San Luis Reservoir via two intakes on the west side of the reservoir. From the intakes, water flows west through the Pacheco Tunnel Reach 1 to the Pacheco Pumping Plant. At the plant, water is lifted to Reach 2 of the Pacheco Tunnel and conveyed through the Pacheco Conduit to the bifurcation of the Santa Clara and Hollister Conduits.

Water for SCVWD is delivered to the Coyote Pumping Plant via the Santa Clara Conduit, a tunnel that runs through the Diablo Mountains. From Coyote Pumping Plant, the water can be delivered to Anderson Reservoir, Calero Reservoir, groundwater recharge facilities, or the Rinconada and/or Santa Teresa WTPs.

Water from the Hollister Conduit serves San Benito County and extends from Pacheco Conduit to San Justo Reservoir. San Justo Reservoir, located three miles southwest of the City of Hollister, has a total storage capacity of 9,785 AF (Reclamation 2011b). The reservoir regulates San Benito County’s imported water supplies, provides for pressure deliveries to some agricultural lands in the service area, and provides storage for peaking of agricultural water (USFWS 2008). SCVWD operates all San Felipe Division facilities with the exception of the Hollister Conduit and San Justo Reservoir, which are operated by SBCWD.

3.4 Santa Clara Valley Water District/Santa Clara County

The SCVWD service area has several water supply sources, including imported water (CVP and SWP), water from the San Francisco Public Utilities Commission, natural groundwater, local surface water, recycled water, and surface water rights held by San Jose Water Company and Stanford University (SCVWD 2015). Table 3-6 shows a breakdown of the SCVWD water supply sources for 2015.

Table 3-6. SCVWD 2015 Water Supply

Source	Percent
Natural Groundwater Recharge	15%
Local Surface Water	17%
Recycled Water	8%
San Francisco Public Utilities Commission	16%
CVP and SWP Allocations	23%
Carryover, Transfer, and Semitropic Takes	21%

Source: SCVWD 2015

SCVWD receives imported water from the CVP through San Luis Reservoir and Pacheco Conduit, and from the SWP through the SBA. SCVWD has a maximum Table A contract for 100 TAF per year of water from the SWP, although deliveries vary depending on hydrological conditions, environmental regulations, and conveyance limitations. Almost all of this supply is used to meet M&I needs (SCVWD 2010). SCVWD's CVP contract is for a maximum of 152.5 TAF per year, with 119.4 TAF for M&I and 33.1 TAF for agricultural irrigation. The actual amount SCVWD receives from the CVP is generally less than the contractual amount because of climate conditions, environmental regulations, and conveyance limitations.

In Santa Clara County, additional water sources not under the jurisdiction of SCVWD are available, and their use helps to reduce reliance on SCVWD supplies. Several municipalities in Santa Clara County have agreements with the City and County of San Francisco for water from the Hetch Hetchy system. The San Jose Water Company and Stanford University have surface water rights of approximately 11,000 AF per year that they exercise to meet their demands (SCVWD 2015). Approximately 20 TAF of recycled water is currently used from four publicly-owned wastewater treatment plants in Santa Clara County (SCVWD 2015).

SCVWD manages water resources and sells treated water wholesale to retailers in Santa Clara County. SCVWD's infrastructure for water supply includes conveyance facilities, reservoirs, groundwater extraction wells, groundwater recharge basins, and WTPs. About half of the water used in Santa Clara County is pumped from the groundwater subbasins. SCVWD uses local and imported surface water to supplement natural recharge. Raw water is treated at three SCVWD WTPs (Santa Teresa, Penitencia, and Rinconada) and then distributed, or used for groundwater recharge, providing a significant portion of the potable water used within the service area serving the greater San Jose metropolitan region. Santa Teresa WTP in San Jose would be affected by Alternative 3. The Santa Teresa WTP primarily treats Federal (or CVP) water from San Luis Reservoir and other local reservoirs and serves the eastern and central regions of the SCVWD service area. Ten reservoirs managed by SCVWD capture local runoff and store it for groundwater recharge, irrigation, or drinking water treatment (SCVWD 2015). The total storage capacity of all ten reservoirs is approximately 170 TAF; however, this capacity has been restricted to approximately 113 TAF due to SOD interim operating restrictions (SCVWD 2010). With the exception of Anderson Reservoir, the local reservoirs were constructed for annual operations, storing water in the winter and releasing that water in the summer and fall for groundwater recharge. Santa Clara County includes five watersheds. Santa Teresa WTP is located in the Guadalupe watershed (SCVWD 2016).

PG&E provides natural gas and power service to Santa Clara County. SCVWD receives power from the Power and Water Resource Pooling Authority (PWRPA), a California Joint Powers Authority that consists of 15 water purveyors. Power is delivered through PG&E facilities. Numerous landfills exist within the SCVWD service area. In Santa Clara County, there are at least five solid waste landfills.

The major urban areas within Santa Clara County have numerous stormwater runoff collection and discharge facilities. Also, non-point source pollution management plans are established in Santa Clara County to minimize environmental impacts from stormwater runoff to San Francisco Bay and other local waters (Santa Clara County 1994a). Flood control structures are in place to minimize flooding during major storm events. As described in the Santa Clara County General Plan Draft EIR, approximately 20 percent of the valley floor is flood-prone (Santa Clara County 1994b). Most areas with flooding potential are located on the main valley floor and in the baylands, especially along the Guadalupe and Coyote Creeks. The area around Santa Teresa WTP is designated on FEMA's current FIRMs as within Flood Zone D, defined as possible but undetermined flood risk.

The northern and western areas of Santa Clara County are urban, with San Jose as the largest city. The eastern and southern portions of Santa Clara County are rural and designated as Ranchlands, Other Public Open Lands, and Regional Parks, with the exception of the lands immediately surrounding and in the cities of Morgan Hill and Gilroy (Santa Clara County 2013). Appendix H includes land use maps of these areas. Santa Teresa WTP is located on land designated as open space. There is no land surrounding the WTP designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance or land enrolled in Williamson Act contracts.

At Santa Teresa WTP, the estimated noise level is a L_{dn} of 55 dBA. This is based on noise monitoring data in the *Envision San Jose 2040 General Plan Comprehensive Update Environmental Noise Assessment* (Illingworth & Rodkin, Inc. 2010). At the closest monitored location to the water treatment plant, a L_{dn} of 56 dBA was measured 110 feet from the nearest lane of the Almaden Expressway. Santa Teresa WTP is located in an open space area adjacent to a residential neighborhood.

The existing Santa Teresa WTP is boarded by Greystone Lane and the Santa Teresa hills in the City of San Jose. The environmental setting of the existing WTP is primarily built. Utilizing the USDA SMS to classify the visual resources, Santa Teresa WTP and the surrounding area are Class C resources.

In the vicinity of the Santa Teresa WTP, soils are defined as having a surface texture of clay and sandy loam (USDA, NRCS 2016a). The clay soils have low erodibility while the sandy loam soils have a high erodibility (USDA, NRCS 2016b). In addition, clay soils have a high shrink-swell potential while the sandy loam soils have a low shrink-swell potential (USDA, NRCS 2016c). There are no areas prone to landslides near the construction site under Alternative 3 (Santa Clara County 2006).

There are two schools, San Jose Chinese School and Leland High School, located within one-quarter of a mile of existing and proposed WTP facilities where hazardous materials could be used during construction or operation of the new or expanded facilities. There are no active or hazardous materials sites under evaluation in the vicinity of the Santa Teresa WTP. The City of San Jose does not specifically designate evacuation routes (City of San Jose 2011). For the purpose of this study, it is assumed that all freeways, State highways, arterials, and major city roads would be used for an evacuation if needed.

Table 3-7 presents the 2016 population and housing characteristics for San Jose. Because of its large population, it is assumed that under Alternative 3 most of the local workers would come from San Jose and the non-local workers would likely find accommodations in San Jose.

Table 3-7. Population and Housing for San Jose near the Santa Teresa Water Treatment Plant (Estimated 2012-2016)

Population and Housing	San Jose
2014 Population	1,009,363
Total Housing Units	328,185
Total Occupied	317,317
Total Vacant	10,868
Vacant: For Rent	7,548
Vacant: For Sale	1,641

Demographic data show that Santa Clara County is considered a minority affected area, as the county exhibits a total minority proportion exceeding 50 percent, at 66.8 percent (U.S. Census Bureau 2016b). Economic data show that Santa Clara County has a lower proportion of low-income residents, lower than that for the State (6.2 percent), and is not considered a low-income affected area (U.S. Census Bureau 2016c).

Figure F-2 in Appendix F identifies the roads that would provide access to and from the construction site at the Santa Teresa WTP. Table 3-8 provides a summary of existing (2016) operating conditions of highway segments located in the SCVWD service area. The local area roads throughout the SCVWD's service area are identified in Table 3-9.

Table 3-8. Existing Highway Operations – Santa Clara Valley Water District Service Area

Highway	Junction	Lanes	Road Type	Capacity[1] (vph)	2016 AADT[2]	2016 Maximum Density[3]	2016 Average Speed[3]	2016 LOS[3]
I-280	SR 17/I-880	8	Urban Freeway	18,400	205,000	114	10	F
SR 87	I-280	6	Urban Freeway	13,800	169,000	93	16	F
SR 85	SR 17	6	Urban Freeway	13,800	128,000	122	9	F

AADT – Annual Average Daily Traffic Volumes, LOS – Level of Service, vph – Vehicles per hour

Notes: [1]Based on the guidelines provided in the Transportation Impact Analysis Guidelines, VTA, CMP, October 2014.

[2] Source: Caltrans 2016.

[3] Source: Santa Clara County 2016. Reported the worst of the a.m. or p.m. LOS level for the mixed-use lanes. The source document reports a.m. values for 2016 and p.m. values for 2014.

Table 3-9. Local Roadways – Santa Clara Valley Water District Service Area

Road Type[1]	Name	Number of Lanes	Provides Access to
Suburban Non-Freeway	Almaden Expressway	6	Santa Teresa WTP
Suburban Non-Freeway	Camden Avenue	4	Guadalupe Sanitary Landfill, Santa Teresa WTP
Suburban Collector	Guadalupe Mines Road	2	Guadalupe Sanitary Landfill
Suburban Collector	Graystone Lane	2	Santa Teresa WTP
Suburban Collector	Carriage Hill Drive	2	Santa Teresa WTP
Suburban Collector	Rosalind Lane	2	Santa Teresa WTP

[1] Road Type is assigned based on description of road and number of lanes.

The Santa Teresa WTP is located within Census Tract 5119.11 in the City of San Jose (see Figure I-2 in Appendix I). Demographic data show that Census Tract 5119.11 has a total minority proportion of 41.3 percent, below 50 percent, and is not considered a minority affected area (U.S. Census Bureau 2016b). Economic data indicate that the Santa Teresa WTP census tract has a median and per capita income above both the State and county averages and does not fall below the U.S. Census Bureau's defined poverty thresholds, and it is not considered a low-income affected area (U.S. Census Bureau 2016c).

3.5 Pacheco Reservoir

Pacheco Reservoir is located on the North Fork of Pacheco Creek and was established in 1939 through construction of the North Fork Dam. This existing earthen dam is owned and operated by Pacheco Pass Water District (PPWD). Water released from the Reservoir flows down Pacheco Creek and seeps through the creek bed and into the underlying groundwater aquifer as it winds towards its confluence with the Pajaro River. The released flow is controlled to fully infiltrate into a groundwater aquifer that begins at the northern tip in Santa Clara County and extends southwards into San Benito County. Agricultural users in PPWD and SBCWD’s service areas pump water from the aquifer.

The design capacity of Pacheco Reservoir is 6,000 AF, with an operational capacity of 5,500 AF. The earthen dam is 100 feet tall and collects rainfall from a 75-square-mile watershed. Since the 1940s, the facility has undergone multiple repairs to its spillway. North Fork Dam is currently under restricted-operation criteria through an April 5, 2017 order of DWR’s Division of Safety of Dams (DSOD) due to existing spillway deficiencies. The PPWD is coordinating with FEMA and DSOD on short-term and long-term repairs. The DSOD has stated that if satisfactory progress is not made to address spillway deficiencies, additional remedies would be invoked, inclusive of revocation of the PPWD’s Certificate of Approval to store water.

Pacheco Reservoir is situated on the North Fork of Pacheco Creek, a tributary of the Pajaro River (see Chapter 2, Figure 2-6). Water released from Pacheco Reservoir flows into the North Fork Pacheco Creek and joins the South Fork Pacheco Creek, just upstream from SR 152 to flow downstream as Pacheco Creek. East of the City of Gilroy, San Felipe Lake, a natural lake, is formed by the confluence of Pacheco Creek, Tequisquita Slough and Ortega Creek. The lake drains through two man-made outlet channels that join to form Miller Canal, which was completed in 1874 to facilitate agricultural development. Miller Canal joins the Pajaro River southwest of San Felipe Lake. The Pajaro River then flows southwest until it drains into Monterey Bay.

Pacheco Creek is designated on the 303(d) List for DO and turbidity impairment. Potential sources of the impairment are listed as unknown. Rearing and migratory habitat for South-Central California Coast steelhead in Pacheco Creek downstream of the dam is almost completely dependent upon releases from Pacheco Reservoir. The reservoir may not fill completely in dry years, leading to inadequate flow releases to the North Fork of Pacheco Creek in spring and summer months to provide suitable habitat for rearing steelhead downstream. Even in wet years, flow releases can be inadequate to support steelhead rearing in Pacheco Creek by mid-summer.

No established facilities exist at Pacheco Reservoir that require wastewater service. Residents in the area of the reservoir rely on septic systems for wastewater needs. There is no established stormwater infrastructure at the reservoir. Stormwater is captured in Pacheco Reservoir and then released downstream in Pacheco Creek and it is not collected by any established drains or collectors. The South Valley Recology facility in Gilroy has the capacity to accept Class A debris (such as construction debris). Some debris may be brought to the John Smith Landfill in Hollister. Gas and electricity service in the area is provided by PG&E.

Pacheco Reservoir area is within Zones A and D (FEMA 2018). Areas susceptible to flooding include low-lying areas along Pacheco Creek and around Pacheco Reservoir. Pacheco Dam failure inundation mapping is presented in the Santa Clara County General Plan Book B (Santa Clara County 1994a). The dam failure inundation area is primarily along Pacheco Creek toward its confluence with the Pajaro River and into the northern section of San Benito County. Historically, flooding downstream of the dam occurs during major storm events along portions of SR 152, agricultural land, and rural residential properties within the Pacheco Creek floodplain. If the dam were to fail, it would likely inundate these same areas. Currently, the North Fork Dam is operating under restricted operations due to spillway deficiencies.

The land surrounding Pacheco Reservoir is privately owned and is rural, primarily used for livestock grazing, designated by the Santa Clara County General Plan as ranchlands (Santa Clara County 1994a). Two single-family residences are located 1 mile south of the existing North Fork Dam. There is no land surrounding Pacheco Reservoir designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance. Several parcel of grazing land surrounding Pacheco Reservoir are enrolled in ongoing Williamson Act contracts.

The Henry W. Coe SP boundary is located less than 0.5 mile from the reservoir. At 87,000 acres, Henry W. Coe SP is the largest state park in Northern California. Recreational uses in the park include hiking, backpacking, camping, mountain biking, fishing, and horseback riding. The state park is open year-round for hikers, mountain bikers, backpackers, equestrians, campers, and picnickers.

At Pacheco Reservoir, the estimated noise level is L_{dn} of 40 dBA. This is based on the *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (USEPA 1974). The following are the sensitive receptors closest to Pacheco Reservoir: a residence on El Toro Road, a residence on Dinosaur Point Road, and a produce stand along SR 152.

Pacheco Reservoir is located within the Diablo Range portion of the Coast Ranges Geomorphic Province. Soils in the vicinity are defined as having surface texture of loam and gravelly loam (USDA, NRCS 2018). The loam and gravelly loam soils have a low to moderate erodibility and have a low shrink-swell potential (USDA, NRCS 2018). There are no areas prone to landslides near the construction site for Alternative 5 (Santa Clara County 2006). There are no wells or mines in the vicinity of Pacheco Reservoir.

Utilizing the USDA SMS to classify the visual resources, the area surrounding Pacheco Reservoir is rural, pastoral landscape of open space (Class B and C resources). Current views of the reservoir and dam are limited to the few private properties surrounding the reservoir. No views of the reservoir exist from any scenic overlooks, trails, or roads within Henry W. Coe SP.

Much of the area surrounding Pacheco Reservoir and Pacheco Creek is designated within moderate to high fire severity zones, and these areas are within the State Responsibility Area, which is protected by CAL FIRE (CAL FIRE 2007). Emergency evacuation routes within the Pacheco Reservoir area include SR 152, County and private roads. There are no active or hazardous materials sites, schools, or airports within 5 miles of Pacheco Reservoir.

Pacheco Reservoir is located within Census Tract 5153 in unincorporated Santa Clara County (see Figure I-3 in Appendix I). Census Tract 5153 has a minority proportion of 43.7 percent, below 50 percent, and is not considered a minority affected area (U.S. Census Bureau 2016b). Economic data indicate that the Pacheco Reservoir census tracts have median and per capita incomes above both the State and county averages, do not fall below the U.S. Census Bureau's defined poverty thresholds, and are not considered low-income affected area (U.S. Census Bureau 2016c). All work on Alternative 5 would occur at Pacheco Reservoir in Santa Clara County. Table 3-10 below presents the 2016 population and housing characteristics for the communities nearest to Pacheco Reservoir that would be expected to supply local workers and provide housing for non-local workers.

Table 3-10. Population and Housing for Communities near Pacheco Reservoir (Estimated 2012–2016)

Population and Housing	Hollister	Los Banos	Gilroy	Santa Nella	Total
2016 Population	36,901	37,012	52,576	1,965	128,454
Total Housing Units	10,669	11,272	15,802	630	38,373
Total Occupied	10,386	10,698	15,386	606	37,076
Total Vacant	283	574	416	24	1,297
Vacant: For Rent	67	199	96	0	362
Vacant: For Sale	11	53	43	6	113

Source: U.S. Census Bureau 2016a.

SR 152 would provide access to and from the construction site at Pacheco Reservoir. The Transportation Element of the Santa Clara County General Plan (Santa Clara County 1994a) describes SR 152 as a busy highway and one of the scenic gateways in Santa Clara County. SR 152 is built to rural standards, with direct at-grade access to the highway, allowing for cross roads at various locations. Vehicles would access Pacheco Reservoir via the existing access road adjacent to SR 152.

3.6 Groundwater Basins

The South-of-Delta CVP contractor service area includes the San Joaquin Valley Groundwater Basin. Table 3-11 summarizes the key groundwater characteristics in the CVP contractor service area. The South-of-Delta SWP contractor service area includes 14 groundwater basins. Table 3-12 lists the groundwater basins and summarizes the key groundwater characteristics in the SWP Contractor Service areas. See Appendix J for detailed discussion of the groundwater basins.

There are no mapped groundwater basins underlying San Luis Reservoir or Pacheco Reservoir areas (DWR 2016b), but the San Joaquin Valley Groundwater Basin (Delta-Mendota subbasin) underlies O'Neill Forebay (see Table 3-11). Though there would be minimal to no direct recharge under the Pacheco Reservoir, the reservoir is currently operated for groundwater recharge through releases to Pacheco Creek. Pacheco Creek flows through the Gilroy-Hollister groundwater subbasin (see Table 3-12).

Table 3-11. CVP Groundwater Basins and Key Characteristics

Groundwater Basin/Subbasin	CASGEM Prioritization	Issues of Concern in the basin
San Joaquin Valley Groundwater basin (Tracy subbasin)	Medium Priority	Degraded water quality throughout the subbasin (DWR 2014a) Subbasin has high potential for subsidence (DWR 2014b) NASA's InSAR study has recorded up to 2 feet of subsidence in portions of the San Joaquin Valley for the period between May 2015 through September 2016 (Farr et al. 2016)
San Joaquin Valley Groundwater basin (Delta-Mendota subbasin)	High Priority	Overdraft concerns in the subbasin (DWR 2014a) Subbasin has high potential for subsidence (DWR 2014b) NASA's InSAR study has recorded up to 2 feet of subsidence in portions of the San Joaquin Valley for the period between May 2015 through September 2016 (Farr et al. 2016)
San Joaquin Valley Groundwater basin (Westside subbasin)	High Priority	Overdraft, land subsidence and water quality concerns in the subbasin including saline conditions, very high TDS and pesticide contamination in portions of the subbasin (DWR 2014a). Subbasin has high potential for subsidence (DWR 2014b) NASA's InSAR study has recorded up to 2 feet of subsidence in portions of the San Joaquin Valley for the period between May 2015 through September 2016 (Farr et al. 2016).

Sources: DWR 2014a, DWR 2014b, Farr et al. 2016

Table 3-12. SWP Groundwater Basins and Key Characteristics

Groundwater Basin/Subbasin	CASGEM Prioritization	Issues of Concern in the basin
Santa Clara Valley Groundwater Basin (Santa Clara subbasin)[1]	Medium Priority	Water Quality concerns in the subbasin with elevated mineral levels in portions of the northern subbasin and elevated nitrate in portions of the southern subbasin (DWR 2014a and Santa Clara Valley WD 2017). Santa Clara Valley Water District manages its groundwater use to avoid subsidence and has established subsidence thresholds equal to the current acceptable rate of 0.01 feet per year (Santa Clara Valley WD 2012)
Gilroy-Hollister Groundwater Basin (Llagas Subbasin)[1]	High Priority	Water Quality concerns in the subbasin with elevated Nitrate levels. Perchlorate is also a problem in portions of the subbasin (San Clara Valley WD 2017). Subbasin has high potential for subsidence (DWR 2014b)
Fremont Valley Groundwater Basin	Low Priority	Basin has naturally high TDS and other constituents like fluoride and sodium (DWR 2014a) Subbasin has medium to high potential for subsidence (DWR 2014b) and CGPS station within the subbasin have recorded up to 0.02 feet of subsidence since 2005 (DWR 2016b).
Antelope Valley Groundwater Basin	High Priority	Basin is undergoing groundwater overuse and has groundwater quality concerns. Subbasin has high potential for subsidence (DWR 2014) and CGPS station within the subbasin have recorded up to 0.03 feet of subsidence since 2005 (DWR 2016b)
Ames Valley Groundwater Basin	Very Low Priority	Groundwater in the subbasin has locally occurring high TDS, fluoride and chloride levels (DWR 2014a).
Copper Mountain Valley Groundwater Basin	Very Low Priority	Groundwater in the subbasin has locally occurring high TDS levels (DWR 2014a).
Warren Valley Groundwater Basin	Medium priority	Adjudicated since 1977 and is managed by Warren Valley Basin Watermaster
Coachella Valley Groundwater Basin (Indio, San Gorgonio and Mission Creek subbasins)	Medium priority (Indio, San Gorgonio and Mission Creek subbasins)	Groundwater Quality concerns including high nitrate levels, salts due to use of imported Colorado River water for irrigation within subbasins (DWR 2014a) San Gorgonio subbasin has overdraft concerns (DWR 2014a)
Northwest Metropolitan Area Groundwater Basins (Oxnard Plain, Oxnard Forebay, Pleasant Valley, Santa Rosa and West, East and South Los Posas subbasins)	High Priority (Oxnard Plain, Oxnard Forebay, and Pleasant Valley subbasins) Medium Priority (Santa Rosa subbasin)	Saline intrusion, nitrates, pesticides, and PCBs have impacted some water wells in the Oxnard Plain and Oxnard Forebay subbasins (DWR 2014a). Pleasant Valley subbasin has discharge of poor-quality groundwater from dewatering wells and effluent discharge from the wastewater treatment facility into the Arroyo Simi have led to rising water levels in the basin along with higher TDS and Chloride levels (DWR 2014a).
San Fernando Valley Groundwater Basin	Medium priority	Basin has been adjudicated since 1979.
San Gabriel Valley Groundwater Basin	High priority	Basin has been adjudicated since 1971.

Groundwater Basin/Subbasin	CASGEM Prioritization	Issues of Concern in the basin
Coastal Plains of Los Angeles Groundwater Basin (Santa Monica, Hollywood, West Coast, and Central subbasins)	Medium priority (Santa Monica and West Coast subbasins) High Priority (Central subbasins)	Central and west coast basins have been adjudicated since 1965 and 1961 respectively.
Coastal Plains of Orange County Groundwater Basin	Medium priority	Basin has noticed saline water intrusion issues (DWR 2014a). Basin is prioritized as having high potential for subsidence (DWR 2014b)
Upper Santa Ana Valley Groundwater Basin	High priority	High nitrates, salinity, and TDS (DWR 2014a) Water quality degradation issues known in several public supply wells (DWR 2014a).

Notes: [1] SCVWD manages these groundwater basins. SCVWD is a SWP and CVP contractor.
Sources: DWR 2014a, DWR 2014b, SCVWD 2012, SCVWD 2017

3.7 Air Quality and Greenhouse Gases

3.7.1 Air Quality

San Luis Reservoir is located in Merced County, which is within the San Joaquin Valley Air Basin (SJVAB). The Valley is bordered on the west by the Coast Ranges, on the east by the Sierra Nevada Mountains and on the south by the Tehachapi Mountains. The region is highly susceptible to pollutant accumulation over time because of the mountains that surround the valley. Marine air flows toward the east through gaps in the Coast Range at the Golden Gate Strait and Carquinez Strait.

Low wind speeds contribute to high concentrations of air pollutants in the winter time. During the summer, winds typically originate from the north end of the basin and flow in a south-southeast direction though the valley. These conditions contribute to persistent summer inversions that prevent the vertical dispersion of air pollutants. Summertime inversions occur when a layer of cool, marine air is trapped below a mass of warmer air above.

The Federal Clean Air Act requires States to classify air basins (or portions thereof) as either attainment or nonattainment with respect to criteria air pollutants, based on whether the National Ambient Air Quality Standards (NAAQS) have been achieved, and to prepare air quality plans containing emission reduction strategies for those areas designated as nonattainment. Table 3-13 shows the attainment status for the SJVAB.

While Pacheco Reservoir is located in Santa Clara County, it is located near San Luis Reservoir (Merced County) and so the air quality in the region of Pacheco Reservoir is assumed to be similar to that described for Merced County.

Table 3-13. Attainment Status for SJVAB (Merced County)

Pollutant	National Standards [1,2,3]	California Standards [1,2]
Ozone (O_3)	Nonattainment, extreme [4]	Nonattainment
Carbon monoxide (CO)	Attainment	Unclassified
Nitrogen dioxide (NO_2)	Attainment	Attainment
Sulfur dioxide (SO_2)	Attainment	Attainment
Inhalable Particulate Matter (PM_{10})	Maintenance	Nonattainment
Fine Particulate Matter ($PM_{2.5}$)	Nonattainment [5]	Nonattainment
Lead (Pb)	Attainment	Attainment

Source: California Air Resources Board (CARB) 2017; USEPA 2018a; 40 CFR 81.305.

Notes:

[1] Nonattainment means that the area does not meet the ambient air quality standard for that pollutant.

[2] Attainment means that the area meets the ambient air quality standard for that pollutant.

[3] Maintenance means that the area has recently met the standard and must continue to provide USEPA with information showing that it is maintaining the standard before the area can qualify for redesignation as attainment.

[4] The San Joaquin Valley, which includes Merced County, was designated as a nonattainment area for the 2015 O_3 NAAQS on August 3, 2018 (83 FR 25776).

[5] Classified as moderate nonattainment for the 2012 annual primary NAAQS and serious nonattainment for the 2006 24-hour NAAQS.

Santa Teresa WTP is located in Santa Clara County, which is in the San Francisco Bay Area Air Basin (SFBAAB). The basin is mostly covered on the east and south by the Diablo Range, on the west by the Pacific Ocean, and on the north by the Coast Ranges. The basin is characterized by complex terrain consisting of inland valleys, coastal mountain ranges, and the San Francisco Bay.

The basin's climate is mostly determined by a high pressure system regularly present over the eastern Pacific Ocean off the West Coast. This high pressure system shifts to the south during the winter, allowing storms to pass through the region. During the summer, abundant sunshine and the region's topography and subsidence inversion create conditions that favor the formation of pollutants such as ozone. Table 3-14 shows the attainment status for the SFBAAB.

Sensitive receptors are segments of the population susceptible to poor air quality—children, elderly, and people with pre-existing health problems. Examples of sensitive receptors include residences, schools and school yards, parks and playgrounds, daycare centers, nursing homes, and medical facilities. Table 3-15 summarizes the health effects associated with criteria air pollutants. The USEPA set the NAAQS and the air districts set CEQA significance thresholds to reduce these health risks to acceptable levels. See Appendix E1 for more information on sensitive receptors in the study area.

Table 3-14. Attainment Status for SFBAAB

Pollutant	National Standards [1,2,3]	California Standards [1,2]
Ozone (O_3)	Nonattainment, marginal [4]	Nonattainment
Carbon monoxide (CO)	Maintenance	Attainment
Nitrogen dioxide (NO_2)	Attainment	Attainment
Sulfur dioxide (SO_2)	Attainment	Attainment
Inhalable Particulate Matter (PM_{10})	Attainment	Nonattainment
Fine Particulate Matter ($PM_{2.5}$)	Nonattainment [5]	Nonattainment
Lead (Pb)	Attainment	Attainment

Source: CARB 2017; USEPA 2018a; 40 CFR 81.305.

Notes:

[1] Nonattainment means that the area does not meet the ambient air quality standard for that pollutant.

[2] Attainment means that the area meets the ambient air quality standard for that pollutant.

[3] Maintenance means that the area has recently met the standard and must continue to provide USEPA with information showing that it is maintaining the standard before the area can qualify for redesignation as attainment.

[4] The San Francisco Bay Area, which includes Santa Clara County, was designated as a nonattainment area for the 2015 O_3 NAAQS on August 3, 2018 (83 FR 25776).

[5] Classified as moderate nonattainment for the 2006 24-hour NAAQS.

Table 3-15. Criteria Pollutants and Their Effects on Health

Pollutant	Characteristics	Health Effects	Major Sources
O_3	A highly reactive photochemical pollutant created by the action of sunshine on O_3 precursors	• Cough, chest tightness pain upon taking a deep breath • Worsening of wheezing and other asthma symptoms • Reduced lung function • Increased hospitalizations for respiratory causes	Pollutants emitted from vehicles, factories, and other industrial sources, fossil fuels combustion, consumer products, and evaporation of paints.
NO_2	Reactive, oxidizing gas formed during combustion	• Respiratory symptoms • Episodes of respiratory illness • Impaired lung function	High temperature combustion processes, such as those occurring in trucks, cars, and power plants
SO_2	Colorless gas with a pungent odor	• Wheezing, shortness of breath, and chest tightness • Pulmonary symptoms and disease • Decreased pulmonary function • Increased risk of mortality	Sulfur-containing fuel burned by locomotives, ships, and off-road diesel equipment or industrial sources like petroleum refining and metal processing
CO	Odorless, colorless gas that is highly toxic. Formed by the incomplete combustion of fuels	• Impairment of oxygen transport in the bloodstream • Aggravation of cardiovascular disease • Fatigue, headache, dizziness	Carbon-containing fuels like gasoline or wood

Pollutant	Characteristics	Health Effects	Major Sources
PM_{10} and $PM_{2.5}$	Small particles that measure 10 microns or less are term PM_{10} (fine particles less than 2.5 microns are $PM_{2.5}$). Solid and liquid particles of dust, soot, aerosols, smoke, ash, and pollen and other matter that is small enough to remain suspended in the air for a long period.	• Increased risk of hospitalization for lung and heart-related respiratory illness • Increased risk of premature deaths • Reduced lung function • Increased respiratory symptoms and illness	Burning fuels like gasoline, oil, diesel or wood ($PM_{2.5}$) and windblown dust (PM_{10}).
Pb	Soft and resilient metal	• Impaired blood formation and nerve conduction • Fatigue, anxiety, short-term memory loss, depression, weakness in extremities, and learning disabilities in children • Cancer	Various industrial activities

3.7.2 Greenhouse Gas Emissions

Greenhouse gases (GHGs) – carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons – are emitted from human activities and natural systems into the atmosphere and trap heat that would otherwise be released into space. Thermal radiation absorbed by the GHGs is re-radiated in all directions, including back toward the surface of the earth. This results in an increase of Earth’s surface temperatures above what they would be without the presence of the GHGs, which are persistent and remain in the atmosphere for long periods of time. GHGs differ from criteria pollutants in that GHG emissions do not cause direct adverse human health effects. Rather, the direct environmental effect of GHG emissions is the increase in global temperatures, which in turn has numerous indirect effects on the environment and humans.

Scientific research shows that global GHG emissions from human activities have grown since pre-industrial times, with an increase of 78 percent between 1970 and 2010 (Intergovernmental Panel on Climate Change 2014). Atmospheric concentrations of carbon dioxide equivalent (CO2e) reached 405.5 parts per million (ppm) in 2017, up from 403.3 ppm in 2016 and 400.1 ppm in 2015, far exceeding the natural range over the last 800,000 years, as measured in ice core samples (American Meteorological Society 2017). A majority of anthropogenic CO2 emissions is attributed to the burning of fossil fuels electricity, heat, and transportation and land use changes, such as deforestation (USEPA 2018b).

If left unchecked, by the end of the century CO2 concentrations could reach levels three times higher than pre-industrial times, leading to climate change that threatens the public health, economy, and environment. Efforts are underway globally to both mitigate GHG emissions to reduce further climate change as well as to adapt to the unavoidable changes in climate that will result from past and future GHG emissions that have already been emitted. However, recent studies show that global GHG emissions continue to rise (Melillo 2014).

3.8 Cultural Resources in Study Area

The cultural resources area of analysis is centered on the area of potential effects (APE) for each alternative considered in this EIS/EIR. The APE encompasses all areas in which cultural resources may be directly or indirectly impacted by project activities. The cultural resources area of analysis also includes a buffer surrounding the APE for each alternative. The APE for the four action alternatives is as follows: (1) the Alternative 2 APE, which encompasses a proposed aeration facility, the Basalt Use Area, the Dinosaur Point Use Area, Dinosaur Point Road, an intake or dredging area surrounding the proposed pipeline or tunnel, and Gate Shaft Island (2,087 acres); (2) the Alternative 3 APE, which includes the full extents of the existing Santa Teresa WTP (11.8 acres); (3) the Alternative 4 APE, which spans the Basalt Hill borrow area and Borrow Area 6, the Cottonwood Bay levee modification and levee raise areas, the Dinosaur Point boat launch modification area, downstream fill impact areas, haul road and Highway 152 impact areas, potential construction staging areas, and the San Luis Reservoir shoreline (4,483 acres); and (4) the Alternative 5 APE, which includes the existing North Fork Dam, a proposed dam and reservoir, new pipelines and tunnels, inlet/outlet facilities, a pump station, borrow areas, temporary haul roads, and a new transmission line (2,269 acres). Buffers centered on the APE for each alternative include a generalized 0.5-mile radius for Alternative 2, a 300-foot radius for Alternative 3, and a 0.5-mile radius for Alternatives 4 and 5.

Reclamation serves as the Federal Lead Agency for the SLLPIP under NEPA, and SCVWD serves as the State Lead Agency under CEQA. Federal laws, policies, and regulations applicable to the project include NEPA, the National Historic Preservation Act (NHPA), the Native American Graves Protection and Repatriation Act (NAGPRA), and regulations published by the Advisory Council on Historic Preservation (ACHP) and the National Park Service (NPS). Relevant State laws, policies, and regulations include CEQA and California Office of Historic Preservation (OHP) guidelines. Regional or local policies and regulations may be found in the effected county general plans. All of these laws, policies, and regulations are described more fully in Appendix C.

Information on cultural resources within the area of analysis for each action alternative was collected through archival and record searches; an examination of current literature; cultural resource inventory surveys; and an analysis of buried cultural resource sensitivity. This information is detailed fully in the Project technical report (Pacific Legacy 2018) attached as Appendix K.

Indian Trust Assets (ITAs) are defined as legal interests in property held in trust by the United States government for Indian tribes or individuals, or property protected under United States (U.S.) law for Indian tribes or individuals. There are no ITAs within or adjacent to the area of analysis. A map indicating the closest ITAs to the study area is included in Appendix H. The ITAs in closest proximity to the area of analysis are Chicken Ranch ITA, northeast of Merced County in Tuolumne County, and Picayune ITA, east of Merced County in Madera County. See Section 4.6 for additional information on ITAs.

3.8.1 Cultural Context

The Project action alternatives span the Central Coast and Central Valley regions, which were inhabited by Native Americans beginning at least 10,000 years ago. The Ohlone and the Northern Valley Yokuts, the two major Native groups who would have been encountered by early Euro-Americans, left behind a rich material culture evident in archaeological sites throughout both regions. These groups were followed by Spanish, Mexican, and American explorers, missionaries, soldiers, and settlers who later altered the landscape in distinct ways. The prehistoric, ethnographic, and historic period cultural history of the SLLPIP area of analysis is explored in depth in Appendix K and provides a more detailed context for the cultural resources discussed below.

3.8.2 Archival and Record Searches and Cultural Resource Inventory Surveys

Archival and record searches of known cultural resource locations and prior cultural resource studies were carried out in 2009, 2012, 2016, and 2018 at the Central California Information Center (CCIC) and the Northwest Information Center (NWIC) of the California Historical Resources Information System (CHRIS) for the cultural resources area of analysis associated with each proposed action alternative. Pedestrian inventory surveys within the APE for Alternatives 2, 4, and 5 were conducted between 2012 and 2018 while the APE for Alternative 3 was examined in 2002. Due to access issues and/or changes in alternative design since the initial surveys, the approximately 405 acres within the Alternative 4 APE and 381 acres within Alternative 5 APE remain pending. Although existing record search and survey information is adequate to support the impact analysis and conclusions in this EIS/EIR, if either is selected as the preferred alternative, the inventory survey of remaining portions of the Alternative 4 or Alternative 5 APE will be completed following Congressional authorization and prior to the release of a Final EIS/EIR and the signing of a ROD. The APE for each action alternative was examined using a survey interval of no more than 12 to 15 meters, and all previously recorded and newly discovered cultural resources were documented as appropriate. An architectural field survey and evaluation of the B.F. Sisk Dam and its associated features was conducted in 2018 (JRP 2018). Archival and record search and inventory survey results for the action alternatives are summarized below, and further details on these efforts are presented in Appendix K.

Lower San Felipe Intake Alternative

Forty-two cultural resources were previously recorded within the Alternative 2 area of analysis, including 11 within the APE and 31 within a surrounding 0.5-mile buffer. Six of the 11 resources within the APE are prehistoric archaeological sites, one is a prehistoric archaeological district, three are historic period resources, and one is a historic period district. The prehistoric district (P-24-000489/San Luis Gonzaga Archaeological District) is listed in the National Register of Historic Places (NRHP) and California Register of Historical Resources (CRHR), and one historic period resource (P-24-000643/California State Historical Landmark [CHL] 829) is listed in the CRHR. Twenty-eight prior cultural resource studies overlapped the Alternative 2 area of analysis, including 17 that encompassed portions of the APE.

All accessible areas (856 acres) within the Alternative 2 APE were subject to inventory survey in 2012 (Pacific Legacy 2018). Twelve historic period archaeological sites or built environment resources were newly discovered and three known resources were re-recorded. The newly discovered resources included seven historic period roads (CA-MER-487H, CA-MER-488H, CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, and CA-MER-495H); transmission poles and a debris scatter (CA-MER-484H); two historic period debris scatters (CA-MER-485H and CA-MER-490H); an earthworks dam (CA-MER-486H); and an industrial site (CA-MER-492H) used in the construction of the B.F. Sisk Dam. A multi-component site with a historic period earthen dam, a stock pond, and a prehistoric lithic scatter (CA-MER-26/H); a prehistoric lithic scatter with midden and human remains (CA-MER-94); and a series of road segments (P-24-001822) were re-recorded. One resource was noted but required no further documentation (P-24-000643/CHL 829). Two known districts (P-24-000489/San Luis Gonzaga Archaeological District and P-24-001856/ San Luis Gonzaga Rancho Historic District) lacked any material presence within the APE and were not re-recorded, while four resources were not relocated because they were inundated (CA-MER-8, CA-MER-17, and P-24-001818) or capped with fill soil (CA-MER-27). One previously recorded resource (CA-MER-437) was found to be non-cultural.

Treatment Alternative

One prehistoric resource (CA-SCL-377) containing a single chert flake, possible midden soils, and a possible bedrock mortar feature was previously recorded within the Alternative 3 area of analysis; both the midden soils and bedrock mortar were interpreted as potentially natural features. The resource lay outside the APE but within a surrounding 300-foot buffer. Four prior cultural resource studies overlapped the Alternative 3 APE, including one pedestrian inventory that fully encompassed it. The Alternative 3 APE (11.8 acres) was subject to a full inventory survey in 2002 (Cartier 2002) in support of a SCVWD project and was not re-examined for the SLLPIP. No cultural resources were discovered.

San Luis Reservoir Expansion Alternative

Fifty cultural resources were previously recorded within the Alternative 4 area of analysis, including 19 within the APE and 31 within a surrounding 0.5-mile buffer. Fifteen of the 19 resources within the APE are prehistoric archaeological sites, one is a prehistoric archaeological district, and three are historic period resources. Of the 19 resources in the APE, two prehistoric sites (CA-MER-130 and CA-MER-136) and the prehistoric district (P-24-000489/San Luis Gonzaga Archaeological District) are listed in the NRHP and CRHR. Fifty-two prior cultural resource studies overlapped the Alternative 4 area of analysis, including 33 that encompassed portions of the APE.

All accessible areas (4,083 acres) within the Alternative 4 APE were subject to inventory survey in 2012 or in 2016. Nineteen historic period archaeological sites or built environment resources were newly identified and seven known resources were re-recorded. Resources newly discovered in 2012 or 2016 included a series of historic period transmission poles with a debris scatter (CA-MER-484H); two industrial sites (CA-MER-492H and CA-MER-509H) associated with construction of the B.F. Sisk Dam; seven historic period road segments (CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, CA-MER-495H, CA-MER-513H, and CA-MER-519H); a concrete equipment pad (CA-MER-510H); a water tank on railroad ties (CA-MER-511H); a helicopter pad (CA-MER-512H); a ditch segment (CA-MER-514H); three earthen dams with impound ponds (CA-MER-515H, CA-MER-516H, and CA-MER-518H); a prehistoric midden site with lithics and groundstone (CA-MER-517); and a series of survey markers and monitoring wells (CA-MER-520H) associated with the B.F. Sisk Dam.

The seven known resources that were re-recorded within the Alternative 4 APE included five prehistoric sites (CA-MER-15, CA-MER-28, CA-MER-82, CA-MER-83, and CA-MER-130), most with midden, lithics, and groundstone; one historic period water tank and trough (CA-MER-521H); and one historic period road (P-24-001822). Two of the known resources that were re-recorded within the APE were originally plotted outside it but were found to intersect it during inventory survey. Two known resources that were not re-recorded in 2012 or 2016 included the San Luis Gonzaga Archaeological District (P-24-000489), which comprises an artificial boundary lacking any material presence within the APE, and the B.F. Sisk Dam and its key features, which were recorded in 2018 during an architectural field survey (JRP 2018).

Eleven resources previously recorded in the Alternative 4 APE were not relocated. Seven were prehistoric archaeological sites originally noted along the reservoir shoreline (CA-MER-20, CA-MER-21, CA-MER-22, CA-MER-23, CA-MER-27, CA-MER-29, and CA-MER-41) that may have been mis-plotted during prior recording, destroyed or obscured through geomorphic processes, or subject to modern disturbance. Two prehistoric sites (CA-MER-136 and CA-MER-137) lay along the Cottonwood Bay shoreline, which was inaccessible during the 2016 inventory survey. One historic period ranch complex (CA-MER-451H) lay within an area added to the Alternative 4 APE after the 2016 inventory survey was completed. One prehistoric site (CA-MER-14) lay within the dam footprint and was presumed destroyed.

Pacheco Reservoir Expansion Alternative

Thirty-five cultural resources were previously recorded within the Alternative 5 area of analysis, including 12 within the APE and 23 within a surrounding 0.5 mile buffer. Nine of the 12 previously recorded resources within the APE are prehistoric archaeological sites (CA-SCL-116, CA-SCL-121, CA-SCL-322, CA-SCL-682, CA-SCL-683, CA-SCL-684, CA-SCL-685, CA-SCL-686, and CA-SCL-687), most containing lithics as well as midden and/or groundstone; two are multi-component resources, one containing a prehistoric lithic scatter with midden and groundstone as well as historic period debris (CA-SCL-679/H), the other containing prehistoric midden deposits and a historic period structure with associated debris (CA-SCL-680/H); and one is a historic period farmhouse and barn (P-35-000236). One additional historic period built environment resource, the North Fork Dam, intersects the Alternative 5 APE, though it has never been formally recorded. None of these resources have been evaluated for listing in the NRHP and/or the CRHR. Forty-seven prior cultural resource studies overlapped the Alternative 5 area of analysis, including 23 that encompassed portions of the APE.

Accessible areas (1,152 acres) within the Alternative 5 APE were subject to inventory survey in 2018 and 2019. One built environment resource and nine prehistoric archaeological sites were newly identified while eight known resources were re-recorded. Resources newly discovered in 2018 or 2019 included a bedrock milling site (PL-Pacheco-CRP-007); three prehistoric midden sites with lithics, groundstone, and other artifacts (PL-Pacheco-CRP-010, PL-Pacheco-CRP-012, PL-Pacheco-CRP-015); four prehistoric lithic scatters (PL-Pacheco-CRP-013, PL-Pacheco-CRP-017, PL-Pacheco-CRP-019, and PL-Pacheco-CRP-023); one lithic scatter with groundstone (PL-Pacheco-CRP-022); and a historic period concrete bridge (PL-Pacheco-CRP-009).

The eight known resources that were re-recorded within the Alternative 5 APE included six prehistoric sites (CA-SCL-682, CA-SCL-683, CA-SCL-684, CA-SCL-685, CA-SCL-686, and

CA-SCL-687), most with midden, lithics, and groundstone, as well as the two multi-component sites (CA-SCL-679/H and CA-SCL-680/H). The North Fork Dam is being examined as a part of a separate architectural field survey. The four resources that have not been re-recorded are in areas for which access permissions have not yet been granted.

3.8.3 Tribal Cultural Resources

No Native American resources were identified by the Native American Heritage Commission (NAHC) through a search of the Sacred Lands Inventory as it encompasses the APE for the four action alternatives. No tribal cultural resources as defined under PRC Section 21074 have been reported within the APE for the action alternatives. Formal consultation with tribes under AB 52 (Chapter 532, Statutes of 2014) was not required for this EIS/EIR because the Notice of Preparation (NOP) was published in 2008; AB 52 consultation is required for projects that have NOPs filed on or after July 1, 2015.

3.9 Paleontological Resources in Study Area

Paleontological resources include fossilized remains and the geologic context in which they occur, providing information about the history of life on earth (City of San Jose 2011). Paleontological sensitivity is defined as the potential for a geologic unit to produce scientifically significant fossils. This is determined using a qualitative measurement of fossil data, including rock type, history of the geologic unit in producing significant fossils, and fossil localities that are recorded from that geologic unit. In areas of high sensitivity, full-time monitoring by a professionally trained paleontologist is recommended during any type of ground disturbance (City and County of San Francisco 2005).

Pacheco Reservoir and the western side shoreline of San Luis Reservoir lie within the Franciscan Formation, from the Jurassic or Cretaceous Period 80 million to 200 million years ago (Reclamation and CDPR 2013). This formation consists of a thick assemblage of sedimentary, igneous, and metamorphic rocks and has been ranked at low sensitivity due to the general lack of recorded vertebrate fossils (City and County of San Francisco 2005). The Panoche Formation makes up most of the eastern shore of San Luis Reservoir, from the late Cretaceous Period about 65 million years ago (Reclamation and CDPR 2013). The Panoche Formation consists of shale and thinly bedded sandstone, approximately 25,000 feet thick and has been ranked as moderately sensitive due to the discovery of noteworthy invertebrate marine fossils (California High Speed Rail Authority [CHSRA] 2004).

Santa Clara Valley consists mostly of Holocene Epoch sediments from the past 10,000 years after the last major glacial period, which cover the Santa Clara Formation, older sediments of the Pleistocene Epoch from 1.8 million to about 10,000 years ago (City of San Jose 2011). Paleontological resources are primarily located in the hills of San Jose, including the Santa Teresa Hills, where the Santa Teresa WTP is located. The Santa Teresa Hills are within an area of Unnamed Sedimentary Rock from the Eocene Epoch, dating from 56 million to 33 million years ago (Dibblee and Minch 2005). The Santa Teresa WTP is within a Holocene Epoch alluvial fan, which is classified as highly sensitive (City of San Jose 2011).

3.10 Fisheries Resources in Study Area

The area of fisheries analysis includes the area around San Luis Reservoir that is Federally-owned and leased to the CDPR. San Luis Reservoir is a large and intensively managed reservoir that contains warm water fishes, primarily exported from the Delta. San Luis Reservoir is an artificial environment and does not support a naturally evolved aquatic community. Although a few native species may still be present, the vast majority of fish species in the reservoir have either been directly introduced or transported into the reservoir via the California Aqueduct and DMC.

The Delta region includes the Delta, which comprises channels of the Sacramento and San Joaquin Rivers, including from about the I-Street Bridge in Sacramento on the Sacramento River and Vernalis on the San Joaquin River, west to Martinez and includes Suisun Bay and the Suisun Marsh. The Delta is tidally influenced and is the diversion point for both the CVP and the SWP. The Delta is made up of tidal river channels and sloughs and many constructed features. More than 120 fish species rely on the Delta and San Francisco Bay as important areas to complete one or more life stages. Channels and sloughs of the Delta and Suisun Bay provide important migration and rearing habitats for anadromous salmonids, delta smelt, longfin smelt and splittail.

The existing North Fork Pacheco Reservoir is operated by the Pacheco Water District to supply agricultural irrigation water through streambed percolation (Smith 2007). Rearing and migratory habitat for South-Central California Coast steelhead in Pacheco Creek downstream of the dam is almost completely dependent upon releases from North Fork Pacheco Reservoir (Smith 2007). The reservoir may not fill completely in dry years, and, even in wet years, there is usually no additional inflow to the reservoir by early to mid-summer, making Pacheco Creek unsuitable for rearing steelhead (Smith 2007).

See Appendix L1 for details on special status fish species present in San Luis Reservoir, the Delta Region, and Pacheco Creek.

3.11 Terrestrial Resources in Study Area

3.11.1 Natural Communities

Dominant natural communities within the San Luis Reservoir Region include valley foothill riparian, coast live oak woodland, chaparral/scrub, annual grassland, purple needlegrass grassland, freshwater emergent wetland, seasonal wetland, agricultural, and urban/disturbed (Reclamation and CDPR 2013, Reclamation 2018b, ESA 2018) (see Figures M1-1a and M1-1b in Appendix M1).

Major vegetation communities that occur in the SCVWD service area include grassland, chaparral and coastal scrub, oak woodland, riparian forest and scrub, and wetland and open water (Santa Clara County 2012). The Santa Teresa WTP is located primarily within developed areas. However, grassland, oak woodland, and riparian forest and scrub vegetation communities occur at or near proposed construction areas.

The area surrounding Pacheco Reservoir is mostly undeveloped. Oak woodland comprises the majority of land cover in the vicinity of the reservoir including: foothill-pine oak woodland, mixed oak woodland, blue oak woodland, and valley oak woodland. Other habitat types in the area include valley foothill riparian, annual grassland, and scrub/chaparral (see Figures M1-2a and M1-2b in Appendix M1).

See Appendix M2 for a description of common natural communities, sensitive natural communities, and wildlife in the area of analysis.

Common Natural Communities

Common natural communities in the project area include annual grassland, chaparral/scrub, and disturbed areas. Annual grassland is the dominant natural community in the San Luis Reservoir Area and within the SCVWD Service Area. It is dominated by introduced grasses and forbs, with occasional patches of native grasses. Chaparral/scrub communities occur principally west of San Luis Reservoir, interspersed in the grasslands on undisturbed slopes of the SCVWD Service Area, and around Pacheco Reservoir.

Sensitive Natural Communities

Sensitive natural communities in the area of analysis include oak woodland, valley foothill riparian, freshwater emergent wetland, and seasonal wetlands. Oak woodlands occur within the area around San Luis Reservoir, but not within the vicinity of the dam where construction activities would occur. The Pacheco Creek watershed is comprised of oak woodlands, including blue oak woodland and foothill pine-oak woodland. Patches of valley foothill riparian habitat generally occur in draws on the margin of San Luis Reservoir. The mainstem reach of Pacheco Creek supports a broad, relatively wide floodplain with valley foothill riparian vegetation and alluvial sycamore woodland. Freshwater emergent wetland occurs along creek banks and within the few ponds around San Luis Reservoir, as well as within the reservoir. Seasonal wetlands occur within grasslands near San Luis Reservoir, including short-lived pools that may pond water long enough to support listed crustaceans.

Wildlife

The annual grassland, oak woodland, chaparral/scrub and wetlands support a wide variety of common wildlife species. Grassland and chaparral habitats support many species of migratory birds and raptors. A variety of amphibians, reptiles and mammals also inhabit grassland, and chaparral/scrub may provide cover for these types of wildlife. Riparian woodland support numerous common wildlife species, including amphibians and nesting migratory birds.

3.11.2 Special Status Species

Special status species are protected pursuant to Federal and/or State endangered species laws or have been designated as species of concern by the California Department of Fish and Wildlife (CDFW). In addition, Section 15380(b) of the CEQA Guidelines provides a definition of rare, endangered, or threatened species that are not included in any listing. Species recognized under these terms are collectively referred to as “special-status species.” Appendix M2 describes the database searches and surveys conducted to determine which special-status species have potential to occur in the area of analysis. Focused surveys for special-status plants and wildlife have not been completed in all areas; the absence of documented special-status species occurrences does not indicate species absence. Appendix M2 provides a table with the potential for occurrence of special-status species and provides species accounts for the species that could be affected. Maps of known occurrences of special-status species in the vicinity of the area of analysis are provided in Appendix M1, Figures M1-3, M1-4, and M1-5.

Invertebrates

Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) has potential to occur near San Luis Reservoir because stands of at least 35 elderberry (*Sambucus nigra* ssp. *caerulea*), the beetle's host plant, were found on-site (ESA 2018). Valley elderberry longhorn beetle (VELB) were observed in 1987 about 6 miles from the reservoir (CDFW 2018). The Pacheco Reservoir area is not within the known range of this species. Small areas of suitable habitat for vernal pool fairy shrimp (*Branchinecta lynchi*) and vernal pool tadpole shrimp (*Lepidurus packardi*) were found within grassland below B.F. Sisk Dam (ESA 2018). However, ooccurrences of these species have not been documented within the area of analysis.

Amphibians and Reptiles

For California tiger salamander (*Ambystoma californiense*), there are three California Natural Diversity Database (CNDDB) records over 2.5 and 4 miles from San Luis Reservoir. Critical habitat is designated for California tiger salamander approximately 1 mile southeast of San Luis Reservoir and approximately 2.5 miles from the construction gravel pit area (USFWS 2018). Suitable habitat is present in grasslands surrounding the reservoir. Critical habitat is also located 6 miles downstream of Pacheco Reservoir.

There are several CNDDB occurrences documented for California red-legged frog (*Rana draytonii*) (CRLF) within the western portion of the San Luis Reservoir region. Critical habitat is designated along the western boundary of San Luis Reservoir (see Figure M1-6 in Appendix M1). In addition, ESA (2018) identified a California red-legged frog breeding population at the Willow Spring pond, approximately 0.3 mile south of San Luis Reservoir (see Figure M1-7 in Appendix M1). Though within the project site, this location is on the fringe of the designated borrow area. CRLF occurrences are documented within the SCVWD service area. The riverine habitat, ponds, and associated riparian habitat within the Pacheco Reservoir region provide suitable habitat for this species, and the entire area is designated critical habitat (see Figure M1-6). Biological resource surveys in the Pacheco Reservoir region are planned for winter 2018 and results will be incorporated in this chapter.

Foothill yellow-legged frog (*Rana boylii*) and San Joaquin whipsnake (*Masticophis flagellum ruddocki*) also have potential to occur in the area of analysis. Though at the fringe of this species' range, Alameda whipsnake (*Masticophis lateralis euryxanthus*) may be of concern in chaparral habitat surrounding Pacheco Reservoir. Additional California species of special concern identified in Appendix M2 also have potential to occur in the project area.

Birds

Foraging habitat for bald eagle (*Haliaeetus leucocephalus*), California condor (*Gymnogyps californianus*), golden eagle (*Aquila chrysaetos*), and Swainson's hawk (Buteo swainsoni) occurs in the area of analysis. Breeding and foraging habitat for tricolored blackbird (*Agelaius tricolor*) and white-tailed kite (*Elanus leucrus*) have potential to occur in the area of analysis. The California species of special concern identified in Appendix M2 may also have potential to occur in the project area.

Mammals

The endangered San Joaquin kit fox (*Vulpes macrotis mutica*) and California species of special concern including American badger (*Taxidea taxus*) have potential to occur in the area of analysis. Three observations of kit foxes were made in 2005 between San Luis Reservoir and Los Banos Creek Reservoir. A habitat evaluation for kit fox in 2010 found one known den (with kit fox tracks) and 194 potential kit fox dens within the B.F. Sisk SOD Modification Project boundary, similar to the current area of analysis (Reclamation, 2010). CNDDB records of San Joaquin kit fox are located within both the SCVWD Service Area and the Pacheco Reservoir Region. Badgers are known to occur in grasslands surrounding San Luis Reservoir, including within the project area (ESA 2018).

Plants

Thirty-two special-status plant species have at least a moderate potential to occur within the area of analysis. These species may occur in grassland, oak woodland, chaparral/scrub, seasonal and emergent wetlands, and riparian habitat (see Table M2-1 in Appendix M2). Rare plant surveys have not been conducted within the San Luis or Pacheco Reservoir areas; thus, potential to occur is based on analysis of habitat suitability, range, and database occurrences (CNDDB and Calflora).

3.12 Regulatory Setting

Table 3-16 lists the Federal, State, regional, and local laws, regulations, policies, and plans that are relevant and applicable to the affected environment, area of analysis, and analysis of impacts. The alternatives would not have any inconsistencies with applicable local and regional plans.

Table 3-16. Federal, State, and Local Laws, Regulations, and Plans

Laws, Regulations, and Plans	Applicable Resources	Full Description
Federal		
Advisory Council on Historic Preservation Section 106 Consultation	Cultural	C.1.1
Bald and Golden Eagle Protection Act	Terrestrial	C.1.2
Central Valley Project Improvement Act	Water Supply	C.1.3
Civil Rights Act of 1964 and EO 12898	Environmental Justice	C.1.4

Laws, Regulations, and Plans	Applicable Resources	Full Description
Clean Air Act	Air Quality	C.1.5
Clean Water Act	Water Quality, Fisheries, Terrestrial	C.1.6
Comprehensive Environmental Response, Compensation, and Liability Act	Hazards & Hazardous Materials	C.1.7
Dam Safety Guidelines	Flood Control	C.1.8
Earthquake Hazard Reduction Act of 1977	Geology, Seismicity, & Soils	C.1.9
Endangered Species Act	Water Supply, Fisheries, Terrestrial	C.1.10
EO 11990, Protection of Wetlands	Water Quality, Terrestrial	C.1.11
EO 11988, Floodplain Management	Flood Control	C.1.12
EO 13007, Indian Sacred Sites	Cultural	C.1.13
EO 13783, Promoting Energy Independence and Economic Growth	GHG	C.1.14
Federal Water Project Recreation Act	Recreation	C.1.15
Fish and Wildlife Coordination Act	Fisheries, Terrestrial, Recreation	C.1.16
Magnuson-Stevens Fishery Conservation and Management Act	Fisheries	C.1.17
Memorandum of April 29, 1994, "Government-to-Government Relations with Native American Tribal Governments"	Indian Trust Assets (ITAs)	C.1.18
Migratory Bird Treaty Act	Terrestrial	C.1.19
Native American Graves Protection and Repartition Act	Cultural	C.1.20
National Environmental Policy Act	All	C.1.21
National Flood Insurance Program	Flood Control	C.1.22
National Historic Preservation Act	Cultural	C.1.23
National Park Service Regulations	Cultural	C.1.24
Noise and Vibration Legislation	Noise & Vibration	C.1.25
Principles and Requirements for Federal Investments in Water Resources	GHG	C.1.26
Real-Time Decision-Making to Assist Fishery Management	Fisheries	C.1.27
Resource Conservation and Recovery Act	Hazards & Hazardous Materials	C.1.28
Safe Drinking Water Act	Water Quality	C.1.29
San Luis Reservoir State Recreation Area	Visual	C.1.30
Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule: Long Term 1 Enhanced Surface Water Treatment Rule and Long Term 2 Enhanced Surface Water Treatment Rule	Water Quality	C.1.31
Superfund Amendments and Reauthorization Act	Hazards & Hazardous Materials	C.1.32
Surface Water Treatment Rule	Water Quality	C.1.33
US DOI, Reclamation NEPA Handbook	GHG	C.1.34
US DOI, Reclamation Safety of Dams Act	Flood Control	C.1.35
US DOI, Climate Change Adaptation Plan	GHG	C.1.36
US DOI Plan for a Coordinated, Science-based Response to Climate Change Impacts on Our Land, Water, and Wildlife Resources	GHG	C.1.37
US DOI Secretarial Order No. 3215	ITAs	C.1.38
US DOI Secretarial Order No. 3289, Amendment No.1	GHG	C.1.39
US DOI Secretarial Order No. 3360	GHG	C.1.40

Laws, Regulations, and Plans	Applicable Resources	Full Description
State		
Alquist-Priolo Earthquake Fault Zoning Act	Geology, Seismicity, & Soils	C.2.1
California Air Resources Board 2017 Scoping Plan	GHG	C.2.2
California Assembly Bill 32	GHG	C.2.3
California Building Code	Geology, Seismicity, & Soils, Noise & Vibration	C.2.4
California Clean Air Act	Air Quality	C.2.5
CDFW Species Designations	Fisheries	C.2.6
California Department of Toxic Substances Control	Hazards & Hazardous Materials	C.2.7
DWR Division of Safety of Dams	Flood Control	C.2.8
DWR Non-Project Water Acceptance Criteria	Water Quality	C.2.9
California Endangered Species Act	Fisheries, Terrestrial	C.2.10
California Energy Efficiency Strategic Plan	Public Utilities	C.2.11
Cal EPA Unified Program	Hazards & Hazardous Materials	C.2.12
CEQA Guidelines	GHG	C.2.13
California EO S-3-05	GHG	C.2.14
California EO B-30-15 and Senate Bill 32	GHG	C.2.15
California Fish and Game Code Section 1600, Streambed Alterations	Terrestrial	C.2.16
California Fish and Game Code Sections 3500-3705, Migratory Bird Protection	Terrestrial	C.2.17
California General Plan Guidelines	Noise & Vibration	C.2.18
California Government Code 65040.12	Environmental Justice	C.2.19
California Occupational Safety and Health Administration Standards	Hazards & Hazardous Materials	C.2.20
California Porter-Cologne Water Quality Control Act	Water Quality	C.2.21
California Register of Historical Resources	Cultural	C.2.22
California Safe Drinking Water Act	Water Quality	C.2.23
California Senate Bill 32	GHG	C.2.24
California State Parks Guidelines	Noise & Vibration	C.2.25
California Water Code	Water Quality, Water Supply, Groundwater	C.2.26
Hazardous Waste Control Act	Hazards & Hazardous Materials	C.2.27
Noise Element Guidelines	Noise & Vibration	C.2.28
Seismic Hazards Mapping Act	Geology, Seismicity, & Soils	C.2.29
State Scenic Highways	Visual	C.2.30
SWRCB and DTSC Hazardous Waste Management	Hazards & Hazardous Materials	C.2.31
Surface Mining and Reclamation Act of 1975	Geology, Seismicity, & Soils	C.2.32
Williamson Act	Land Use & Agriculture	C.2.33
Local/ Regional		
BAAQMD Plans and Regulations, including 2017 Clean Air Plan	Air Quality	C.3.1
California DWR San Luis Division	Hazards & Hazardous Materials	C.3.2
City of Gilroy Performance Standards	Noise & Vibration	C.3.3
City of Gustine Code of Ordinances	Noise & Vibration	C.3.4
City of Los Banos Municipal Code	Noise & Vibration	C.3.5
City of San Jose General Plan	Visual, Noise & Vibration, Land Use & Agriculture, Public Utilities, Cultural	C.3.6

Laws, Regulations, and Plans	Applicable Resources	Full Description
City of San Jose Municipal Code	Noise & Vibration	C.3.7
Merced County Code	Noise & Vibration	C.3.8
Merced County General Plan	Water Quality, Flood Control, Geology, Seismicity, & Soils, Visual, Noise & Vibration, Fisheries, Terrestrial, Land Use & Agriculture, Recreation, Public Utilities, Cultural	C.3.9
Merced County Office of Environmental Services	Hazards & Hazardous Materials	C.3.10
Pacheco State Park General Plan	Recreation	C.3.11
SJVAPCD Plans	Air Quality	C.3.12
Santa Clara County General Plan	Water Quality, Flood Control, Geology, Seismicity, & Soils, Visual, Noise & Vibration, Fisheries, Terrestrial, Land Use & Agriculture, Recreation, Public Utilities, Cultural	C.3.13
Santa Clara County Ordinance Code	Noise & Vibration	C.3.14
Santa Clara County OES Services	Hazards & Hazardous Materials	C.3.15
Santa Clara Valley Habitat Plan	Fisheries, Terrestrial	C.3.16
SCVWD Flood Control	Flood Control	C.3.17
SCVWD Groundwater Management Plan	Groundwater	C.3.18
SCVWD Water Resources Protection Ordinance	Water Quality	C.3.19
San Luis Reservoir SRA Resource Management Plan/General Plan	Terrestrial, Recreation, Public Utilities	C.3.20
Traffic and Transportation Regulations	Traffic & Transportation	C.3.21
Tree Protection Ordinances	Terrestrial	C.3.22

Chapter 4 Environmental Consequences/Environmental Impacts

This chapter presents the analysis of impacts associated with implementation of each alternative. The subsection begins with an explanation of the assessment method(s) used to identify and address potential impacts and then presents the basis and criteria for determining whether the potential impacts are significant (under CEQA), and whether mitigation of the impact is warranted. Impacts are determined relative to the No Project Alternative, or existing condition baseline (for CEQA), and the No Action Alternative (for NEPA). However, the No Action Alternative would be the same as existing conditions/No Project Alternative at the time of the NOP because substantive changes in the area of analysis are not expected. Therefore, for this analysis the No Action/No Project Alternative (Alternative 1) is used as the basis for comparison for both CEQA and NEPA.

The subsections begin with an explanation of the assessment method(s) used to identify and address potential impacts and then presents the basis and criteria. In general the Lead Agencies identified the severity or extent of the impacts that would result from implementation of each of the alternatives within the context of the environmental baseline and regulatory framework. The Lead Agencies used a variety of data sources, models, and various other types of research and analysis to predict the impacts. The Lead Agencies then determined the magnitude or significance of the impacts based on significance criteria, where required.

For each resource area, significance criteria were developed consistent with the CEQA Guidelines and used to assess the significance level of the impacts under CEQA. Pursuant to NEPA, significance is used to determine whether an EIS or some other level of documentation is required, and once the decision to prepare an EIS is made, the magnitude of the impact is evaluated and no further judgment of significance is required. Therefore, any determinations of significance are for CEQA purposes only.

The impact discussion is concluded with a bold CEQA significance determination that indicates if there is no impact to a resource area or if the impact to a resource area is beneficial, less than significant, or significant. For those impacts that would be significant, the Lead Agencies identified feasible mitigation measures, if they exist, to reduce the level of the impact. Impacts for each resource are summarized in this chapter, with detailed analysis in appendices. Each resource subsection contains an effects analysis table containing a summary of the significance criteria, assessment methodology, significance determination, mitigation measures, and the location of the evaluation support, which is located either within the chapter or in an appendix.

4.1 Water Quality

4.1.1 Assessment Methods

Water quality monitoring data and computer modeling were used to aid in evaluating potential impacts. Temporary construction impacts were evaluated qualitatively based on anticipated construction practices, materials, locations, and duration of construction and related activities. Long-term effects were evaluated using results from computer modeling tools. Specifically, the California Simulation Model II (CalSim II) was used to estimate both existing (short term) and future (long term) changes in reservoir storage and stream flow within the area of analysis. Hydrodynamic and water quality modeling of the Delta was performed using the Delta Simulation Model-2 (DSM2). Where modeling is not available, effects are evaluated based on changes in CVP deliveries, anticipated changes in flow through the Delta (increases or decreases), and the timing of the changes. Appendix D describes the changes to water quality under each action alternative and includes the detailed modeling results and interpretation of those results.

4.1.2 Significance Criteria

Impacts would be significant if they resulted in one or more of the following conditions or situations: (1) violate existing water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality; (2) substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would: (a) result in substantial erosion or siltation on or off-site, (b) create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; (3) in flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation; (4) conflict with or obstruct implementation of a water quality control plan; or (5) result in substantial effects on water quality related beneficial uses. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-1.

Table 4-1. Water Quality Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Cause a violation of existing water quality standards or waste discharge requirements.	Evaluation of how the alternatives could potentially generate violations of water quality standards or waste discharge requirements during construction or operation of new facilities	1	NI	--	Section 4.1.3
		2	LTS	None	Section 4.1.4 Appendix D
		3	LTS	None	Section 4.1.5 Appendix D
		4	LTS	None	Section 4.1.6 Appendix D
		5	LTS	None	Section 4.1.7 Appendix D
Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on or off-site or provide substantial additional sources of polluted runoff.	Evaluation of how construction or operation of the alternatives could alter the existing drainage pattern and create or contribute runoff water when compared to existing conditions.	1	NI	--	Section 4.1.3
		2	Construction - S, LTS Operations - LTS	WQ-1	Section 4.1.4
		3	Construction - S, LTS Operations - LTS	WQ-1	Section 4.1.5
		4	Construction - S, LTS Operations - LTS	WQ-1	Section 4.1.6
		5	Construction - S, LTS Operations - LTS	WQ-1	Section 4.1.7
In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation.	Evaluation the risk of how construction or operation of the alternatives could release pollutants due to project inundation in flood hazard, tsunami, or seiche zones.	1	NI	--	Section 4.1.3
		2	NI	None	Section 4.1.4
		3	NI	None	Section 4.1.5
		4	NI	None	Section 4.1.6
		5	NI	None	Section 4.1.7
Conflict with or obstruct implementation of a water quality control plan.	Evaluation of whether construction or operation of the alternatives could conflict with or obstruct water quality control plan objectives.	1	NI	--	Section 4.1.3
		2	S, LTS	WQ-1	Section 4.1.4
		3	S, LTS	WQ-1	Section 4.1.5
		4	S, LTS	WQ-1	Section 4.1.6
		5	S, LTS	WQ-1	Section 4.1.7

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Result in effects on water quality related beneficial uses.	Evaluation of whether construction or operation of the alternatives could limit the use of potentially impacted water's beneficial uses	1	S, SU	--	Section 4.1.3
		2	B	None	Section 4.1.4
		3	SCVWD Service Area - B SBCWD Service Area - NI	None	Section 4.1.5
		4	B	None	Section 4.1.6
		5	B	None	Section 4.1.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.1.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

The No Action/No Project Alternative includes the most likely future conditions in the absence of the project. No physical modifications or operational or institutional changes would occur under this alternative to alter existing drainage patterns, create or contribute runoff water or degrade existing water quality conditions. Water quality conditions within the area of analysis would remain similar to existing conditions. In the No Action/No Project Alternative, low point issues would continue when San Luis Reservoir falls below 300 TAF. At this point, the San Felipe intake receives algae-laden water that is not treatable with existing treatment facilities in SCVWD. Due to potential adverse effects, SCVWD would not use the algae-laden water during this period. **This would be a significant impact.** The proposed action alternatives considered as a part of the SLLPIP would mitigate this impact, however as a part of the No Action/No Project Alternative they cannot be considered. **Therefore, this impact is significant and unavoidable.**

4.1.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Under Alternative 2, X2 results indicate that on average there are negligible changes to Delta water quality resulting from changes in Delta outflows. Table D-5 in Appendix D summarizes X2 results that modeled potential changes in salinity. As shown in Tables D-7 and D-10 in Appendix D, changes in South-of-Delta export of CVP and SWP water and Delta outflow under this alternative would be minimal. **This impact would be less than significant.**

San Luis Reservoir is not located within a flood hazard, tsunami, or seiche zone. Therefore, construction and operation of Alternative 2 would not result in an increased risk of pollutants released due to project inundation within a flood hazard, tsunami, or seiche zone. **There would be no impact.**

Under Alternative 2, SCVWD would be able to fully divert its CVP allocation and would not have to leave water in San Luis storage as it does in the No Action/No Project Alternative; therefore, reservoir levels would be lower (see Table D-16 in Appendix D). During periods with lower reservoir levels algae growth could further reduce DO levels, increasing cyanobacteria levels and associated taste and odor issues, which would adversely affect beneficial uses identified for San Luis Reservoir. However, the alternative includes a hypolimnetic aeration facility to address these DO effects and improve conditions for the beneficial use of the water, specifically its treatability at SCVWD WTPs and odor issues at San Luis Reservoir for recreational users. After construction of the new lower intake, San Felipe Division water users would be able to pump and treat water from the reservoir until the water level reaches 331 feet, as opposed to being limited to pumping until 369 feet, increasing water users’ access to usable storage capacity and improving municipal, industrial and agricultural supply beneficial uses. Operation of the alternative would generate no impact on the other beneficial uses at San Luis Reservoir. **This would be a beneficial impact.**

During construction of the tunnel option, excavated material would be generated and disposed of at Dinosaur Point to extend the existing boat ramp farther into the reservoir. The placement of this soil has the potential to result in the dispersion of this disposed soil into the adjacent reservoir which could affect water quality. During construction of the pipeline option, soil would be dredged from within San Luis Reservoir and disposed of across the reservoir floor. Dredging activities could impact water quality and substantially degrade existing water quality during construction. The known presence of mercury in the reservoir, regardless of its original source, makes it that reservoir sediment disturbed during dredging operations would likely contain at least trace amounts of mercury. While natural amounts of suspended sediments are essential to the ecological function of a water body, in excessive amounts they can constitute a major ecosystem stressor. In addition, runoff from exposed soils in active work areas at San Luis Reservoir are likely to contain high concentrations of particulates and potentially, residual petroleum products from construction equipment. Therefore, construction-related activities have the potential to degrade water quality and create additional sources of polluted runoff. Disturbance at surface areas used for construction staging along with excavated material storage and disposal locations could also result in localized surface erosion, minor changes in drainage patterns, and changes in erosion rates.

Construction would likely require permits under Sections 402 and 401 of the CWA, preparation of a stormwater pollution prevention plan (SWPPP) would be required by the RWQCB under the Construction General Permit. Additionally, the RWQCB and would require best management practices (BMPs), monitoring and other construction controls to protect water quality. Water quality regulations are further described in Appendix D. **Notwithstanding compliance with these regulations, this impact would be significant**. Mitigation Measure WQ-1, described below in Section 4.1.8, would be implemented to decrease erosion rates and delivery of sediments along with any other resident pollutants to surface waters through the use of mechanisms such as stockpile covering, fill material compaction, construction vehicle washing and revegetation. **Therefore, impacts on water quality would be less than significant after mitigation.**

Several different regional Water Quality Control Plans govern water bodies within the SLLPIP area of analysis (See Section C.2.24 in Appendix C). These plans establish water quality standards and requirements for parameters such as toxic chemicals, bacterial contamination, and other factors which have the potential to adversely affect beneficial uses or cause nuisance conditions (SWRCB 2006). As previously discussed, changes to Delta water quality would be minimal and would not cause nuisance conditions or adversely affect beneficial use of the Delta. Construction-related activities have the potential to degrade water quality under Alternative 2, which could adversely affect beneficial use of San Luis Reservoir and conflict with a water quality control plan. Water quality regulations require preparation of a SWPPP, BMPs, monitoring and other construction controls would be required to protect water quality. **Nevertheless, this impact would be significant.** Mitigation Measure WQ-1, described below in Section 4.1.8, would be implemented to decrease erosion rates and delivery of sediments along with any other resident pollutants to surface waters. **Therefore, conflicts with water quality control plans would be less than significant after mitigation.**

4.1.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Under Alternative 3, X2 results and changes to Delta exports and outflows would be similar to effects described above under Alternative 2. Changes to Delta exports and outflows would be minimal and would have minimal effects on Delta water quality. **This impact would be less than significant.**

Santa Teresa WTP is not located within a flood hazard, tsunami, or seiche zone. Therefore, construction and operation of Alternative 3 would not result in an increased risk of pollutants released due to project inundation within a flood hazard, tsunami, or seiche zone. **There would be no impact.**

Similar to Alternative 2, SCVWD would be able to fully divert its CVP allocation under Alternative 3 and would not have to leave water in San Luis storage as it does in the No Action/No Project Alternative; therefore, reservoir levels would be lower (see Table D-16 in Appendix D). The potential water quality issues as algae conditions contribute to reduced DO levels and taste and odor issues identified under Alternative 2 would not be addressed by Alternative 3. These conditions would persist consistent with conditions present in San Luis Reservoir when it is drawn down to low levels under existing conditions. The continued delivery of CVP supply to SCVWD during periods when storage in the reservoir is drawn down below 300 TAF would not contribute to new violations of water quality standards at San Luis Reservoir or substantial degradation of water quality in the reservoir. **This impact would be less than significant.**

The current algae generated water quality issues that affect treatability and use would be avoided by improving Santa Teresa WTP’s ability to treat algae-laden water from the reservoir, increasing SCVWD water users’ access to usable storage capacity. The alternative would not change water quality conditions for agricultural water users in the SBCWD service area. While the filter clogging issues generated by low point conditions increase back flushing requirements, they do not require interruption of CVP supply deliveries. **This effect would have a beneficial impact on beneficial uses in the SCVWD Service Area and no change from existing conditions in the SBCWD Service Area.**

Ground-disturbing construction activities at the Santa Teresa WTP could generate changes in local stormwater drainage patterns and temporarily create additional sources of polluted runoff resulting in erosion from the construction areas and increased sediment content in receiving surface waters (Alamitos Creek). Changes in runoff to surface water bodies downstream from the Santa Teresa WTP site could adversely affect aquatic habitat. Construction activities would likely require permits under Sections 402 and 401 of the CWA. Preparation of a SWPPP would be required by the RWQCB under the Construction General Permit. **Nevertheless, these impacts would be significant.** Implementation of Mitigation Measures WQ-1, described below in Section 4.1.8, would reduce these impacts to less than significant. **Therefore, impacts on water quality would be less than significant after mitigation.**

Several different regional Water Quality Control Plans govern water bodies within the SLLPIP area of analysis (See Section C.2.24 in Appendix C). As previously discussed, changes to Delta water quality would be minimal and would not cause nuisance conditions or adversely affect beneficial use of the Delta. Construction-related activities have the potential to degrade water quality under Alternative 3, which could adversely affect beneficial use of water bodies in the San Felipe Division Region and conflict with a water quality control plan. Water quality regulations require preparation of a SWPPP, BMPs, monitoring and other construction controls would be required to protect water quality. **Nevertheless, this impact would be significant.** Mitigation Measure WQ-1, described below in Section 4.1.8, would be implemented to decrease erosion rates and delivery of sediments along with any other resident pollutants to surface waters. **Therefore, conflicts with water quality control plans would be less than significant after mitigation.**

4.1.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

San Luis Reservoir is not located within a flood hazard, tsunami, or seiche zone. Therefore, construction and operation of Alternative 4 would not result in an increased risk of pollutants released due to project inundation within a flood hazard, tsunami, or seiche zone. **There would be no impact.**

Under Alternative 4, on average there are negligible changes to Delta water quality resulting from changes in Delta outflows compared to the No Action/No Project Alternative. Appendix D summarizes X2 results which modeled potential changes in salinity. While there would be changes to Delta exports and outflows, changes in Delta water quality would not be impacted, as noted in Table D-6. **This impact would be less than significant.**

During construction of the expanded reservoir and during the implementation of Mitigation Measure REC-1 and REC-2, described in Section 4.17.8, the exposure of bare soils, soil and material stockpiles, and the presence of fuels, lubricants, and solid and liquid wastes could cause short-term water quality impacts to the reservoir if not managed properly. Therefore, construction-related activities have the potential to degrade water quality and create additional sources of polluted runoff. Soil disturbance at surface areas used for construction staging along with excavated material storage and disposal locations could result in localized surface erosion, minor changes in drainage patterns and changes in erosion rates.

Construction activities would likely require permits under Sections 402 and 401 of the CWA. Preparation of a SWPPP would be required by the RWQCB under the Construction General Permit. **Nevertheless, this impact would be significant.** Mitigation Measure WQ-1, described below in Section 4.1.8, would be implemented to significantly decrease erosion rates and delivery of sediments and any other resident pollutants to surface waters during construction and following construction prior to and after the reestablishment of vegetation at construction sites. **Therefore, the impact on water quality would be less than significant after mitigation.**

Following construction, storage of CVP and SWP supplies in the new expanded reservoir footprint is anticipated to result in the loss of primarily grassland vegetation, as is detailed in Section 4.14.6. Following the loss of this vegetation in the first water year where the new capacity is exercised, this new section of reservoir floor would interact with the water stored in the reservoir in the same fashion as the current reservoir floor. **Therefore, the impact on water**

quality in San Luis Reservoir from the long-term operation of the expanded reservoir capacity would be the same as existing conditions and there would be no impact.

Alternative 4 would generate slightly increased storage levels in San Luis Reservoir when compared to the No Action/No Project Alternative (see Table D-17 in Appendix D). At higher reservoir storage levels, wind and warming effects of the sun would have less influence on water temperatures, which could decrease algae growth and could result in increased DO levels and decreased associated taste and odor issues when compared to existing conditions. These increased water quality conditions could positively affect beneficial uses identified for San Luis Reservoir. In addition, following the B.F. Sisk Dam raise, SCVWD would have access to additional usable storage capacity during most water year types. **This would be a beneficial impact.**

Several different regional Water Quality Control Plans govern water bodies within the SLLPIP area of analysis (See Section C.2.24 in Appendix C). As previously discussed, changes to Delta water quality would be minimal and would not cause nuisance conditions or adversely affect beneficial use of the Delta. Construction-related activities have the potential to degrade water quality under Alternative 4, which could adversely affect beneficial use of San Luis Reservoir and conflict with a water quality control plan. Water quality regulations require preparation of a SWPPP, BMPs, monitoring and other construction controls would be required to protect water quality. **Nevertheless, this impact would be significant.** Mitigation Measure WQ-1, described below in Section 4.1.8, would be implemented to decrease erosion rates and delivery of sediments along with any other resident pollutants to surface waters. **Therefore, conflicts with water quality control plans would be less than significant after mitigation.**

4.1.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Under Alternative 5, on average there are negligible changes to Delta water quality resulting from changes in Delta outflows compared to the No Action/No Project Alternative. Appendix D summarizes X2 results, which estimate potential changes in salinity. While there would be changes to Delta exports and outflows, changes in Delta water quality would not be impacted, as noted in Table D-5 of Appendix D. **This impact would be less than significant.**

Pacheco Reservoir is not located within a flood hazard, tsunami, or seiche zone. Therefore, construction and operation of Alternative 5 would not result in an increased risk of pollutants released due to project inundation within a flood hazard, tsunami, or seiche zone. **There would be no impact.**

During construction of the Pacheco Reservoir and related pipelines, exposure of bare soils, soil and material stockpiles and the presence of fuels, lubricants, and solid and liquid wastes could cause short-term water quality impacts to the reservoir if not managed properly. Therefore, construction-related activities have the potential to degrade water quality and create additional sources of polluted runoff. Soil disturbance at surface areas used for construction staging along with excavated material storage and disposal locations could result in localized surface erosion, minor changes in drainage patterns and changes in erosion rates.

Construction activities would likely require permits under Sections 402 and 401 of the CWA. Preparation of a SWPPP would be required by the RWQCB under the Construction General Permit. **Nevertheless, this impact would be significant.** Mitigation Measure WQ-1, described below in Section 4.1.8, would be implemented to significantly decrease erosion rates and delivery of sediments and any other resident pollutants to surface waters during construction and following construction prior to and after the reestablishment of vegetation at construction sites. **Therefore, this impact would be less than significant after mitigation.**

Similar to Alternative 2, SCVWD would be able to fully divert its CVP allocation under Alternative 5 and would not have to leave water in San Luis storage as it does in the No Action/No Project Alternative; therefore, reservoir levels would be lower (see Table D-16 in Appendix D). Lower San Luis Reservoir levels could promote algae growth and result in reduced DO levels, increasing cyanobacteria levels and associated taste and odor issues, which would adversely affect beneficial uses. However, based on the small changes in overall reservoir storage, as well as the regular refill during fall and winter, neither water quality nor beneficial uses are expected to be substantially changed as a result of the alternative.

The expanded Pacheco Reservoir would continue to limit the frequency of and impact from harmful cyanobacteria blooms in Pacheco Reservoir. Prior to the implementation of an experimental reservoir operations plan in 2014 designed to improve habitat conditions on Pacheco Creek downstream, cyanobacteria blooms toxic to fish downstream occurred during mid-summer low water storage conditions (Smith 2007, Micko 2014, Smith 2014). Increased reservoir carryover storage under this experimental operations plan limited the occurrence of these cyanobacteria blooms by reserving a larger storage volume in Pacheco Reservoir later in the year. As is noted in Section 2.2.5, since April 2018 North Fork Dam has been operated under the terms of a DWR Division of Safety of Dams order requiring upstream and downstream outlets to be maintained in a fully open position to maintain the lowest possible water surface elevation, limiting the benefits of this experimental reservoir operations plan that had been in place since 2014. Under Alternative 5, the expanded reservoir would, similar to the experimental reservoir operations plan, be operated to minimize low storage volume conditions conducive to cyanobacteria blooms. The import of CVP supplies from San Luis Reservoir is not anticipated to further contribute to these algae conditions given small proportion of these supplies in comparison to the natural inflow to the reservoir. **This impact would be less than significant.**

After construction, the dam and reservoir would be operated in compliance with federal, state, and local regulations. Operation of Alternative 5 would not contribute pollutants identified as impairing water quality in Pacheco Reservoir or Pacheco Creek. In addition, the operation of the new reservoir will provide for improved flows and temperatures in Pacheco Creek. Increased late-spring, summer, and fall flows and reduced water temperatures are anticipated to have beneficial effects on dissolved oxygen levels in Pacheco Creek. Therefore, water quality impacts from the operation of Alternative 5 are not expected to change significantly beyond existing conditions. **This impact would be less than significant.**

Currently, San Felipe Division water users, including SCVWD and SBCWD, experience water quality issues that affect treatability and use for municipal, industrial, and agricultural irrigation when San Luis Reservoir reaches an elevation of 369 feet or less due to the presence of algal blooms. Following the construction of the expanded Pacheco Dam, SCVWD would have access to additional usable storage capacity during most water year types. **This would be a beneficial impact.**

Several different regional Water Quality Control Plans govern water bodies within the SLLPIP area of analysis (See Section C.2.24 in Appendix C). As previously discussed, changes to Delta water quality would be minimal and would not cause nuisance conditions or adversely affect beneficial use of the Delta. Operation of Alternative 5 is not expected to change water quality significantly beyond existing conditions and would not adversely affect beneficial use of Pacheco Creek. Construction-related activities have the potential to degrade water quality under Alternative 5, which could adversely affect beneficial use of Pacheco Reservoir and conflict with a water quality control plan. Water quality regulations require preparation of a SWPPP, BMPs, monitoring and other construction controls would be required to protect water quality. **Nevertheless, this impact would be significant.** Mitigation Measure WQ-1, described below in Section 4.1.8, would be implemented to decrease erosion rates and delivery of sediments along with any other resident pollutants to surface waters. **Therefore, conflicts with water quality control plans would be less than significant after mitigation.**

4.1.8 Mitigation Measures

Mitigation Measure WQ-1: Construction Water Quality Impact Avoidance Measures. The following construction requirements will be required by Reclamation for Alternatives 2 and 4, and SCVWD for Alternatives 3 and 5, to help avoid adverse water quality impacts. Many of these construction requirements were modified from those listed in the SCVWD Best Management Practices Handbook, as noted (SCVWD 2014).

1. **General Requirements for Construction Personnel**
   a. All food-related trash items such as wrappers, cans, bottles, and food scraps generated during construction, subsequent facility operation, or permitted operations and maintenance activities of existing facilities will be disposed of in closed containers only and removed at least once a week from the site.

   b. Dispose of refuse frequently. Prohibit burning or burying refuse inside the plan area.

2. **Assess Pump/Generator Set Operations and Maintenance**

   Pumps and generators will be maintained and operated in a manner that minimizes impacts to water quality and aquatic species.

   a. Pumps and generators will be maintained according to manufacturers' specifications to regulate flows to prevent dry-back or washout conditions.

   b. Pumps will be operated and monitored to prevent low water conditions, which could pump muddy bottom water, or high water conditions, which creates ponding.

   c. Sufficient back-up pumps and generators will be onsite to replace defective or damaged pumps and generators.

d. Pumps and generators that operate within the bankfull channel will be placed in a suitable containment structure to prevent the accidental release of hydrocarbons into area waterways.

3. **Handle Sediments so as to Minimize Water Quality Impacts**

Sediments will be stored and transported in a manner that minimizes water quality impacts.

a. Wet sediments may be stockpiled outside of a live stream or water body so water can drain or evaporate before removal.

b. This measure applies to saturated, not damp, sediments and depends upon the availability of a stockpile site.

c. Water draining from stockpiles will not be allowed to flow back into a water body or into local storm drains that enter the creek, unless water quality protection measures recommended by the RWQCB are implemented.

d. Trucks may be lined with an impervious material (e.g. plastic), or the tail gate blocked with dry dirt or hay bales, for example, or trucks may drain excess water by slightly tilting their loads and allowing the water to drain out.

e. Water will not drain directly into water bodies (outside of the work area) or onto public streets without providing water quality control measures.

f. Streets will be cleared of mud and/or dirt by street sweeping (with a vacuum-powered street sweeper), as necessary, and not by hosing down the street.

4. **Avoid Runoff from Soil Stockpiles**

If soil is to be stockpiled, no run-off will be allowed to flow to a water body. Store and stabilize excavated material in upland areas to prevent discharge into water bodies or wetlands. Stockpiled materials should be covered during the rainy season when not in use.

5. **Use Temporary Seeding for Erosion Control As Appropriate**

For banks that are scraped, an erosion control seed mix will be used. Temporary earthen access roads will be seeded when site and horticultural conditions are suitable.

6. **Stabilize Construction Entrances and Exits**

Measures will be implemented to minimize soil from being tracked onto streets near work sites:

a. Methods used to prevent mud from being tracked out of work sites onto roadways include installing a layer of geotextile mat, followed by a 4-inch thick layer of 1 to 3-inch diameter gravel on unsurfaced access roads.

b. Access will be provided as close to the work area as possible, using existing ramps where available and planning work site access so as to minimize disturbance to the water body bed and banks, and the surrounding land uses.

7. **Maintain Clean Conditions at Work Sites**

The work site, areas adjacent to the work site, and access roads will be maintained in an orderly condition, free and clear from debris and discarded materials. Personnel will not sweep, grade, or flush surplus materials, rubbish, debris, or dust into storm drains or waterways.

Upon completion of work, all building materials, debris, unused materials, concrete forms, and other construction-related materials will be removed from the work site.

8. **Assure Proper Vehicle and Equipment Fueling**

No fueling will be done in a waterway or immediate flood plain, unless equipment stationed in these locations is not readily relocated (i.e., pumps, generators).

a. For stationary equipment that must be fueled on-site, containment will be provided in such a manner that any accidental spill of fuel will not be able to enter the water or contaminate sediments that may come in contact with water.

b. Any equipment that is readily moved out of the waterway will not be fueled in the waterway or immediate flood plain.

c. All fueling done at the job site will provide containment to the degree that any spill will be unable to enter any waterway or damage riparian vegetation (SCVWD 2014).

9. **Assure Proper Vehicle and Equipment Maintenance**

No equipment servicing will be done in a water body or immediate flood plain, unless equipment stationed in these locations cannot be readily relocated (i.e., pumps, generators).

a. Any equipment that can be readily moved out of the water body will not be serviced in the water body or immediate flood plain.

b. All servicing of equipment done at the job site will provide containment to the degree that any spill will be unable to enter any channel or damage stream vegetation.

c. If emergency repairs are required in the field, only those repairs necessary to move equipment to a more secure location will be done in a water body or flood plain.

d. If emergency repairs are required, containment will be provided equivalent to that done for fueling or servicing.

e. Inspect equipment for hydraulic and oil leaks prior to use on construction sites, and implement inspection schedules to prevent contamination of soil and water.

f. Dispose of volatile wastes and oils in approved containers for removal from the site to avoid contamination of soils, drainages, and watercourses

10. **Spill Prevention and Control**

Prevent the accidental release of chemicals, fuels, lubricants, and non-storm drainage water.

a. Field personnel will be appropriately trained in spill prevention, hazardous material control, and clean-up of accidental spills.

b. No fueling, repair, cleaning, maintenance, or vehicle washing will be performed in a creek channel or in areas at the top of a channel bank that may flow into a creek channel (SCVWD 2014).

c. Keep absorbent pads, booms, and other material on-site to contain oil, hydraulic fluid, and solvents in locations where heavy equipment is used.

11. **Manage Well or Exploratory Boring Materials**

All materials or waters generated during drilling, well or exploratory boring construction, well development, pump testing, or other activities associated with wells or exploratory borings, will be safely handled, properly managed, and disposed of according to all applicable Federal, State, and local statutes regulating such. In no case will these materials and/or waters be allowed to enter, or potentially enter, on- or off-site storm sewers, dry wells, or waterways. Such materials/waters must not be allowed to move off the property where the work is being completed (SCVWD 2014).

12. **Protect Well or Exploratory Borings from Contaminants**

Any substances or materials that may degrade groundwater quality will not be allowed to enter any well or boring. Lubricants used on drill bits, drill pipe, or tremie pipe will not be comprised of oily or greasy substances or other materials that may degrade groundwater quality. Well openings or entrances will be sealed or secured in such a way as to prevent the introduction of contaminants (SCVWD 2014).

13. **Prevent Stormwater Pollution**

Suitable erosion control, sediment control, source control, treatment control, material management, and non-stormwater management BMPs will be implemented consistent with the latest edition of the California Stormwater Quality Association "Stormwater Best Management Practices Handbook" (SCVWD 2014).

14. **Manage Groundwater at Work Sites**

If high levels of groundwater in a work area are encountered, the water will be pumped out of the work site. If necessary to protect water quality, the water will be directed into specifically constructed infiltration basins, into holding ponds, or onto areas with vegetation to remove sediment prior to the water re-entering a receiving water body. Water pumped into vegetated areas will be pumped in a manner that will not create erosion around vegetation.

4.2 Surface Water Supply

4.2.1 Assessment Methods

This chapter estimates the potential water supply effects of SLLPIP implementation using the CalSim II model (see Appendix B for a model description). Because the differences between existing conditions and the No Action/No Project Alternative are minimal (generally less than 10 AF), the analysis compares the impacts of the action alternatives only to the impacts of the No Action/No Project Alternative. Appendix N describes the changes to water supply associated with each action alternative and includes the detailed modeling results and interpretation of those results.

4.2.2 Significance Criteria

Impacts on water supply would be considered significant if the alternative would: (1) Substantially reduce the annual supply of water available to the CVP, SWP, or other water users. This criterion, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-2.

4.2.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Under the No Action/No Project Alternative, the CVP and SWP would continue to operate and provide water supply, as under existing conditions. Future changes in hydrology, land use, and regulations could affect water deliveries; however, the types of changes that could occur are unclear and incorporating these changes into the No Action/No Project Alternative would be speculative.

Under the No Action/No Project alternative, SCVWD operations would remain the same as existing conditions. Under this alternative, modeling results have predicted that there would be 17 years (out of the 82 calendar years analyzed) where the San Luis Reservoir would be drawn below 300 TAF of storage, i.e. low point years. During dry years when a low point supply interruption occurs (or could occur) SCVWD would change operations to ensure adequate supplies for essential uses and public health and safety. Low point events would likely result in reduced deliveries of treated water and would require using alternative supplies that would otherwise be dedicated to other uses to reduce the potential for curtailments to M&I customers. SCVWD would likely rely on local and other imported water supplies to cover the periods when CVP supplies were not available; however, local and imported water supplies may or may not be able to meet demands during the low point years. **This would be a significant impact.** The proposed action alternatives considered as a part of the SLLPIP would mitigate this impact, however as a part of the No Action/No Project Alternative they cannot be considered. **Therefore, this impact is significant and unavoidable.**

Table 4-2. Water Supply Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Substantially reduce the annual supply of water available to the CVP, SWP, or other water users.	Evaluation of how the alternatives could change CVP and SWP water supply deliveries	1	S, SU	--	Section 4.2.3, Appendix B, Appendix N
		2	South-of-Delta CVP and SWP - LTS SCVWD - B	None	Section 4.2.4, Appendix B, Appendix N
		3	South-of-Delta CVP and SWP - LTS SCVWD - B	None	Section 4.2.5, Appendix B, Appendix N
		4	S, SU (Short-term, with shear key) NI (Short-term, without shear key) South-of-Delta SWP - LTS (Long-term) South-of-Delta CVP - B (Long-term)	None	Section 4.2.6, Appendix B, Appendix N
		5	South of Delta CVP and SWP - LTS SCVWD - B	None	Section 4.2.7, Appendix B, Appendix N

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.2.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

4.2.4.1 South-of-Delta CVP and SWP Facilities and Contractors

Construction of Alternative 2 could result in temporary interruptions in CVP water supply to the San Felipe Division. Both SCVWD and SBCWD would be provided a schedule ahead of time with any planned short-term outages and are expected to be able to rely on other existing local supplies. Long-term operation of Alternative 2 would support the delivery of M&I water supply to SCVWD that is currently interrupted during low point conditions and carried over in San Luis Reservoir as undelivered supply. This reduction in undelivered supply could generate small reductions in deliveries in subsequent years to other South-of-Delta CVP and SWP contractors.

Under Alternative 1, deliveries from San Luis Reservoir to SCVWD are interrupted during low point events. These supplies remain in San Luis storage and increase the amount of reservoir carryover storage. In the year following a low point event, the amount of water in San Luis would be greater than in years without prior low point events because of the undelivered SCVWD water. Under Alternative 2, average storage in San Luis Reservoir would be less than Alternative 1 because SCVWD would be able to withdraw their full CVP water allocation each year from San Luis Reservoir, even during low point months. This would result in less carryover water stored in San Luis Reservoir and less overall storage during some years. Decreased carryover storage after low point events could decrease deliveries to CVP South-of-Delta agricultural contractors in subsequent years. As shown in Tables N-8 and N-9 in Appendix N, the change in delivery of water to CVP South-of-Delta agricultural contractors would be less than one percent and only evident in above normal, below normal, and dry water years. While Alternative 2 would affect the operations of CVP supplies, SWP supplies would remain unchanged. As shown in Tables N-10 and N-11, there is functionally no difference in the SWP deliveries and surplus water supply. **This impact would be less than significant**.

4.2.4.2 Santa Clara Valley Water District

During a low point issue, Alternative 2 would reduce or avoid the need to blend San Luis Reservoir water with other higher quality water supplies or switch to alternate water supply sources such as groundwater when surface water supplies were reduced. Under this alternative, annual San Felipe Division CVP M&I deliveries would increase on average by 3,200 AF and there would be a negligible difference in agricultural deliveries, as shown in Tables N-12 and N-13. Alternative 2 would allow uninterrupted delivery of SCVWD CVP M&I deliveries in all low point years and would be able to fully replace SCVWD’s unmet treated water demand in 10 of the 17 low point years compared to the No Action/No Project Alternative. **This would be a beneficial long-term water supply impact for SCVWD.**

4.2.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

4.2.5.1 South-of-Delta CVP and SWP Facilities and Contractors

Alternative 3 would allow SCVWD to divert water from San Luis Reservoir regardless of water levels within the reservoir. It would result in similar impacts to South-of-Delta CVP and SWP contractors and benefits to SCVWD as described for Alternative 2 because it would allow uninterrupted deliveries in the same way as Alternative 2. **Impacts from Alternative 3 on South-of-Delta CVP and SWP contractors water supply would be less than significant.**

4.2.5.2 Santa Clara Valley Water District

Alternative 3 would result in modifications to the existing Santa Teresa WTP to allow it to more effectively treat the algae-laden water from San Luis Reservoir and avoid supply curtailments during low point events. Algae-laden water that would have otherwise remained in San Luis Reservoir would be treated at the WTP and then conveyed to users. Alternative 3 would deliver additional M&I supply in all low point years when compared to the No Action/No Project Alternative, reducing SCVWD unmet demand during low point events. **This would be a beneficial long-term water supply impact for SCVWD.**

4.2.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

4.2.6.1 South-of-Delta CVP and SWP Facilities and Contractors

South-of-Delta CVP agricultural deliveries are expected to increase up to 25,000 AF under certain water year types, as shown in Tables N-16 and N-17 in Appendix N. Increased CVP supplies would be available during wetter years when surplus water is available in the Delta and San Luis Reservoir would have filled in the No Action/No Project Alternative. Under this alternative, there would be a slight reduction in Table A SWP deliveries, an average of 3,000 AF, as summarized in Tables N-18 and N-19 in Appendix N. In addition, this alternative would reduce potential surplus water supply (Article 21) deliveries to SWP contractors as CVP deliveries increase. The availability of this surplus water in any particular year is uncertain, and contractors do not base long-term water supply decisions on the availability of this water. **Therefore, operating Alternative 4 would have a less than significant impact on South-of-Delta SWP contractors and a beneficial effect on South-of-Delta CVP contractors.**

As described in Chapter 2, construction of Alternative 4 would be scheduled for completion during times when the reservoir is typically drawn down to lower levels to avoid any adverse impact on storage capacity and water supply. However, implementation of the optional shear key action would require limits on the maximum surface elevation in San Luis Reservoir for two seasons, during the period that the berm foundation would be excavated. This reduction in surface elevation would reduce storage capacity in the reservoir and would limit CVP and SWP deliveries during this construction period. **The Crest Raise Alternative without the shear key option would have no impact on South-of-Delta CVP and South-of-Delta SWP water contractors, however with the shear key option the alternative would have a short-term significant impact for these contractors.**

With the shear key option, the temporary reduction in water supply deliveries would not be able to be replaced reliably from other sources, such as groundwater pumping or water transfers, or new surface storage. Reclamation evaluated the potential use of groundwater banking as an option to replace the lost storage in San Luis Reservoir and determined that given the availability of capacity in existing groundwater banks, the time necessary and complexity of developing a new groundwater bank with the capacity to reduce this impact to a less than significant level, that this option would not be feasible. Similarly, the use of water transfers to mitigate this impact was evaluated and was determined to be unable to meaningfully offset this impact given uncertainty with the availability of willing sellers of sufficient amounts of water and the availability of conveyance capacity to transfer those supplies at the time they are needed. The development of new surface storage at a different location to offset the lost capacity at San Luis Reservoir was determined to be infeasible given the potential for numerous significant environmental effects potentially generated by that action and the time necessary to develop this new storage facility. Given the environmental and technological limits and the time necessary to implement other potential options to offset this impact during the two water years that the Shear Key Option would restrict reservoir operations no feasible[1] mitigation has been identified to reduce these impacts to a less than significant level. **Therefore, the short-term water supply impact under Alternative 4 with the shear key option remains significant and unavoidable.**

4.2.6.2 Santa Clara Valley Water District

Under Alternative 4, annual San Felipe Division CVP M&I and agricultural deliveries would both increase on average by 300 AF, as shown in Tables N-20 and N-21 in Appendix N. The alternative would deliver additional M&I supply in 7 out of the 17 low point years when compared to the No Action/No Project Alternative, partially reducing SCVWD unmet demand during low point events. **This would be a beneficial long-term water supply impact for SCVWD.**

4.2.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Under Alternative 5, SCVWD would transfer 2,000 AF of its CVP water supplies (in below normal water years), directly or through transfer and exchanges, in perpetuity to Reclamation and USFWS' RWSP, for use in the Incremental Level 4 water supply pool for wildlife refuges. **This impact would be beneficial.**

4.2.7.1 South-of-Delta CVP and SWP Facilities and Contractors

Alternative 5 would allow SCVWD to divert water from San Luis Reservoir regardless of water levels within the reservoir. It would result in similar impacts to South-of-Delta CVP and SWP contractors and benefits to SCVWD as described for Alternative 2 because it would allow uninterrupted deliveries in the same way as Alternative 2. **This impact would be less than significant**.

[1] As defined in CEQA Guidelines Section 15364

4.2.7.2 Santa Clara Valley Water District

Under this alternative, the expanded Pacheco Reservoir would provide an alternate source of water to SCVWD during a low point event. It would also provide additional water supply to SCVWD during dry conditions and would increase annual San Felipe Division CVP M&I deliveries on average by 2,800 AF, as shown in Tables N-26 and N-27 in Appendix N. Alternative 5 would allow uninterrupted delivery of SCVWD CVP M&I deliveries 14 out of the 17 low point years when compared to the No Action/No Project Alternative, partially reducing SCVWD unmet demand during low point events. **This would be a beneficial long-term water supply impact for SCVWD.**

4.2.8 Significant Unavoidable Impacts

Alternative 1 and Alternative 4 would have significant and unavoidable impacts on water supply. Under Alternative 1, low point events would continue and likely result in reduced deliveries of treated water to SCVWD M&I customers. The construction of the shear key option under Alternative 4 would temporarily reduce storage in the San Luis Reservoir for two seasons, resulting in a short-term decrease in water supply deliveries to CVP and SWP contractors. No feasible mitigation measures were identified that could reduce these impacts to a less than significant level.

4.3 Groundwater Resources

4.3.1 Assessment Methods

Potential impacts to groundwater resources were estimated using results from the CalSim II model (see Appendix B for description of the assumptions and methods used in the CalSim II model). The CalSim II model provides the projected change in imported water supply under each alternative. Potential changes to groundwater levels, land subsidence, and changes in groundwater quality were assessed qualitatively. For land subsidence, the expected increase in groundwater pumping and drawdown were compared to areas with existing subsidence to identify areas that may be susceptible to impacts. Groundwater quality impacts were assessed by considering areas of known quality concerns and determining whether modeled groundwater drawdown could cause those areas to migrate.

4.3.2 Significance Criteria

An impact would be significant if the proposed alternative would result in: (1) substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin; (2) degradation in groundwater quality such that it would exceed regulatory standards or would substantially impair reasonably anticipated beneficial uses of groundwater; (3) increases in groundwater use that generates permanent/inelastic land subsidence caused by water level declines; or (4) conflict with or obstruct implementation of a sustainable groundwater management plan. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-3.

Table 4-3. Groundwater Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin	Evaluation of how the alternatives could change surface water availability and associated groundwater use in a way that impacted its long-term availability for both water supply and environmental purposes like stream/river inflow or outflow	1	NI	--	Section 4.3.3
		2	South-of-Delta CVP – LTS South-of-Delta SWP – NI SCVWD Service Area - B	None	Section 4.3.4
		3	South-of-Delta CVP – LTS South-of-Delta SWP – NI SCVWD Service Area (Constr.) – LTS SCVWD Service Area (Oper.) – B	None	Section 4.3.5
		4	South-of-Delta CVP – B South-of-Delta SWP – LTS SCVWD Service Area - B	None	Section 4.3.6
		5	South-of-Delta CVP – LTS South-of-Delta SWP – NI SCVWD Service Area - B	None	Section 4.3.7
Cause a degradation in groundwater quality such that it would exceed regulatory standards or would substantially impair reasonably anticipated beneficial uses of groundwater	Evaluation of whether the alternatives would introduce groundwater extraction or recharge facilities in locations where they do not currently exist to determine whether and to what degree they might introduce contaminated water or induce new groundwater migration	1	NI	--	Section 4.3.3
		2	NI	None	Section 4.3.4
		3	NI	None	Section 4.3.5
		4	NI	None	Section 4.3.6
		5	NI	None	Section 4.3.7
Cause an increase in groundwater use that generates a net reduction in groundwater levels that would generate permanent/ inelastic land subsidence caused by water level declines	Evaluation of how the alternatives could change surface water availability and associated groundwater use in a way that would contribute to any permanent/ inelastic land subsidence	1	NI	--	Section 4.3.3
		2	NI	None	Section 4.3.4
		3	NI	None	Section 4.3.5
		4	NI	None	Section 4.3.6
		5	NI	None	Section 4.3.7

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Conflict with or obstruct implementation of a sustainable groundwater management plan	Evaluation of whether construction or operation of the alternatives could conflict with or obstruct implementation of a sustainable groundwater management plan.	1	NI	--	Section 4.3.3
		2	NI	None	Section 4.3.4
		3	NI	None	Section 4.3.5
		4	B	None	Section 4.3.6
		5	NI	None	Section 4.3.7

Key: Alt = alternative; B = beneficial; Constr. = construction; LTS = less than significant; NI = no impact; Oper. = operation; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.3.3 Environmental Consequences/Environmental Impacts of Alternative 1 - No Action/No Project Alternative

Under the No Action/No Project Alternative, future reductions in CVP and SWP deliveries via the Delta-Mendota Canal to South-of-Delta contractors could result in increased groundwater use. However, implementation of the Sustainable Groundwater Management Act (SGMA) could establish limits on groundwater use within the valley and prevent additional overdraft. The types and magnitude of changes in imported supplies and groundwater use that could occur are not currently known and incorporating these changes into the No Action/No Project Alternative would be speculative. **Under the No Action/No Project Alternative, groundwater use in the CVP and SWP contractor service areas would be same as under existing conditions and there would be no impact.**

SCVWD would continue to rely on local surface water supplies and groundwater during dry periods when local and imported water supplies do not meet Santa Clara County's water needs. Groundwater levels within the county (Santa Clara and Llagas subbasins) would continue to have fluctuations based on hydrologic conditions (with increased drawdown during dry periods). Under the No Action/No Project Alternative, these fluctuations would be similar to those under existing conditions. SCVWD off-stream recharge facilities depend on locally conserved and imported water deliveries. SCVWD would continue operating recharge facilities and accessing groundwater supplies to anticipating interruptions or curtailment of imported CVP supply from San Luis Reservoir; however, local and imported water supplies may or may not be able to meet demands during the low point years. This alternative would continue to subject SCVWD's customers to water curtailments. **Under the No Action/No Project Alternative, the SCVWD recharge facilities would be operated in the same manner as under existing conditions and there would be no impact.**

4.3.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Alternative 2 would not introduce groundwater extraction or recharge facilities in locations where they do not currently exist and as a result would have no effect on groundwater quality through the introduction of contaminated water or the inducement of new groundwater migration. Alternative 2 also would not involve any construction activities with the potential to decrease groundwater levels or contribute to any permanent/ inelastic land subsidence. **There would be no impact.**

Alternative 2 would result in less carryover water stored in the San Luis Reservoir and potentially decrease deliveries to South-of-Delta CVP agricultural contractors. Supply shortages due to decreased imported water deliveries could be made up through groundwater pumping in addition to existing groundwater pumping. Under Alternative 2 reductions to imported deliveries would be minimal, at an annual average of approximately 2,000 AF reduction in supplies to South-of-Delta CVP agricultural contractors. The Central Valley Hydrologic Model (CVHM) estimates groundwater pumping in the western portion of the valley to be approximately 60,000 AF per year. Therefore, potential increase in groundwater pumping, even if all the deficit in delivery is made up via groundwater pumping, would be less than 4 percent of the total pumping in the area. **This impact would be less than significant**.

Alternative 2 would affect the operations of CVP supplies, but SWP supplies would remain unchanged. **Therefore, groundwater pumping under this alternative would be same as under existing conditions and there would be no impact.**

Alternative 2 would on average increase San Felipe Division CVP M&I deliveries by 3,200 AF when compared to the No Action/No Project Alternative. Improved water supply reliability during low point years would reduce Santa Clara County's reliance on groundwater to make up the difference between the county's water demands and available local and imported water supplies. Additionally, SCVWD off-stream recharge facilities depend on locally conserved and imported water deliveries. Thus, under Alternative 2, SCVWD would be better able to operate recharge facilities. **This impact would be beneficial.**

Alternative 2 would impact groundwater use in the South-of-Delta CVP contractor service area, which includes medium and high priority subbasins. SGMA requires those high and medium priority basins to be managed under a groundwater sustainability plan by January 31, 2020. Implementation of the groundwater sustainability plans would establish limits on groundwater use within the subbasins and prevent additional overdraft. The potential 4 percent increase of total pumping in the area would not significantly impact the sustainable management of the subbasins. **Construction and operation of Alternative 2 would not conflict with or obstruct the implementation of a sustainable groundwater management plan.**

4.3.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Alternative 3 would not introduce groundwater extraction or recharge facilities in locations where they do not currently exist and, as a result, would have no effect on groundwater quality through the introduction of contaminated water or the inducement of new groundwater migration or contribute to any permanent/ inelastic land subsidence. **There would be no impact.**

The effects in the CVP contractors' service area under this alternative would be similar to the impacts under Alternative 2. **This impact would be less than significant**. Similar to Alternative 2, Alternative 3 would affect the operations of CVP supplies, but SWP supplies would remain unchanged. **There would be no impact.**

Excavation and trenching activities during construction might encounter groundwater; however, Santa Teresa WTP is not located over a groundwater aquifer and the likelihood of encountering groundwater would be minimal. If any groundwater is encountered during construction activities, it would be pumped from the excavated area and contained and treated in accordance with all applicable State and Federal regulations before being discharged. This pumping of groundwater from the shallow aquifer encountered by these trenching activities could cause temporary groundwater level declines at the Santa Teresa WTP during construction activities. These impacts would only occur during construction and any dewatering activities would end after construction is complete. **This impact would be short-term and less than significant**.

Alternative 3 would on average increase San Felipe Division CVP M&I deliveries by 3,200 AF when compared to the No Action/No Project Alternative. Improved water supply reliability during low point years would reduce Santa Clara County's reliance on groundwater to make up the difference between the county's water demands and available local and imported water supplies. Additionally, SCVWD off-stream recharge facilities depend on locally conserved and imported water deliveries. Thus, under Alternative 3 SCVWD would be better able to operate recharge facilities. **This impact would be beneficial.**

Alternative 3 would impact groundwater use in the South-of-Delta CVP contractor service area, which includes medium and high priority subbasins. SGMA requires those high and medium priority basins to be managed under a groundwater sustainability plan by January 31, 2020. Implementation of the groundwater sustainability plans would establish limits on groundwater use within the subbasins and prevent additional overdraft. The potential 4 percent increase of total pumping in the area would not significantly impact the sustainable management of the subbasins. **Construction and operation of Alternative 2 would not conflict with or obstruct the implementation of a sustainable groundwater management plan.**

4.3.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Alternative 4 would not introduce groundwater extraction or recharge facilities in locations where they do not currently exist and as a result would have no effect on groundwater quality through the introduction of contaminated water or the inducement of new groundwater migration. Alternative 4 also would not involve any construction activities with the potential to decrease groundwater levels or contribute to any permanent/ inelastic land subsidence. **There would be no impact.**

Alternative 4 would result in increased deliveries to CVP contractors by approximately 14,000 AF per year on average. Alternative 4 would support a reduced reliance on groundwater because of improved imported CVP water supply reliability. Under this alternative, there would be a slight reduction in Table A SWP deliveries, an average of 3,000 AF, and would also reduce potential surplus water supply (Article 21) deliveries to SWP. Potential increases in SWP groundwater pumping even if all the deficit in delivery is made up via groundwater pumping would be minimal. **Therefore, operating Alternative 4 would have a less than significant impact on South-of-Delta SWP groundwater use and a beneficial effect on South-of-Delta CVP groundwater use.**

Alternative 4 would support additional San Felipe Division M&I deliveries of approximately 600 AF on average to meet SCVWD demands. Increased water supply during low point years would reduce Santa Clara County's reliability on groundwater to make up the difference between the county's water demands and available local and imported water supplies. Additionally, SCVWD off-stream recharge facilities depend on imported water deliveries. Thus, under Alternative 4, SCVWD would be able to operate recharge facilities without imported water supply interruptions or curtailment. Alternative 4 would support a reduced reliance on groundwater because of improved imported water supply reliability during low point years which would be beneficial to groundwater resources. **This impact would be beneficial.**

Alternative 4 would reduce reliability on groundwater use in the San Felipe Division and South-of-Delta contractor service area, which includes medium and high priority subbasins. SGMA requires those high and medium priority basins to be managed under a groundwater sustainability plan by January 31, 2020. Implementation of the groundwater sustainability plans would establish limits on groundwater use within the subbasins and prevent additional overdraft. The potential decrease in pumping in the area would improve the sustainable management of the subbasins. **This impact would be beneficial.**

4.3.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Alternative 5 would not introduce groundwater extraction or recharge facilities in locations where they do not exist and would have no effect on groundwater quality through the introduction of contaminated water or the inducement of new groundwater migration. Alternative 5 also would not involve any construction activities with the potential to decrease groundwater levels or contribute to any permanent/ inelastic land subsidence. **There would be no impact.**

The effects in the CVP contractors' service area under this alternative would be similar to the impacts under Alternative 2. **This impact would be less than significant.** Similar to Alternative 2, Alternative 5 would affect the operations of CVP supplies, but SWP supplies would remain unchanged. **There would be no impact.**

Under this alternative, the expanded Pacheco Reservoir would provide an alternate source of water to SCVWD during a low point event. It would also provide additional water supply to SCVWD during dry conditions. Alternative 5 would support additional San Felipe Division deliveries of approximately 2,800 AF on average to meet SCVWD demands. Increased water supply during low point years would reduce Santa Clara County's reliance on groundwater to make up the difference between the county's water demands and available local and imported water supplies. Additionally, SCVWD off-stream recharge facilities depend on imported water deliveries and local supplies. Under Alternative 5, SCVWD would be able to operate recharge facilities without imported water supply interruptions or curtailment during low point years. The Pacheco Reservoir is currently operated under a 2018 DWR Division of Safety of Dams order requiring that the upstream and downstream controls be left fully open to maximize release and maintain the lowest possible surface elevation. Prior to this, under the existing 2014 revised operations plan for Pacheco Reservoir, early season inflow was stored in the reservoir for the purpose of groundwater recharge through releases to Pacheco Creek later in the year.

During construction, a temporary cofferdam and bypass structure would be constructed to ensure flows in Pacheco Creek are maintained. Following construction, average monthly releases to Pacheco Creek would be higher than under existing conditions in most months given the reservoir's current operation with its outlet structures open. Pacheco Creek flows under existing conditions are expected to be higher in January, February and March of wet year types based on historic hydrology from 2012 to 2017. Therefore, there would be an overall increase in downstream Pacheco Creek flows under Alternative 5 in comparison to existing conditions. Consequently, groundwater recharge of the Gilroy-Hollister groundwater subbasin through Pacheco Creek flows would be higher under Alternative 5. In addition, the delivery of Incremental Level 4 refuge water supply to Grassland Resource Conservation District in below normal water years can, in part, reduce reliance on groundwater pumping in a region that has experienced significant land subsidence due to chronic overdraft. **This impact would be beneficial.**

Alternative 5 would impact groundwater use in the South-of-Delta contractor service area, which includes medium and high priority subbasins. SGMA requires those high and medium priority basins to be managed under a groundwater sustainability plan by January 31, 2020. Implementation of the groundwater sustainability plans would establish limits on groundwater use within the subbasins and prevent additional overdraft. The potential 4 percent increase of total pumping in the area would not significantly impact the sustainable management of the subbasins. **Construction and operation of Alternative 5 would not conflict with or obstruct the implementation of a sustainable groundwater management plan.**

4.4 Flood Control

4.4.1 Assessment Methods

Flood impacts under the action alternatives would stem from construction activities impeding flood flow or exposing people to flooding risks. Additionally, short- or long-term increases in runoff could result in flooding impacts. Under Alternative 4 and Alternative 5, surface elevations and total storage capacity would increase at both reservoirs. Potential changes to increases to flood risk are assessed qualitatively.

4.4.2 Significance Criteria

Impacts related to flooding would be considered significant if the project would result in the: (1) substantial alteration of the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would: (a) substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site, (b) impede or redirect flood flows. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-4.

Table 4-4. Flood Control Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Substantial alteration of the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would: (a) substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site, (b) impede or redirect flood flows.	a) Comparison of new proposed infrastructure against stream, river and drainage mapping to determine how it would interact with those features and whether it could alter the rate or amount of surface runoff from the site, b) Comparison of all proposed structures against 100-year flood mapping to determine their relation to the 100-year flood hazard area.	1	NI	--	Section 4.4.3
		2	LTS	None	Section 4.4.4
		3	LTS	None	Section 4.4.5
		4	LTS	None	Section 4.4.6
		5	Construction - LTS Operation - NI	None	Section 4.4.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.4.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

There would be no construction of any new structures under the No Action/No Project Alternative. Under the No Action/No Project Alternative, current operations at San Luis Reservoir, Anderson Reservoir, and Pacheco Reservoir would remain unchanged. Flooding occurrence and flood risk in Merced and Santa Clara Counties would not change. There would be no placement of structures in FEMA-defined flood zones and no alteration of existing drainage patterns. There would be no addition of impervious surfaces and no increase in runoff water that would result in flooding on- or off-site. **There would be no impact.**

4.4.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

All proposed components of Alternative 2 would be located in Flood Zone D, defined as possible but undetermined flood risk. No permanent structures would be placed in the 100-year flood hazard area at San Luis Reservoir. While the potential for flood hazards exists during construction, risks of flood hazard would not increase. Long-term operations of the reservoir would not differ from existing operations in ways that would increase the likelihood or susceptibility of flooding or the risk of dam failure. The aeration system structure would be a new facility with an approximate footprint of 1,200 square feet and constructed on already developed land. Increases in runoff would be negligible and could infiltrate into surrounding pervious land. As mentioned in Section 4.1, preparation of a SWPPP would be required, which would include measures to ensure stormwater during construction does not substantially increase during construction and prior to establishment of revegetation efforts. **Therefore, impacts to the drainage pattern and surface runoff and associated flood risks would be less than significant.**

4.4.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

The Santa Teresa WTP is located in Flood Zone D, defined as possible but undetermined flood risk and there would be no impact to the 100-year flood hazard area. The plant sits on a hillside at an elevation of approximately 450 feet above mean sea level. The nearest creek is found downslope at approximately 265 feet above mean sea level. New structures would be constructed in Zone D and would be surrounded by the existing facility causing no change to flood flows or increased flood risk. Operation of the technology retrofits under Alternative 3 would be similar to existing operations with respect to flood risk related to levee or pond embankment failure. Ground-disturbing construction activities at the Santa Teresa WTP could generate changes in local stormwater drainage patterns and temporarily increase stormwater runoff rates. However, as mentioned in Section 4.1, preparation of a SWPPP would be required, which would include measures to ensure stormwater during construction does not substantially increase during construction to prevent any exceedance of the existing drainage systems capacity. **Therefore, impacts to the drainage pattern and surface runoff and associated flood risks would be less than significant.**

4.4.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Construction activity would temporarily place equipment and structures downstream of the reservoir. Modification to the existing glory hole spillway would temporarily interrupt operation of the spillway. The temporary removal of embankment material and excavation of portions of the embankment down to bedrock would temporarily reduce the dam's capacity until the fill material is replaced. Final design of the corrective action and the dam raise would include a construction schedule that completes this type of work within the portion of a single water year when rain is unlikely and reservoir levels are lower. This schedule approach may require the completion of some construction components in phases over multiple water years. The construction health and safety plan would include a response plan to flood forecasts to suspend construction activities and move equipment to higher ground. The borrow and staging areas would not result in significant additions of new impervious surfaces or structures that would impede flows and are all located upstream of the reservoir. Increases in runoff would be negligible and could infiltrate into surrounding pervious land. As mentioned in Section 4.1, preparation of a SWPPP would be required, which would include measures to ensure stormwater during construction does not substantially increase during construction and prior to establishment of revegetation efforts. Long-term operations of the expanded reservoir under Alternative 4 would not differ significantly from operations under existing conditions. **Impacts to flood flows and flood control system capacity during construction and operation would be less than significant.**

4.4.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction at the Pacheco Pumping Plant is the only work within Merced County, and it would not impede or restrict flood flows nor increase flood risk to the surrounding areas. The area surrounding Pacheco Reservoir and Pacheco Creek in Santa Clara County is primarily within FEMA-designated Flood Zone D with low-lying areas within FEMA-designated Flood Zone A (100-year floodplain). Removal of the existing dam and construction of the new dam, spillway and facilities would temporarily place equipment and temporary and permanent structures within the 100-year floodplain. Flood hazards at North Fork Dam and in the downstream inundation could increase temporarily. Final design would include developing a construction schedule that times the work to occur when rain is unlikely and reservoir levels are lower. The water level would be drawn down prior to removal of the dam and a coffer dam would be constructed upstream of the new dam location. The coffer dam crest would be 500 feet to ensure flows in Pacheco Creek are maintained during construction and accommodate a 50-year flood event. The contractor would be required to develop a health and safety plan, which would include a response plan to flood forecasts to suspend construction activities and move equipment to higher ground.

Borrow areas and access roads are located within Flood Zones A and D. Although proposed improvements would be in areas of the 100-year floodplain and where flood risks are undetermined, they would not result in significant additions of new impervious surfaces or structures that would impede flows in undeveloped areas around the reservoir. The drawdown prior to construction would reduce the risk of flooding during construction. With the timing of construction and the reservoir drawdown schedule, no increases in flooding, including flooding from failure of a levee or dam, would be anticipated. Construction activities would not significantly alter the existing drainage patterns or increase stormwater runoff. New permanent access roads would replace existing access roads to be inundated with the new reservoir capacity and would be similar in size to the existing access roads. As mentioned in Section 4.1, preparation of a SWPPP would be required, which would include measures to control stormwater runoff and ensure runoff volumes do not substantially increase to prevent any exceedance of the existing drainage systems capacity. Permanent post-construction controls would be identified in the SWPPP to reduce erosion and flooding. **Impacts to flood flows and flood control system capacity during construction would be less than significant.**

Long term operation of the reservoir would alter the physical structure of Pacheco Creek, changing the size and location of areas impacted by flooding. However, through design of project features and incidental increased storage during the flood season, Alternative 5 would reduce downstream flood flows and corresponding flood stages along Pacheco Creek, by storing and regulating the release of peak flows during storm events. **There would be no impact to flood flows and flood control system capacity during operation of Alternative 5.**

4.5 Geology and Soils

4.5.1 Assessment Methods

The environmental consequences of the proposed alternatives were analyzed qualitatively, based on a review of soil, geologic, and paleontological data. Analysis of potential impacts focuses on the alternatives' potential to increase the risk of personal injury, loss of life, and damage to property, including project facilities, as a result of geologic conditions in the area of analysis as well as the alternative's potential to destroy paleontological resources. Because substantive changes to geology and soils are not anticipated into the future, the analysis compares the impacts of the action alternatives only to the impacts of the No Action/No Project Alternative.

4.5.2 Significance Criteria

Impacts related to geology, seismicity, and soils would be considered significant if the project would: (1) directly or indirectly cause potential substantial adverse effects, including risk of loss, injury, or death, through rupture of a known earthquake fault; strong seismic ground shaking; seismic-related ground failure; and landslides; (2) be located on a geologic unit or soil that is unstable or would become unstable as a result of the project, and potentially would result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse; (3) be located on expansive soil[2], creating substantial direct or indirect risk to life or property; (4) result in substantial soil erosion or the loss of topsoil; (5) result in the loss of availability of a known mineral resource that would be of value to the region and residents of the State; (6) result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan; or (7) directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. These criteria, the associated

[2] As defined in Table 18-1-B of the UBC (1994)

significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-5.

4.5.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Under the No Action/No Project Alternative, current operations at San Luis Reservoir and Pacheco Reservoir would remain unchanged. There would be no construction activities and no impact on geology, soils, or paleontological resources in the area of analysis in Merced or Santa Clara Counties. **The No Action/No Project Alternative would result in no impact to geology and soils.**

4.5.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction activities would not directly influence earthquake activity; however, in the case of an earthquake or strong ground movement during construction, workers would be exposed to the risk of loss, injury, or death. San Luis Reservoir is located within a low to medium landslide hazard area. Construction and tunneling activities would follow standard safety measures as well as compliance with safety requirements of the Federal Occupational Safety and Health Administration (OSHA). In addition, construction activities would not result in moisture changes in soils and would have no impacts from expansive soils. Potential impacts would be similar for both the tunnel construction and pipeline construction. Construction activities could impact soil erosion and result in the potential for loss of topsoil around San Luis Reservoir where construction would take place. As mentioned in Section 4.1, a SWPPP would be implemented to control accelerated erosion and loss of topsoil during and after project construction.

While earthquake activity and unstable soil pose a risk if strong seismic ground shaking and associated ground failure, liquefaction, or landslides occurred while workers were on-site for maintenance activities, the action alternative is not constructing structures for human habitation. Additionally, regular maintenance occurs at the facilities under existing conditions; therefore, operation and maintenance under Alternative 2 would not result in risks greater than the existing conditions. In addition, this alternative would be designed to accommodate potential seismic-related ground shaking and ground failure generated by nearby faults without structure failure. Engineering design would include emergency shutoff features in the event of structure failure to prevent impacts to other existing water conveyance infrastructure. **Alternative 2 would have less than significant impact to geology and soils.**

Table 4-5. Geology and Soils Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Directly or indirectly cause potential substantial adverse effects, including risk of loss, injury, or death, through rupture of a known earthquake fault; strong seismic ground shaking; seismic-related ground failure; and landslides	Comparison of all proposed alternative infrastructure locations to available fault mapping, seismic risk data, liquefaction risk, and landslide mapping data	1	NI	--	Section 4.5.3
		2	LTS	None	Section 4.5.4
		3	LTS	None	Section 4.5.5
		4	LTS	None	Section 4.5.6
		5	LTS	None	Section 4.5.7
Located on a geologic unit or soil that is unstable or would become unstable as a result of the project, and potentially would result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse	Comparison of all proposed alternative infrastructure locations to available unstable soil mapping data	1	NI	--	Section 4.5.3
		2	NI	None	Section 4.5.4
		3	NI	None	Section 4.5.5
		4	LTS	None	Section 4.5.6
		5	LTS	None	Section 4.5.7
Complete construction on expansive soils creating a substantial risk to life or property	Comparison of all proposed alternative infrastructure locations to available expansive soil mapping data	1	NI	--	Section 4.5.3
		2	NI	None	Section 4.5.4
		3	NI	None	Section 4.5.5
		4	LTS	None	Section 4.5.6
		5	LTS	None	Section 4.5.7
Result in substantial soil erosion or the loss of topsoil	Evaluation of how construction or operation of the alternatives could result in soil erosion or the loss of topsoil.	1	NI	--	Section 4.5.3
		2	LTS	None	Section 4.5.4
		3	LTS	None	Section 4.5.5
		4	LTS	None	Section 4.5.6
		5	LTS	None	Section 4.5.7
Result in the loss of availability of a known mineral resource of regional or local importance	Comparison of all proposed alternative infrastructure locations to available mineral resource mapping data	1	NI	--	Section 4.5.3
		2	NI	None	Section 4.5.4
		3	NI	None	Section 4.5.5
		4	NI	None	Section 4.5.6
		5	NI	None	Section 4.5.7

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Result in long term impacts to geology, soils, or mineral resources	Comparison of all proposed alternative infrastructure locations to available geology, soils, or mineral resources mapping data	1	NI	--	Section 4.5.3
		2	NI	None	Section 4.5.4
		3	NI	None	Section 4.5.5
		4	NI	None	Section 4.5.6
		5	NI	None	Section 4.5.7
Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature	Evaluation of the potential for impacts to known or previously undiscovered paleontological resources or unique geologic features through the review of literature and previously completed survey reports to determine the potential for impacts to known resources and estimate the potential for impacts to previously undiscovered resources.	1	NI	--	Section 4.5.3
		2	S, LTS	PR-1	Section 4.5.4
		3	NI	None	Section 4.5.5
		4	S, LTS	PR-1	Section 4.5.6
		5	S, LTS	PR-1	Section 4.5.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

Construction activities would not affect the availability of a known mineral resource of value to the region or State, or cause the loss of a locally important resource recovery site. **There would be no impacts to mineral resources.**

There are no unique geologic features that could be directly or indirectly destroyed during construction and operation of Alternative 2. There is the potential to encounter previously undetected but potentially significant paleontological resources during construction of Alternative 2. The area surrounding San Luis Reservoir has been ranked as low to moderately sensitive (see Section 3.8.4 in Chapter 3). Therefore, there is a low to moderate probability of encountering previously undetected paleontological resources in the vicinity of known paleontological resources, in areas of poor surface visibility where detection may have been impeded, and in areas that have not been subject to prior investigation. **Impacts would be significant.** Mitigation Measure PR-1, discussed in Section 4.5.8, would ensure earthmoving construction activities would be monitored by a qualified paleontologist and implementation of measures to avoid, record, preserve, or recover unique paleontological resources if encountered. **Implementation of Mitigation Measure PR-1 would reduce these impacts to a less than significant.**

4.5.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Construction activities would not directly influence earthquake activity; however, in the case of an earthquake or strong ground movement during construction, workers would be exposed to the risk of loss, injury, or death. Construction at the Santa Teresa WTP would follow standard safety measures and compliance with safety requirements of the Federal OSHA. While earthquake activity during construction could result in adverse effects to workers, this risk is temporary during the timeframe of construction. Additionally, Alternative 3 would not construct structures for human habitation. Construction would take place on already developed sites and would not result in moisture changes in soils. In addition, there is no unstable soil and no landslide or liquefaction zones near the WTP. Construction activities could impact soil erosion and result in the potential for loss of topsoil around Santa Teresa WTP where construction would take place. As mentioned in Section 4.1, a SWPPP would be implemented to control accelerated erosion and loss of topsoil during and after project construction. Following construction, operations at the WTP would be the same as under existing conditions and there would be no long-term impact. **Alternative 3 would have short term, less than significant impact to geology and soils.**

Construction activities would not affect the availability of a known mineral resource of value to the region or State, or cause the loss of a locally important resource recovery site. **There would be no impacts to mineral resources.**

No new or expanded facilities are proposed under Alternative 3, and all technological retrofits would be made within the existing footprint of the Santa Teresa WTP. Therefore, there are no unique geologic features that could be directly or indirectly destroyed and there is no potential to encounter significant paleontological resources during construction and operation of Alternative 3. **There would be no impacts to geologic features or paleontological resources.**

4.5.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

The area where construction would take place at San Luis Reservoir is not in a high landslide or liquefaction hazard area; however, ground failure can occur during earthquake activity. Pre-construction design would include the detailed survey and mapping of any locations in the construction footprint with the potential for liquefaction and landslide and the development of construction plans to avoid or minimize that risk. Construction activities would not directly influence earthquake activity; however, in the case of an earthquake or strong ground movement during construction, workers would be exposed to the risk of loss, injury, or death. Construction activities would follow the safety requirements of OSHA to reduce the potential for harm to construction workers or equipment. Construction activities requiring the excavation and redevelopment of the dam foundation and embankment slope would be scheduled for completion during periods of the year when reservoir storage levels are lower to limit potential for a seismic event during construction to cause dam overtopping or failure that could expose construction workers to injury or death. In addition, construction activities that would result in moisture changes in soils would be evaluated during engineering design to accommodate potential soil expansion. Construction activities and reservoir-level fluctuations would have the potential to contribute to accelerated soil erosion and loss of top soil around San Luis Reservoir where construction would take place. As mentioned in Section 4.1, a SWPPP would be implemented to control accelerated erosion and loss of topsoil during and after project construction. Erosion resulting from reservoir fluctuations would be contained by the reservoir and could be minimized through management of reservoir-level operations.

While earthquake activity and unstable soil pose a risk if strong seismic ground shaking and associated ground failure, liquefaction, or landslides occurred while workers were on-site for operations, the San Luis Reservoir expansion is not constructing structures for human habitation. Additionally, regular maintenance occurs at the facilities under existing conditions; therefore, operation and maintenance associated with Alternative 4 would not result in risks that are greater than existing conditions. In addition, Alternative 4 would be designed to accommodate potential seismic-related ground shaking and ground failure generated by nearby faults without structure failure based on the findings of the geologic investigations and engineering designs developed for the Safety of Dams Corrective Action Study. **Alternative 4 would have less than significant impact to geology and soils.**

Construction activities would not affect the availability of a known mineral resource of value to the region or State, or cause the loss of a locally important resource recovery site. **There would be no impacts to mineral resources.**

There are no unique geologic features that could be directly or indirectly destroyed during construction and operation of Alternative 4. There is the potential to encounter previously undetected but potentially significant paleontological resources during construction of Alternative 4. The area surrounding San Luis Reservoir has been ranked as low to moderately sensitive (see Section 3.8.4 in Chapter 3). Therefore, there is a low to moderate probability of encountering previously undetected paleontological resources in the vicinity of known paleontological resources, in areas of poor surface visibility where detection may have been impeded, and in areas that have not been subject to prior investigation. **Impacts would be**

significant. Mitigation Measure PR-1, discussed in Section 4.5.8, would ensure earthmoving construction activities would be monitored by a qualified paleontologist and implementation of measures to avoid, record, preserve, or recover unique paleontological resources if encountered. **Implementation of Mitigation Measure PR-1 would reduce these impacts to a less than significant.**

4.5.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activities would not take place in a high liquefaction hazard area and would not directly influence earthquake activity; however, in the case of an earthquake or strong ground movement during construction, workers would be exposed to the risk of loss, injury, or death. Construction activities would follow the safety requirements of OSHA to reduce the potential for harm to construction workers or equipment. Moderate expansive soils are present surrounding Pacheco Reservoir, however construction activities that would result in moisture changes in soils and result in expansive soils, would be evaluated during engineering design to accommodate potential soil expansion. Construction activities and reservoir-level fluctuations would have the potential to contribute to accelerated soil erosion and loss of top soil around Pacheco Reservoir where construction would take place. As mentioned in Section 4.1, a SWPPP would be implemented to control accelerated erosion and loss of topsoil during and after project construction. Erosion resulting from reservoir fluctuations would be contained by the reservoir and could be minimized through management of reservoir-level operations.

Earthquake activity and unstable soil pose a risk if strong seismic ground shaking and associated ground failure, liquefaction, or landslides occurred while workers were on-site for operations; however, this alternative is not constructing structures for human habitation and regular maintenance occurs at the facilities under existing conditions; therefore, operation and maintenance associated with Alternative 5 would not result in risks that are greater than existing conditions. In addition, the Pacheco Reservoir Expansion Alternative would be designed to accommodate potential seismic-related ground shaking and ground failure generated by nearby faults without structure failure. **Alternative 5 would have less than significant impact to geology and soils.**

Construction activities would not affect the availability of a known mineral resource of value to the region or State, or cause the loss of a locally important resource recovery site. **There would be no impacts to mineral resources.**

There are no unique geologic features that could be directly or indirectly destroyed during construction and operation of Alternative 5. There is the potential to encounter previously undetected but potentially significant paleontological resources during construction of Alternative 5. The area surrounding Pacheco Reservoir has been ranked as low to moderately sensitive (see Section 3.8.4 in Chapter 3).Therefore, there is a low to moderate probability of encountering previously undetected paleontological resources in the vicinity of known paleontological resources, in areas of poor surface visibility where detection may have been impeded, and in areas that have not been subject to prior investigation. **Impacts would be significant.** Mitigation Measure PR-1, discussed in Section 4.5.8, would ensure earthmoving construction activities would be monitored by a qualified paleontologist and implementation of measures to avoid, record, preserve, or recover unique paleontological resources if encountered. **Implementation of Mitigation Measure PR-1 would reduce these impacts to less than significant.**

4.5.8 Mitigation Measures

Mitigation Measure PR-1: Avoidance and Management of Inadvertent Paleontological Discoveries. The following construction requirements will be required by Reclamation for Alternatives 2 and 4, and SCVWD for Alternative 5, to help avoid adverse paleontological resource impacts. A qualified paleontologist will monitor earth moving construction activities that have the potential to disturb previously undisturbed native sediment. Monitoring will not be conducted in areas where the ground has been previously disturbed, in areas of artificial fill, or in areas where exposed sediment will be buried, but not otherwise disturbed. If paleontological remains are discovered during construction, construction will cease or be directed away from the discovery, and the potential resource will be evaluated by the paleontologist. The paleontologist will recommend appropriate measures to avoid, record, preserve, or recover the resource if determined to be unique.

4.6 Indian Trust Assets

Indian Trust Assets (ITAs) are defined as legal interests in property held in trust by the United States government for Indian tribes or individuals, or property protected under United States (U.S.) law for Indian tribes or individuals. An Indian trust has three components: 1) the trustee, 2) the beneficiary, and 3) the trust asset. ITAs can include land, minerals, Federally-reserved hunting and fishing rights, Federally-reserved water rights, and in-stream flows associated with a reservation or Rancheria. Beneficiaries of the Indian trust relationship are federally-recognized Indian tribes with trust land. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the U.S. The characterization and application of the U.S. trust relationship have been defined by case law that supports Congressional acts, executive orders, and historic treaty provisions. There are no ITAs within or adjacent to the area of analysis, so there would be no impact to ITAs from SLLPIP actions. A map indicating the closest ITAs to the study area is included in Appendix H. The ITAs in closest proximity to the area of analysis are Chicken Ranch ITA, northeast of Merced County in Tuolumne County, and Picayune ITA, east of Merced County in Madera County.

4.7 Air Quality

4.7.1 Assessment Methods

This section describes the assessment methods used to analyze potential air quality effects of the alternatives, including the No Action/No Project Alternative. Construction-related emissions were estimated using the following sources: OFFROAD2017 web database (California Air Resources Board [CARB] 2017), EMFAC2014 web database (CARB 2014), California Emission

Inventory and Reporting System particulate matter speciation profiles (CARB 2016), paved road dust emission factors (USEPA 2011), CalEEMod User's Guide, Appendix D: Default Data Tables (California Air Pollution Control Officers Association [CAPCOA] 2017), and rulemaking documentation related to diesel engines on commercial harbor craft (CARB 2004, CARB 2007, CARB 2010). Appendix O provides detailed information on the emission calculations for off-road construction equipment exhaust; on-road haul/vendor truck and construction worker commuting exhaust; fugitive dust emissions from unpaved road material handling, grading, and bulldozing; and marine exhaust emissions from dredging activities.

4.7.2 Significance Criteria

Impacts on air quality would be considered significant if the proposed project or alternatives would: (1) conflict with or obstruct implementation of the applicable air quality plan; (2) result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (3) expose sensitive receptors to substantial pollutant concentrations; or (4) result in other emissions (such as those leading to objectionable odors) adversely affecting a substantial number of people. The quantitative significance criteria developed by the local air districts and the general conformity *de minimis* thresholds were developed to determine compliance with the first two significance criteria. This project is subject to the general conformity regulations because it involves a Federal agency (Reclamation) and is in a nonattainment or maintenance area. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-6. The second criterion for cumulative impacts is addressed in Chapter 5, Cumulative Effects, and is not discussed further in this chapter.

Table 4-6. Air Quality Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Conflict with or obstruct implementation of the applicable air quality plan	Estimates of potential emissions from the short-term construction generated and long-term operations and maintenance of the alternatives were developed and compared to significance thresholds established by the respective air district where the alternative would be implemented.	1	NI	--	Section 4.5.3 Appendix O
		2	Tunnel Option Constr. - S, LTS Pipeline Option Constr. – S, LTS Operation – LTS	Tunnel - AQ-1, AQ-2, AQ-3 Pipeline - AQ-1, AQ-2, AQ-3, AQ-4, AQ-5	Section 4.5.4 Appendix O
		3	Constr. – LTS Operation - LTS	None	Section 4.5.5 Appendix O
		4	Constr. – S, SU Operation - LTS	AQ-1, AQ-2, AQ-6	Section 4.5.6 Appendix O
		5	Constr. – S, SU Operation - LTS	AQ-1, AQ-2	Section 4.5.7 Appendix O
Expose sensitive receptors to substantial pollutant concentrations	Each alternative's potential to generate TACs was measured and then evaluated considering the distance to the nearest sensitive receptor.	1	NI	--	Section 4.5.3 Appendix O
		2	LTS	None	Section 4.5.4 Appendix O
		3	LTS	None	Section 4.5.5 Appendix O
		4	LTS	None	Section 4.5.6 Appendix O
		5	LTS	None	Section 4.5.7 Appendix O

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people	Each alternatives potential to generate emissions, including objectionable odors, was measured and then evaluated considering the distance to the nearest sensitive receptor.	1	NI	None	Section 4.5.3 Appendix O
		2	NI	None	Section 4.5.4 Appendix O
		3	NI	None	Section 4.5.5 Appendix O
		4	NI	None	Section 4.5.6 Appendix O
		5	NI	None	Section 4.5.7 Appendix O
Cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the general conformity *de minimis* thresholds.	For NEPA purposes, estimates of potential emissions from the short-term construction of the alternatives were developed and compared to the general conformity de minimis threshold.	1	NI	--	Section 4.5.3 Appendix O
		2	No Adverse Impact	None	Section 4.5.4 Appendix O
		3	No Adverse Impact	None	Section 4.5.5 Appendix O
		4	General Conformity Determination Required	None	Section 4.5.6 Appendix O
		5	General Conformity Determination Required	None	Section 4.5.7 Appendix O

Key: Alt = alternative; B = beneficial; Constr. = construction; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; TACs = toxic air contaminants; W = with; WO = without

The San Joaquin Valley Air Pollution Control District (SJVAPCD) (2015) and Bay Area Air Quality Management District (BAAQMD) (2017) publish CEQA guidelines to assist Lead Agencies with uniform procedures for addressing air quality impacts in environmental documentation. Construction and operation activities occurring in Merced County for Alternatives 2 and 4 would be under the jurisdiction of the SJVAPCD, whereas construction and operations in Santa Clara County for Alternatives 3 and 5 would be under the jurisdiction of the BAAQMD. Impacts on air quality would be significant if implementing an alternative would cause the thresholds shown in the CEQA guidance documents to be exceeded; if these thresholds are exceeded, conflicts with applicable air quality plans and contributions to air quality standard violations for applicable pollutants can be assumed.

Table 4-7 summarizes the results of the air quality impacts estimated for the SJVAPCD. Table 4-8 summarizes air quality impacts in the BAAQMD. Detailed calculations are provided in Appendix O.

Table 4-7. Unmitigated and Mitigated Construction Emissions (SJVAPCD)

Alternative	VOC, tpy	NOx, tpy	CO, tpy	SO_2, tpy	PM_{10}, tpy	$PM_{2.5}$, tpy
Alternative 2 (tunnel option)	6	**64**	31	<1	3	3
Alternative 2 (pipeline option)	**16**	**230**	70	<1	10	10
Alternative 4	**12**	**147**	74	<1	**743**	**80**
SJVAPCD Significance Thresholds	*10*	*10*	*100*	*27*	*15*	*15*
General Conformity De Minimis Thresholds	*10*	*10*	*n/a*	*100*	*100*	*100*
Mitigated Alternative 2 (tunnel option)	3	7	23	<1	1	<1
Mitigated Alternative 2 (pipeline option)	6	9	47	<1	1	1
Mitigated Alternative 4	4	9	49	<1	**41**	6

Note: Values in bold indicate that the SJVAPCD significance threshold and/or the general conformity *de minimis* threshold was exceeded.

Key: CO = carbon monoxide; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SJVAPCD = San Joaquin Valley Air Pollution Control District; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

Table 4-8. Unmitigated and Mitigated Construction Emissions (BAAQMD)

Alternative	VOC, lb/day (tpy)	NOx, lb/day (tpy)	CO, lb/day (tpy)	SO_2, lb/day (tpy)	PM_{10}, lb/day (tpy)	$PM_{2.5}$, lb/day (tpy)
Alternative 3	4 (<1)	41 (7)	35 (5)	<1 (<1)	4 (<1)	2 (<1)
Alternative 5	**77** (14)	**647** (**116**)	860 (**156**)	2 (<1)	42 (8)	28 (5)
BAAQMD Significance Thresholds, lb/day	*54*	*54*	*n/a*	*n/a*	*82*	*54*
General Conformity De Minimis Thresholds, tpy	*100*	*100*	*100*	*100*	*n/a*	*100*
Mitigated Alternative 5	45 (8)	**206** (37)	728 (**132**)	2 (<1)	27 (5)	12 (2)

Note: Values in bold indicate that the BAAQMD significance threshold and/or the general conformity *de minimis* threshold was exceeded.

Key: BAAQMD = Bay Area Air Quality Management District; CO = carbon monoxide; lb/day = pound per day; NOx = nitrogen oxides; PM_{10} = inhalable particulate matter; $PM_{2.5}$ = fine particulate matter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

4.7.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

The No Action/No Project Alternative includes the most likely future conditions in the absence of the project. This analysis assumes that no short-term construction activities or long-term operational impacts would occur. As such, air quality conditions under the No Action/No Project Alternative would be the same as existing conditions. **The No Action/No Project Alternative would result in no impact on air quality.**

4.7.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction-related and operational emissions were estimated for the proposed tunnel option. Table 4-7 summarizes the annual construction-related emissions for the tunnel option. Construction of the proposed project has the potential to emit toxic air contaminants (TACs) in exhaust emissions, such as diesel particulate matter (DPM); however, construction would be short term and its impacts would be temporary. DPM is listed by the Office of Environmental Health Hazard Assessment (OEHHA) as a carcinogen and has a non-cancer chronic reference exposure level (REL); DPM does not contribute to acute health hazards because it does not have a published REL for acute health effects. Because there would be no long-term exposures to any TACs, the impact to sensitive receptors would be minimal. Additionally, due to the short installation period and distance to sensitive receptors, odors from diesel exhaust would not affect a substantial number of people.

New long-term operational impacts that could occur during the tunnel option include operation of the aeration facility near the Romero Visitor's Center and additional pumping at the Pacheco Pumping Plant that would increase with SCVWD being able to fully divert its CVP allocation, but no local criteria pollutant emissions would occur. Regional emissions could occur at nearby power plants to accommodate the increased electricity use, but because the plants would only operate within permitted limits, there would be no net increase in criteria pollutant emissions. As shown on Table 4-7, during construction, emissions of nitrogen oxides (NOx) would exceed the CEQA significance threshold and the general conformity *de minimis* threshold. Regulatory requirements and improvements in engine technology generally cause exhaust emissions to decrease with newer model year (e.g., 2015) and higher emission tiers (e.g., Tier 4) when compared to the existing fleet average. As demonstrated in Appendix O and Table 4-7, the required mitigation would reduce emissions below the significance criteria. Implementation of Mitigation Measures AQ-1, AQ-2, and AQ-3, described below in Section 4.7.8, would reduce maximum NOx emissions to less than significant. **Air quality impacts for the tunnel option would be significant pre-mitigation but less than significant with implementation of Mitigation Measures AQ-1, AQ-2, and AQ-3.**

Air quality impacts for the construction and operation of the pipeline option would be similar to those summarized above for the tunnel option. As discussed for the tunnel option, no local criteria pollutant emissions would occur from operation of the aeration facility and additional pumping. However, as shown on Table 4-7, during construction, emissions of volatile organic compound (VOC) and NOx would exceed the CEQA significance threshold and the general conformity *de minimis* threshold. Implementation of Mitigation Measures AQ-1, AQ-2, AQ-3, AQ-4, and AQ-5 described below in Section 4.7.8, would reduce maximum emissions for these pollutants to less than significant.

Pre-mitigation exceedances of SJVAPCD mass emission thresholds for O_3 precursors would, in general, lead to the increased health risks described in Chapter 3 within the affected air basin. For relatively small projects such as this alternative, attempts to model regional O_3 concentration impacts and resulting health impacts pre- and post-mitigation would not be practical or produce meaningful information. O_3 is a regional air pollutant and O_3 formation rates are a function of complex physical factors such as topography, VOC and NOx concentration ratios, meteorology, and sunlight exposure. **Air quality impacts for the pipeline option would be significant pre-mitigation, but less than significant with implementation of Mitigation Measures AQ-1, AQ-2, AQ-3, AQ-4, and AQ-5.**

4.7.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Construction-related emissions were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, and construction worker commuting. The basic fugitive dust control measures would be implemented during any construction activities at the Santa Teresa WTP. Table 4-8 summarizes the average daily construction-related emissions.

As shown in the table, emissions would not exceed the BAAQMD's significance thresholds or the general conformity *de minimis* thresholds. Because no long-term TAC emissions (including DPM) would occur, the impact to sensitive receptors would be minimal. Additionally, due to the short installation period and distance to sensitive receptors, odors from diesel exhaust would not affect a substantial number of people.

The use of raw water ozonation at the WTP would increase the use of liquid oxygen (LOX) at the WTP, thereby increasing the trip generation rate for deliveries. The additional LOX demand would increase truck trips by approximately nine trucks per year. Maximum emissions would not exceed 1 lb/day or 1 tpy for any pollutant and would be less than the BAAQMD's significance thresholds and the general conformity *de minimis* thresholds. **The impact on air quality would be less than significant**.

4.7.6 Environmental Consequences/Environmental Impacts of Alternative 4 - San Luis Reservoir Expansion Alternative

Construction-related emissions in the SJVAPCD were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, construction worker commuting. Table 4-7 summarizes the annual construction-related emissions. Because no long-term TAC emissions (including DPM) would occur, the impact to sensitive receptors would be minimal. Additionally, due to the short installation period and distance to sensitive receptors, odors from diesel exhaust would not affect a substantial number of people. **As shown in the table, VOC, NOx, PM_{10}, and $PM_{2.5}$ emissions would exceed the SJVAPCD's significance thresholds, while VOC, NOx, and PM_{10} would exceed the general conformity *de minimis* thresholds.** Implementation of Mitigation Measures AQ-1, AQ-2, and AQ-6 described below in Section 4.7.8, would be used to reduce VOC, NOx and $PM_{2.5}$ emissions to less than significant; however, PM_{10} emissions would remain significant and unavoidable. Tier 4 emission standards are the strictest emission standards for off-road engines and model year 2015 has the most stringent emission requirements for on-road engines. Given the scale of earth-moving activities proposed under this alternative, no additional technically feasible mitigation could be identified to reduce this impact to a less than significant level while not substantially slowing of the construction schedule. Table 4-7 summarizes the maximum annual emissions that would occur with mitigation.

Health impacts from O_3 precursor emissions are discussed in Alternative 2. Pre- and post-mitigation exceedances of SJVAPCD mass emission thresholds for PM_{10} and $PM_{2.5}$ would, in general, lead to increased health risks within the affected air basin, as described in Chapter 3. Sensitive receptors that could be affected by mass emissions of PM_{10} and $PM_{2.5}$ are identified in Appendix E1, *Noise and Vibration Supporting Information*. Exposure would occur over the duration of construction but would be variable based on the types of equipment being used. The closest sensitive receptor is approximately one mile (5,600 feet) from the center of construction and so any impacts from fugitive dust from a large construction area would be minimal. Therefore, it was not practical or meaningful to model ambient PM_{10} and $PM_{2.5}$ concentrations pre- and post-mitigation. **VOC, NOx, and $PM_{2.5}$ air quality impacts would be significant pre-mitigation but less than significant with implementation of Mitigation Measures AQ-1, AQ-2, and AQ-6, but PM_{10} emissions would be significant and unavoidable. Because mitigated emissions would be more than the general conformity *de minimis* thresholds, a general conformity determination would need to be developed for this alternative if it is Reclamation's preferred alternative in the Final EIS/EIR before a ROD can be issued for the SLLPIP.**

The additional capacity from reservoir enlargement would result in additional pumping into the reservoir and associated electricity consumption, but no local criteria pollutant emissions would occur. Regional emissions could occur at nearby power plants to accommodate the increased electricity use, but because the plants would only operate within permitted limits, there would be no net increase in criteria pollutant emissions. No other operational changes would occur that would increase criteria pollutant emissions. **Air quality impacts from operation of the enlarged reservoir would be less than significant.**

4.7.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction-related emissions in the BAAQMD were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, and construction worker commuting. Because no long-term TAC emissions (including DPM) would occur, the impact to sensitive receptors would be minimal. Additionally, due to the short installation period and distance to sensitive receptors, odors from diesel exhaust would not affect a substantial number of people. Table 4-8 summarizes the daily and annual construction-related emissions. As shown in the table, NOx, VOC, and CO emissions would exceed the BAAQMD's significance thresholds, while NOx and CO emissions would exceed the general conformity *de minimis* thresholds. Implementation of Mitigation Measures AQ-1 and AQ-2, described below in Section 4.7.8, would be sufficient to reduce VOC emissions to less than significant; however, NOx and CO emissions would remain significant and unavoidable. Tier 4 emission standards are the strictest emission standards for off-road engines and model year 2015 has the most stringent emission requirements for on-road engines. Given the scale of earth-moving activities proposed under this alternative, no additional technically feasible mitigation could be identified to reduce this impact to a less than significant level while not substantially slowing of the construction schedule. Table 4-8 summarizes the maximum daily and annual emissions that would occur with mitigation.

Health impacts from O_3 precursor emissions are discussed in Alternative 2. Pre- and post-mitigation exceedances of SJVAPCD mass emission thresholds for CO would, in general, lead to increased health risks within the affected air basin, as described in Chapter 3. Sensitive receptors that could be affected by mass emissions of CO are identified in Appendix E1, *Noise and Vibration Supporting Information*. Exposure would occur over the duration of construction but would be variable based on the types of equipment being used. The closest sensitive receptor is nearly a quarter mile (1,250 feet) from the center of construction and the project site is in an area designated attainment for CO. Because vehicle exhaust would be occurring over a large project area, impacts to nearby receptors would be minimal. Therefore, it was not practical or meaningful to model ambient PM_{10} and $PM_{2.5}$ concentrations pre- and post-mitigation. **VOC air quality impacts would be significant pre-mitigation but less than significant with implementation of Mitigation Measures AQ-1 and AQ-2, but NOx and CO emissions would be significant and unavoidable. Because mitigated emissions would be more than the general conformity *de minimis* thresholds, a general conformity determination would need to be developed for this alternative if it is Reclamation's preferred alternative in the Final EIS/EIR before a ROD can be issued for the SLLPIP.**

The operation of the expanded Pacheco Reservoir would result in additional pumping into the reservoir and associated electricity consumption, but no local criteria pollutant emissions would occur. Regional emissions could occur at nearby power plants to accommodate the increased electricity use, but because the plants would only operate within permitted limits, there would be no net increase in criteria pollutant emissions. No other operational changes would occur that would increase criteria pollutant emissions. **Air quality impacts from operation of the expanded Pacheco Reservoir would be less than significant.**

4.7.8 Mitigation Measures

The following mitigation measures would reduce the severity of the air quality impacts. They would be included in bid documents and construction contracts and their implementation would be monitored by the Lead Agencies.

Mitigation Measure AQ-1. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, would reduce impacts on air quality from construction activities by using construction equipment compliant with the Tier 4 emission standards for off-road diesel engines instead of the fleet average for the San Joaquin Valley Air Basin (Alternatives 2 and 4) or the San Francisco Bay Area Air Basin (Alternative 5). Records will be maintained by the construction contractor that demonstrate that actual emissions would not exceed the SJVAPCD's significance criteria and would be submitted monthly to Reclamation under Alternatives 2 and 4 and to SCVWD under Alternative 5.

If NOx emissions are forecasted to exceed thresholds based on the monthly recordkeeping logs, then changes will be made so that the threshold is not exceeded, or work will be stopped. Possible changes that could be made to reduce emissions include changing the project phasing so less simultaneous operations would be required, reducing the daily number of hours worked per piece of equipment, or using alternative-fueled equipment when feasible.

Mitigation Measure AQ-2. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will ensure all haul trucks, vendor trucks, or other vehicles operating onsite with on-road engines will meet model year 2015 or better emission standards.

Mitigation Measure AQ-3. Reclamation will ensure that the contractor will equip all marine propulsion and auxiliary engines with selective catalytic reduction capable of achieving an 85 percent reduction in NOx.

Mitigation Measure AQ-4. Reclamation will ensure that the contractor will limit tug boat operations to 485 trips per year or less.

Mitigation Measure AQ-5. Reclamation will ensure that the contractor will install diesel oxidation catalysts on all off-road construction equipment capable of achieving an 80 percent reduction in NOx.

Mitigation Measure AQ-6. Reclamation will ensure that the contractor will pave all unpaved haul and access roads to/from borrow and disposal areas (i.e., Basalt Hill and Borrow Area 6) to reduce fugitive PM_{10} and $PM_{2.5}$ emissions.

4.7.9 Significant Unavoidable Impacts

Alternative 4 and Alternative 5 would have significant and unavoidable effects associated with temporary construction activities. As previously discussed, Tier 4 emission standards are the strictest emission standards for off-road engines and model year 2015 has the most stringent emission requirements for on-road engines. Given the magnitude of the project’s construction actions, no additional feasible mitigation measures were identified that could reduce these impacts to a less than significant level.

4.8 Greenhouse Gas Emissions

4.8.1 Assessment Methods

GHG emissions were estimated using the same methods discussed in Section 4.7, Air Quality, with notable differences detailed in Appendix P. Additionally, Appendix Q evaluates how significance determinations for each resource area could change under future climate variability scenarios. This analysis does not identify new impacts that were not analyzed in this EIS/EIR, but it describes how those impacts might change with future climate variability.

4.8.2 Significance Criteria

Impacts on GHG emissions would be considered significant if the proposed project or alternatives would: (1) generate GHG emissions, either directly or indirectly, that may have a significant impact on environment; or (2) conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the GHG emissions. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-9.

The BAAQMD and the SJVAPCD do not publish quantitative GHG significance thresholds to evaluate the effects of construction activities. However, the BAAQMD uses a threshold of 1,100 $MTCO_2e$ per year for project operations (BAAQMD 2017). Furthermore, although the project is not located in its boundaries, the Sacramento Metropolitan Air Quality Management District (SMAQMD) uses a threshold of 1,100 $MTCO_2e$ per year for construction activities (SMAQMD 2015). A threshold of 1,100 $MTCO_2e$ per year was selected as the significance criteria for both construction and operational emissions. Table 4-10 summarizes the results of the GHG impacts estimated for construction of the alternatives. See Appendix P for detailed emission calculations.

Table 4-9. Greenhouse Gas Emissions Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Generate greenhouse gas emissions, either directly or indirectly, that could have a significant impact on the environment.	Estimates of potential emissions from the short-term construction generated and long-term operations and maintenance of the alternatives were developed and compared to project thresholds established by the BAAQMD and the SMAQMD.	1	NI	--	Section 4.8.3 Appendix P
		2	S, LTS	AQ-1, AQ-2, AQ-3, AQ-4, GHG- 1, GHG-2	Section 4.8.4 Appendix P
		3	LTS	None	Section 4.8.5 Appendix P
		4	S, LTS	AQ-1, AQ-2, AQ-3, AQ-4, GHG- 1, GHG-2	Section 4.8.6 Appendix P
		5	S, LTS	AQ-1, AQ-2, AQ-3, AQ-4, GHG- 1, GHG-2	Section 4.8.7 Appendix P
Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases.	Comparison of all proposed alternative emissions estimates against applicable plans, policies, or regulations adopted to reduce GHG emissions	1	NI	--	Section 4.8.3 Appendix P
		2	S, LTS	AQ-1, AQ-2, AQ-3, AQ-4, GHG- 1, GHG-2	Section 4.8.4 Appendix P
		3	LTS	None	Section 4.8.5 Appendix P
		4	S, LTS	AQ-1, AQ-2, AQ-3, AQ-4, GHG- 1, GHG-2	Section 4.8.6 Appendix P
		5	S, LTS	AQ-1, AQ-2, AQ-3, AQ-4, GHG- 1, GHG-2	Section 4.8.7 Appendix P

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SMAQMD = Sacramento Metropolitan Air Quality Management District; SU = significant and unavoidable; W = with; WO = without

Table 4-10. Unmitigated Construction Emissions

Alternative	Total CO_2e (MT/project)	Maximum Annual CO_2e (Mt/year)
Alternative 2 (tunnel option)	**43,265**	**13,753**
Alternative 2 (pipeline option)	**34,916**	**23,541**
Alternative 3	2,279	851
Alternative 4 (shear key option)	**297,850**	**30,688**
Alternative 4 (no shear key)	**239,382**	**30,688**
Alternative 5	**121,742**	**27,290**
Significance Threshold	n/a	1,100

Note: Values in **bold** exceed the significance criteria.
Key: CO_2e = carbon dioxide equivalent; MT = metric tons; n/a = not applicable

4.8.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

The No Action/No Project Alternative includes existing conditions and the most likely future conditions in the absence of the project. This analysis assumes that no short-term construction activities or long-term operational impacts would occur. **The No Action/No Project Alternative would result in no impact on GHG emissions.**

4.8.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction-related emissions were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, construction worker commuting, and marine emissions (tugboats, crew/supply vessels). As shown in Table 4-10, emissions from construction of the tunnel and pipeline options would exceed the significance threshold for maximum annual emissions. **Therefore, construction of the tunnel and pipeline options would be significant.** Annual emissions from operation of the aeration facility and additional pumping would range from 238 to 279 metric tons CO_2e per year ($MTCO_2e$/yr) depending on whether oxygen was provided by a compressed air system or by a LOX tank and would be less than significant.

Mitigation Measures AQ-1 through AQ-4 would reduce construction GHG emissions, and Mitigation Measure GHG-1 would require the use of electrification and/or alternative fuels to further reduce construction emissions, but it is assumed that these types of equipment are not available in sufficient quantities to complete the required construction. Therefore, an additional mitigation measure to purchase GHG emission offsets in an amount necessary to reduce GHG emissions to less than the significance threshold would also be required. Implementation of Mitigation Measures AQ-1 through AQ-4, GHG-1, and GHG-2, described below in Section 4.8.8, would reduce emissions to less than significant.

Because construction GHG emissions exceed the quantitative significance threshold, they would also conflict with GHG reduction plans and policies such as the 2017 Scoping Plan, the BAAQMD Clean Air Plan, AB 32, SB 32, and Executive Order (EO) S-3-05. **The construction of the tunnel and pipeline options could generate GHG emissions that could have a**

significant GHG impact and conflict with GHG reduction plans/policies pre-mitigation but would have a less than significant impact on GHG emissions and GHG reduction plan/policy conflicts with mitigation.

4.8.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

As shown in Table 4-3, emissions from construction of the proposed improvements to the Santa Teresa WTP would not exceed the significance criterion for GHG emissions. The proposed improvements to the WTP increase operational emissions by 3 $MTCO_2e$/year from routine maintenance and solid waste disposal. Impacts associated with construction and operation of Alternative 3 would not exceed the significance criteria and therefore also would not conflict with an applicable plan or policy to reduce GHG emissions. **The construction and operation of Alternative 3 would not generate GHG emissions that would have a significant impact, and would not conflict with GHG reduction plans or policies, resulting in a less than significant impact on GHG emissions.**

4.8.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Table 4-3 summarizes the annual construction-related emissions for this alternative. In addition to routine operational and maintenance emissions associated with the treatment plant retrofits, additional pumping at Gianelli and Pacheco would increase GHG emissions by 6,516 $MTCO_2e$/yr. Impacts associated with construction and operation of the enlarged reservoir would exceed the significance criterion. Because construction and operation GHG emissions exceed the quantitative significance threshold, they would also conflict with GHG reduction plans and policies such as the 2017 Scoping Plan, the BAAQMD Clean Air Plan, AB 32, SB 32, and EO S-3-05. Implementation of Mitigation Measures AQ-1 through AQ-4, GHG-1, and GHG-2, described below in Section 4.8.8, would reduce impacts to less than significant. **The construction and operation of the expanded reservoir would generate GHG emissions that would have a significant GHG impact and conflict with GHG reduction plans/policies pre-mitigation, but would have a less than significant impact on GHG emissions and GHG reduction plan/policy conflicts with mitigation.**

4.8.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Table 4-3 summarizes the annual construction-related emissions for this alternative. Routine operational emissions associated with increased pumping at the expanded Pacheco Reservoir would increase GHG emissions by 263 $MTCO_2e$/yr and would be less than significant. Impacts associated with construction of the enlarged reservoir would exceed the significance criterion. Because construction GHG emissions exceed the quantitative significance threshold, they would also conflict with GHG reduction plans and policies such as the 2017 Scoping Plan, the BAAQMD Clean Air Plan, AB 32, SB 32, and EO S-3-05. Implementation of Mitigation Measures AQ-1 through AQ-4, GHG-1, and GHG-2, described below in Section 4.8.8, would reduce impacts to less than significant. **The construction of the expanded Pacheco Reservoir would generate GHG emissions that would have a significant GHG impact and conflict**

with GHG reduction plans/policies pre-mitigation but would have a less than significant impact on GHG emissions and GHG reduction plan/policy conflicts with mitigation.

4.8.8 Mitigation Measures

The following mitigation measures would further reduce the severity of the GHG impacts. Mitigation Measures AQ-1, AQ-2, AQ-3, and AQ-4, although intended to reduce criteria pollutant emissions, would also reduce GHG emissions. They would be included in bid documents and construction contracts and their implementation would be monitored by the Lead Agencies.

Mitigation Measure GHG-1. Since further on-site reduction of GHG emissions is not feasible or practical, Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will require the contractor to use engine electrification (including hybrid equipment) and use renewable diesel or biodiesel, when feasible, for all on- and off-road construction equipment.

Mitigation Measure GHG-2. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will require the contractor to purchase carbon offsets before construction activities commence in an amount sufficient to reduce GHG emissions remaining after implementation of Mitigation Measures AQ-1 through AQ-4 and GHG-1 to less than significant levels (1,100 $MTCO_2e$/year). Only emission offsets consistent with standards used for CARB's Compliance Offset Protocols may be used to reduce GHG emissions. These standards assure that offsets are real, permanent, quantifiable, verifiable, enforceable, and additional (Health and Safety Code Section 38562(d)). Registries selling approved offsets meeting these standards include the American Carbon Registry, the Climate Action Reserve, and Verra (formally the Verified Carbon Standard).

4.9 Visual Resources

4.9.1 Assessment Methods

The aesthetic value of an area is derived from both natural and artificial features. The value is determined by contrasts, forms, and textures exhibited by geology, hydrology, vegetation, wildlife, and man-made features. Individuals respond differently to changes in the physical environment depending on prior experiences and expectations, as well as proximity and duration of views. Consequently, aesthetic effects analyses tend to be highly subjective in nature.

Assessment of visual resources was accomplished through the use of the U.S. Forest Service's SMS, outlined in *Landscape Aesthetics: A Handbook for Scenery Management*, *Agriculture Handbook Number 701* (USDA U.S. Forest Service 1995). The SMS is used to categorize the visual resources within the project area and to analyze the significance of potential impacts to these resources from the implementation of the project alternatives. The three classes of Scenic Attractiveness that are used in the following assessment are:

- **Class A, Distinctive** – Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide unusual, unique, or outstanding scenic quality. These landscapes have strong positive attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance.

- **Class B, Typical –** Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide ordinary or common scenic quality. These landscapes have generally positive yet common attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance. Normally they would form the basic matrix within the ecological unit.

- **Class C, Indistinctive –** Areas where landform, vegetation patterns, water characteristics, and cultural land use have low scenic quality. Often water and rockform of any consequence are missing in Class C landscapes. These landscapes have weak or missing attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance.

For example, reservoirs are generally Class A or B visual resources when their water surface elevations are near to or at their maximum.

4.9.2 Significance Criteria

Impacts on visual resources would be considered significant if the project would: (1) have a substantial permanent or temporary adverse effect on a scenic vista (areas with Scenic Attractiveness Class A or Class B classifications); (2) substantially damage scenic resources, including, but not limited to trees, rock outcroppings, and historic buildings, within a state scenic highway corridor; (3) in non-urbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings and in urbanized areas, conflict with applicable zoning and other regulations governing scenic quality; or (4) create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-11.

4.9.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Under this No Action/No Project Alternative, there would be no construction or changes to existing operations in the study area. **Therefore, there would be no short- or long-term impacts to visual resources from these construction and operation activities. This alternative would result in no impact on visual resources.**

Table 4-11. Visual Resources Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Have a substantial adverse effect on a scenic vista (areas with Scenic Attractiveness Class A or Class B classifications are considered scenic vistas)	Evaluation of the degree to which construction activities and long-term placement of new infrastructure could detract from viewing experience at scenic vistas	1	NI	--	Section 4.9.3
		2	Construction - LTS Operation - S, LTS	VIS-1, VIS-3	Section 4.9.4
		3	NI	None	Section 4.9.5
		4	LTS	None	Section 4.9.6
		5	LTS	None	Section 4.9.7
Substantially damage scenic resources within a State scenic highway corridor.	Evaluation of the degree to which construction activities and long-term placement of new infrastructure could detract from viewing experience along scenic highway corridors	1	NI	--	Section 4.9.3
		2	S, LTS	VIS-4	Section 4.9.4
		3	NI	None	Section 4.9.5
		4	S, LTS	VIS-4	Section 4.9.6
		5	LTS	None	Section 4.9.7
Substantially degrade the existing visual character or quality of public views of the site and its surroundings or conflict with applicable regulations governing scenic quality.	Evaluation of the degree to which construction activities and long-term placement of new infrastructure could degrade the existing visual character or quality of the site and its surroundings	1	NI	--	Section 4.9.3
		2	S, LTS	VIS-2	Section 4.9.4
		3	NI	None	Section 4.9.5
		4	LTS	None	Section 4.9.6
		5	LTS	None	Section 4.9.7
Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area.	Evaluation of the degree to which construction activities and long-term placement of new infrastructure could introduce new light or glare sources	1	NI	--	Section 4.9.3
		2	S, LTS	VIS-1	Section 4.9.4
		3	NI	None	Section 4.9.5
		4	S, LTS	VIS-1	Section 4.9.6
		5	S, LTS	VIS-1	Section 4.9.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.9.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction and material staging would affect views from public roadways (including SR 152), the Romero Outlook Visitors Center, and open space areas, however impacts would be short-term (approximately 33 to 47 months). In addition, the panoramic nature of background views from distant static viewing locations and the speed of motorists passing the site from adjacent roadways reduce the overall impact generated by construction activities from Alternative 2. **This impact would be less than significant.**

Under the tunnel option, construction activities could take place after day-light hours, in which case lights in the construction staging areas and at Gate Shaft Island could have a negative impact on nighttime views in the project area. Construction lighting would be removed after construction activities are completed. **These impacts would be significant.** Implementation of Mitigation Measure VIS-1, described in Section 4.9.8, would implement measures to reduce light and glare while meeting minimum safety and security standards, reducing these impacts to less than significant. **Therefore, impacts would be less than significant after mitigation.**

The tunnel option would generate excavated material that would need to be disposed at a spoil site at Dinosaur Point Use Area. This deposit of soils material at Dinosaur Point would change the existing visual character of the spoil site by covering existing vegetation until new vegetation is established which is inconsistent with the aesthetics resource goals outlined in the San Luis Reservoir SRA RMP/GP. **These impacts would be significant.** Implementation of Mitigation Measure VIS-2, described in Section 4.9.8, would locate spoils disposal locations primarily out of sight from major public viewsheds, reducing these impacts to less than significant. **Therefore, impacts would be less than significant after mitigation.**

Operations of the new facility in the San Luis Reservoir would allow the reservoir to be drawn down to lower levels during low point years, but this change in reservoir surface elevations would be small and would not affect visual resources. The aeration system would consist of a new facility near Romero Outlook Visitors Center and would permanently change the visual experience of viewers from the Visitor Center, watercraft on the reservoir, and shoreline areas (from a distance) around the reservoir, which is inconsistent with the aesthetics resource goals as outlined in the San Luis Reservoir SRA RMP/GP. **These impacts would be significant.** Implementation of Mitigation Measures VIS-1 and VIS-3, described in Section 4.9.8, would implement measures to reduce light and glare and design and placement standards, reducing these impacts to less than significant. **Therefore, impacts would be less than significant after mitigation.**

As was noted above, the introduction of construction equipment and lighting could introduce new visual distraction to views from SR 152. However, the distance separating motorists from the construction areas, along with the speed that those motorists would be traveling, both limit the magnitude of any impact on those viewers' scenic experience. To complete construction operations, the two existing intersections along SR 152 (at Dinosaur Point Road and at Basalt Road) would be improved to accommodate the high volume of trucks and other heavy equipment anticipated during construction. **These impacts would be significant.** Implementation of

Mitigation Measure VIS-4, described in Section 4.9.8, would ensure compliance with planning and design standards, reducing these impacts to less than significant. **Therefore, impacts would be less than significant after mitigation.**

4.9.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Because the visual character of the site is that of a WTP and improvements are within the character of the site and would not conflict with any applicable regulations governing scenic quality, **there are no short- or long-term impacts to visual resources expected.**

4.9.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Construction of Alternative 4 would take 8 to 12 years and generate up to 240 large deliveries per day. Dam modifications would affect the area around the dam and recreational facilities that surround the dam. The magnitude and length of construction would affect scenic vistas and the scenic character. In the long term, scenic values for recreation users at the San Luis Reservoir and in the background from vistas along public roadways (including SR 152), at the Romero Outlook Visitors Center, and open space areas, such as the Cottonwood Creek Wildlife Area and portions of Pacheco SP, would return to their current quality level and remain consistent with the aesthetics resource goals outline in the San Luis Reservoir SRA RMP/GP. Background views of B.F. Sisk Dam from these same locations would be impacted with the introduction of disturbed earth on the dam face and crest. However, the panoramic nature of background views from distant static viewing locations and the speed of motorists passing the site from adjacent roadways reduce the overall impact generated by construction activities from Alternative 4. Implementation of Mitigation Measure REC-1, as described in Section 4.17.8, would add new camp sites and visitor facilities in areas directly adjacent to similar uses.

Alternative 4 would generate slightly increased storage levels in San Luis Reservoir in both non-low point years and years with low point events (See Section N.5.5 in Appendix N). The 10 foot increase in San Luis Reservoir's maximum surface elevation would inundate 425 acres of new land around the shore of the reservoir when the reservoir is full (See Figure 2-3). Given the large scale of the existing San Luis Reservoir footprint, this increased footprint would be minor. In addition, the annual operation approach would remain unchanged with annual reservoir drawdown and refill targets unchanged. **This impact would be less than significant.**

The introduction of construction lighting to support nighttime work would add a more substantial visual distraction to the landscape with new stationary lighting sources at staging areas and on the dam embankment. In addition, mobile lighting sources on construction equipment and vehicles traversing the site would also contribute to the lighting impacts, given the contrast from the otherwise low-light condition in the surrounding landscape. **Therefore, the use of lighting during the construction of Alternative 4 would have a significant impact on scenic vistas and visual character in the study area. Implementation of Mitigation Measure VIS-1, as described below in Section 4.9.8, would reduce the severity of this impact to less than significant.**

As was noted above, the introduction of construction equipment and vehicles, construction lighting, and the introduction of disturbed earth on the dam face and crest could introduce new visual distraction to views from SR 152. However, the distance separating motorists from the construction areas, along with the speed that those motorists would be traveling, both limit the magnitude of any impact on those viewers' scenic experience. Similar to Alternative 2, to complete construction operations, the two existing intersections along SR 152 (at Dinosaur Point Road and at Basalt Road) would be improved to accommodate the high volume of trucks and other heavy equipment anticipated during construction. **This impact from the roadway improvements would be significant to scenic resources within a designated State scenic highway, but with implementation of Mitigation Measure VIS-4 in Section 4.9.8, this impact would be less than significant.**

4.9.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activity, including the presence of equipment, vehicles, and construction personnel, would temporarily degrade the quality of views in the area. However, due to the topography of the surrounding area, the construction area would not be visible from Henry W. Coe SP and would be temporary. Operations of the expanded Pacheco Reservoir would increase the inundation area and change the scenic quality and character of the area. The new reservoir bed would extend nearly to the southern boundary of Henry W. Coe SP and may be visible from some areas within the park. However, the overall visual effect of raising the water level at the reservoir would be relatively minor because substantial portions of the vegetated landscape would remain visually intact and views of the expanded reservoir would be limited given the narrow valley in its upstream sections. In periods when the reservoir would be drawn down, exposed reservoir bed could introduce small sections of visual contrast visible from Henry W. Coe SP, but the magnitude of this contrast would be limited by the surrounding grassland vegetations similar coloring to these exposed soils given the seasonal drying of this vegetation that corresponds to the anticipated timing of reservoir drawdown.

The introduction of construction equipment and vehicles and construction lighting could introduce new visual distraction to views from SR 152. However, due to the topography of the surrounding area and the distance separating motorists from the construction areas, along with the speed that those motorists would be traveling, the magnitude of any impact on those viewers' scenic experience would be limited. The introduction of construction worker traffic to and from the site along with construction equipment and material haul trucks along SR 152 would not as is evaluated in Section 4.11.7, substantially increase traffic volumes or introduce vehicle types not currently present along this major thoroughfare. Following construction, portions of the new dam would be visible along SR 152 but similar to the construction effect described above, the magnitude of any impact on those viewers' scenic experience from the introduction of this new facility would be limited. **This impact would be less than significant.**

The introduction of construction lighting to support nighttime work would add a more substantial visual distraction to the landscape with new stationary lighting sources at staging and construction areas. In addition, mobile lighting sources on construction equipment and vehicles traversing the site would also contribute to the lighting impacts, given the contrast from the otherwise low-light condition in the surrounding landscape. **Therefore, construction of Alternative 5, including lighting at night, would have a significant impact on scenic vistas and visual character in the study area. Implementation of Mitigation Measure VIS-1, as described below in Section 4.9.8, would reduce the severity of this impact to less than significant.**

4.9.8 Mitigation Measures

The following mitigation measures would reduce the severity of the visual resource impacts.

Mitigation Measure VIS-1. To reduce visual intrusion from light sources, Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, shall require the contractors to implement measures to reduce light and glare while meeting minimum safety and security standards. Light reduction measures must include: directing lighting downward to prevent spillover onto nearby areas, utilization of lighting fixtures with directional shielding to focus on areas being lit, and a construction requirement that all lighting in areas not under active construction be shut off. To reduce the amount of glare, building finishes shall be subdued and earth-toned. Onsite mechanical equipment roofing materials, and any exposed vents or flashings must be constructed of non-glare finishes that minimizes reflectivity.

Mitigation Measure VIS-2. Reclamation will require contractors to locate spoils disposal locations primarily out of sight from major public viewsheds to the greatest extent possible. Spoils and topsoil shall be removed and stockpiled while the underlying soil layer is scarified. Spoils shall then be spread evenly to a thickness of one foot while following the natural topography. The stockpiled topsoil will be replaced over the spoiled material so that the pre-disturbance seed bank and topsoil shall be maintained consistent with the surrounding landscape. Native grasses shall be planted in the disturbed areas to reduce landscape scarring and other aesthetic impacts.

Mitigation Measure VIS-3. To reduce visual intrusion and maintain the existing visual character, Reclamation will require contractors to implement the following measures. The design of new structures visible from major public viewsheds, shall be compatible with the open space of the area. Building design shall complement and harmonize with surrounding buildings, in form, scale, materials, and color. Building finishes shall be subdued and earth-toned. Any fencing surrounding the facilities shall be designed to be minimally intrusive and complimentary of the architectural character of the building.

New structures must be located, to the greatest extent feasible, on a portion of the site with the greatest screening ability in terms of vegetation or landform. Revegetation efforts shall blend with existing vegetation or since the surrounding area is predominately annual grasslands, the revegetation shall be consistent with plants that are native and indigenous to the project area. A vegetation plan shall be implemented within a year of construction completion and include an irrigation and maintenance component during the plant establishment period.

Mitigation Measure VIS-4. Reclamation will require contractors to implement the following measures. Road improvements at highway intersections shall comply with planning and design standards for development of official scenic highways including, but not limited to, (1) detailed land and site planning; (2) careful attention to and control of earthmoving and landscaping; and (3) the design and appearance of structures and equipment (Caltrans 2011).

4.10 Noise

4.10.1 Assessment Methods

Activities with the potential for generating short-term, temporary increases in noise levels include construction activities and construction-related traffic. Long-term noise impacts could occur from operation of new facilities or new water treatment equipment. Appendix E1 presents a framework for understanding noise and vibration levels, a detailed description of the existing environment, area of analysis figures, as well as details on the methods and results of the noise modeling conducted.

4.10.2 Significance Criteria

Impacts on noise would be considered significant if the project would result in: (1) generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity or the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies[3]; (2) generation of excessive groundborne vibration or groundborne noise levels (significance threshold of 0.3 in/sec); (3) a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project; or (4) for a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, expose people residing or working in the project area to excessive noise levels. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-12.

4.10.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Ambient noise levels under the No Action/No Project Alternative would be the same as existing conditions. Neither construction-related activities nor increased operational activities would occur. **The No Action/No Project Alternative would result in no impact on noise.**

[3] The applicable local standards are detailed in Appendix C: Section C.3.7 City of San Jose Municipal Code, Section C.3.8 Merced County Code, and Section C.3.14 Santa Clara County Ordinance Code

Table 4-12. Noise and Vibration Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance.	Comparison of predicted noise levels during construction and operation of the alternatives to established general plan and noise ordinance standards and to existing noise levels in the project area	1	NI	--	Section 4.10.3 Appendix E1
		2	LTS	None	Section 4.10.4 Appendix E1
		3	LTS	None	Section 4.10.5 Appendix E1
		4	Construction – S, SU Operation – LTS	NOISE-1, NOISE-2, HAZ-5	Section 4.10.6 Appendix E1
		5	Construction – S, SU Operation – S, LTS	NOISE-1, NOISE-2, NOISE-3, HAZ-5	Section 4.10.7 Appendix E1
Expose sensitive receptors to excessive groundborne vibration or groundborne noise.	Evaluation of predicted ground borne vibration levels during construction and operation of the alternatives at the nearest sensitive receptors (significance threshold of 0.3 in/sec)	1	NI	--	Section 4.10.3 Appendix E2
		2	LTS	None	Section 4.10.4 Appendix E2
		3	LTS	None	Section 4.10.5 Appendix E2
		4	LTS	None	Section 4.10.6 Appendix E2
		5	LTS	None	Section 4.10.7 Appendix E2
Cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	Comparison of predicted noise levels during construction of the alternatives to existing noise levels in the project area	1	NI	--	Section 4.10.3 Appendix E1
		2	Tunnel Option – S, SU Pipeline Option – LTS	NOISE-1	Section 4.10.4 Appendix E1
		3	S, LTS	NOISE-1	Section 4.10.5 Appendix E1
		4	S, SU	NOISE-1, NOISE-2, HAZ-5	Section 4.10.6 Appendix E1
		5	S, SU	NOISE-1	Section 4.10.7 Appendix E1

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Operational sources located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport could expose people residing or working in the project area to excessive noise levels.	Consideration of the alternative's location in relationship to an airport and their consistency with that airports land use plans	1	NI	--	Section 4.10.3
		2	LTS	None	Section 4.10.4
		3	NI	None	Section 4.10.5
		4	LTS	None	Section 4.10.6
		5	NI	None	Section 4.10.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.10.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

4.10.4.1 Tunnel Option

Construction impacts on ambient noise levels generated by Alternative 2 would be short-term and would not result in permanent increases in ambient noise levels. Limited construction would occur during the 10-hour nighttime shift and would only involve workers directly associated with tunnel boring activities. These activities would be limited to construction workers commuting to the site, operation of the tunnel boring machine, and occasional tug boat trips. Nighttime construction-related noise would be intermittent and limited in duration, and noise levels would not be substantially different from existing background noise from motorboats on the reservoir. Furthermore, any noise from the tunnel boring machine would be limited because it would be submerged. As a result, nighttime noise levels would be less than significant. All other construction activities would occur during daytime hours between 7:00 a.m. and 6:00 p.m. and would be exempt from the Merced County Code sound level limitations, provided all construction equipment is properly muffled and maintained. The peak particle velocity (PPV) for construction activities would not exceed the significance threshold of 0.3 inch/second (in/sec). No long-term project operations would occur that could generate vibrations or groundborne noise, or otherwise expose persons to such impacts. Table E1-8 in Appendix E1 summarizes the results of possible vibration effects from each construction phase. Detailed calculations are provided in Appendix E2. The only new long-term operational impact that would occur from the tunnel option is operation of the aeration facility near the Romero Visitor’s Center, which utilizes an approximately 200 hp electric compressor. Because the nearest sensitive receptor (San Luis Creek Use Area) is approximately 1.9 miles from the proposed aeration facility, the daytime increase in noise levels would be less than 1 A-weighted decibel (dBA) and long-term operational impacts would be negligible (see Appendix E2 for detailed noise level calculations). Noise impacts associated with operating this alternative within an airport land use plan would be less than significant. **These impacts would be less than significant.**

Noise levels at the sensitive receptors, the residence on Harper Lane, the San Luis Creek Use Area, and the residence off Dinosaur Point Road, would not exceed the significance criterion of 10 dBA (see Appendix E2 for detailed noise calculations). However, the addition of heavy-duty haul trucks and construction workers could substantially increase the equivalent noise level on local roads (Fifield Road/ Dinosaur Point Road) by more than 10 dBA, representing a doubling of noise levels and a significant impact (see Appendix E2). **This impact is significant. Implementation of Mitigation Measure NOISE-1, described below in Section 4.12.8, would reduce noise impacts; however, the measure would not reduce impacts to less than significant levels.** The Lead Agencies evaluated potential mitigation measures including the development of permanent or semi-permanent sound barriers at the sensitive receptors to isolate them from the noise sources but determined that given the large construction area across which noise will be generated would not be feasible given their incompatibility with uses at the receptors, including the San Luis Creek Use Area that would create a fixed barrier between the campsites and the O’Neill Forebay. Given the social and environmental limits on implementing other potential options to offset this impact no feasible mitigation (CEQA Section 21061.1) has been identified to further reduce these impacts to a less than significant level. **Noise impacts of the tunnel option would be significant and unavoidable.**

4.10.4.2 Pipeline Option

All construction activities associated with the pipeline option would not conflict with the Merced County Code. The PPV for construction activities would not exceed the significance threshold of 0.3 in/sec. The only new long-term operational impact that would occur with the tunnel option is operation of the aeration facility near the Romero Visitor's Center, which uses an approximately 200 hp electric compressor. Because the nearest sensitive receptor (San Luis Creek Use Area) is approximately 1.9 miles from the proposed aeration facility, the daytime increase in noise levels would be less than 1 dBA and long-term operational impacts would be negligible (see Appendix E2 for noise level calculations). Construction traffic would increase AADT by approximately six times; therefore, the increase in traffic would be noticeably louder but would not cause a significant increase in noise levels and would be consistent with Merced County Code. Noise impacts associated with operating this alternative within an airport land use plan would be less than significant. **This impact would be less than significant.**

4.10.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Daytime unmitigated noise levels (L_{eq}) at the nearest noise-sensitive receptors at the Santa Teresa WTP would range from 60 to 69 dBA. Construction activities at the Santa Teresa WTP would occur within the designated construction hours Monday through Friday 7:00 a.m. to 7:00 p.m. and would not violate the noise ordinance for the City of San Jose. While construction would continue for more than 12 months, it would not involve substantial noise generating activities, as defined in the San Jose 2040 General Plan. The PPV at the Santa Teresa WTP would not exceed 0.3 in/sec significance threshold. Detailed calculations are provided in Appendix E2. No long-term project operations would occur that could generate vibrations or groundborne noise or otherwise expose persons to such impacts. No perceptible change in off-site plant noise levels during operations would occur because the modifications would occur within the existing process area. **Impacts would be less than significant.**

The maximum daytime construction noise increase in 1-hour L_{eq} over existing conditions for the Santa Teresa WTP would be 14 dBA at the nearest residential receptor. Construction traffic would increase the AADT by approximately 2 percent at the Santa Teresa WTP; therefore, the increase in traffic would not cause an increase in noise levels that would be perceptible to the human ear. Detailed calculations are provided in Appendix E2. **Construction noise impacts would be significant.** With implementation of Mitigation Measure NOISE-1, described below in Section 4.10.8, a noise barrier or enclosure that completely breaks the line of sight between the noise source and the receptor could achieve a minimum 5 dBA noise reduction. **Impacts would be less than significant with implementation of Mitigation Measure NOISE-1.**

The Santa Teresa WTP is not located within an airport land use plan or within 2 miles of a public airport. **There would be no impact related to airport noise.**

4.10.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

The PPV for construction activities would not exceed the significance threshold of 0.3 in/sec, see calculations in Appendix E2. No long-term project operations would occur that could generate vibrations or groundborne noise or otherwise expose persons to such impacts. Construction impacts on ambient noise levels generated by the San Luis Reservoir expansion would not result in permanent increases in ambient noise levels. Because the alternative would only raise B.F. Sisk Dam but would not change its methods of operation, there would be no long-term operational noise impacts. Noise impacts associated with operating this alternative within an airport land use plan would be less than significant. **Vibration impacts and noise impacts related to airports would be less than significant.**

Construction activities, except for blasting, would be performed 24 hours per day. Blasting operations at Basalt Hill would be limited to the hours between 6:00 a.m. to 6:00 p.m. Nighttime noise levels to sensitive receptors at San Luis Creek Use Area and a subdivision off SR 152 would exceed the Merced County Code sound level limitations of an increase of 5 dBA between 10:00 p.m. and 7:00 a.m., with an increased noise level of 18 dBA at San Luis Creek Use Area and 13 dBA at the subdivision off SR 152 (see Table E1-12 in Appendix E1 and Appendix E2 for calculations). Due to existing traffic on the local road (Fifield Road/Dinosaur Point Road) is limited with less than 200 cars per day on each road (Reclamation and CDPR 2013), the addition of heavy-duty haul trucks and construction workers to the section of Fifield Road/Dinosaur Point Road that will remain open to the public during the approximately 1 year of construction at Dinosaur Point and at the Gianelli Pumping Plant, could substantially increase the equivalent noise level on this road by more than 10 dBA, representing a doubling of noise levels and a significant impact. **This impact would be significant. Implementation of Mitigation Measures NOISE-1 and NOISE-2, described below in Section 4.10.8, and Mitigation Measure HAZ-5 (blasting plan), described below in Section 4.12.8, would reduce noise impacts; however, the measures would not reduce impacts to less than significant levels.** Even if the construction site was completely enclosed and shielded, only a 10 dBA reduction in noise would be expected (FHWA 2006), leaving the increased nighttime noise level at San Luis Creek Use Area at 8 dBA and still exceeding the 5 dBA nighttime threshold. The Lead Agencies evaluated other potential mitigation measures including the development of permanent or semi-permanent sound barriers at the sensitive receptors to isolate them from the noise sources but determined that given the large construction area across which noise would be generated would not be feasible given their incompatibility with uses at the receptors, including the San Luis Creek Use Area that would create a fixed barrier between the campsites and the O’Neill Forebay. Given the social and environmental limits on implementing other potential options to offset this impact no feasible additional mitigation has been identified to further reduce these impacts to a less than significant level. **Noise impacts remain significant and unavoidable after implementation of Mitigation Measures NOISE-1, NOISE-2, and HAZ-5.**

4.10.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Pacheco Reservoir is not located within an airport land use plan or within 2 miles of a public airport. **Therefore, there would be no impact associated with permanent operational noise within an airport land use plan.**

Construction equipment and activities such as dozers and rollers would generate vibrations that could result in groundborne noise or vibration that may affect nearby structures and sensitive receptors. The PPV for construction activities would not exceed the significance threshold of 0.3 in/sec, see Table E1-14 in Appendix E1. Detailed calculations are presented in Appendix E2. No long-term project operations would occur that could generate vibrations or groundborne noise or otherwise expose persons to such impacts. **This impact is less than significant.**

There would be a temporary construction-related noise increase due to the use of heavy equipment and blasting. Blasting would be infrequent, occurring approximately one to two times a week and only during daytime hours. Noise from blasting would be loud enough to briefly disturb the nearest sensitive receptors, as well as portions of Henry W. Coe SP, particularly the ridgeline overlooking the Pacheco Reservoir. Noise levels at sensitive receptors would be 69 dBA (a 29 dBA increased noise level) at the residence on El Toro Road and 50 dBA (a 10 dBA increased noise level) at the residence off SR 152. Noise levels at the residence on El Toro Road exceed Santa Clara County maximum daytime noise level standard of 55 dBA from 7:00 a.m.-10:00 p.m. The residence off SR 152 and the residence on El Toro Road would exceed County maximum nighttime noise level standard of 45 dBA from 10:00 p.m. – 7:00 a.m. (see Table E1-13 in Appendix E1). The volume of construction-related traffic generated by construction worker vehicles, visitor vehicles, material delivery trucks, and off-hauling of materials would be low in relation to existing traffic volumes along SR-152, I-5, and SR-33. The increase in construction traffic would not substantially increase traffic noise from these highways. Detailed calculations are presented in Appendix E2. **Noise impacts would be significant. Implementation of Mitigation Measures NOISE-1 and NOISE-2, described below in Section 4.10.8, and Mitigation Measure HAZ-5, described below in Section 4.12.8, would reduce noise impacts; however, the measures would not reduce impacts to less than significant levels**. Even if the construction site was completely enclosed and shielded, only a 10 dBA reduction in noise would be expected (FHWA 2006), leaving the increased noise level at the residence on El Toro Road at a 19 dBA noise increase, exceeding the significance criterion. The Lead Agencies evaluated other potential mitigation measures including the development of permanent or semi-permanent sound barriers at the sensitive receptors to isolate them from the noise sources but determined that given the large construction area across which noise would be generated would not be feasible given their incompatibility with uses at the receptors. Given the social and environmental limits on implementing other potential options to offset this impact no feasible additional mitigation has been identified to further reduce these impacts to a less than significant level. **Noise impacts remain significant and unavoidable after implementation of Mitigation Measures NOISE-1, NOISE-2, and HAZ-5.**

This alternative includes building a new dam and pump station, and expanding Pacheco Reservoir, resulting in changes to the reservoir's operations. Long-term operation of the pump station would cause noise levels at the residence on El Toro Road to increase to 54 dBA, exceeding the 45 dBA Santa Clara County Ordinance nighttime exterior noise limit. **Noise**

impacts would be significant (see Table E1-16 in Appendix E1 and Appendix E2 for detailed calculations). Implementing Mitigation Measure NOISE-3, described below in Section 4.10.8, would reduce operational noise impacts by completely enclosing or shielding the pump station, resulting in a 10 dBA reduction in noise level (FHWA 2006). This would reduce noise levels at the residence on El Toro Road to a 44 dBA noise levels, which would be in compliance with the Santa Clara County Ordinance. **Noise impacts would be less than significant after mitigation.**

4.10.8 Mitigation Measures

In addition to Mitigation Measure HAZ-5, the following mitigation measures would reduce the severity of the noise and vibration impacts.

Mitigation Measure NOISE-1. Reclamation, under Alternative 2 (tunnel option) and Alternative 4, and SCVWD, under Alternative 3 and Alternative 5, will ensure a Noise Control Plan (NCP) will be developed by the construction contractor prior to the start of any construction activities to address increased noise levels as a result of the proposed project and alternatives. The NCP will identify the procedures for predicting construction noise levels at sensitive receptors and will describe the reduction measures required to minimize construction noise. The noise mitigation measures in the NCP will include, but are not limited to:

- Appropriate level of sound attenuation will be used or constructed to minimize noise levels by at least 3 dBA. Potential sound attenuation measures could include, but are not limited to stationary equipment and stockpiles, or otherwise placed between the source(s) of construction noise and noise-sensitive receptors, as appropriate. The feasible measures will be determined by the construction contractor based on an initial evaluation of each construction site.
- Contractor will be responsible for maintaining equipment in best possible working condition and outfitting construction equipment with the most effective locally available commercial mufflers or other noise attenuation devices;
- When feasible, the loudest construction activities will be conducted during Merced County construction noise exempt hours, between 7:00 a.m. and 6:00 p.m.;
- Shutting down equipment that are queued or not in use for 5 minutes or more;
- Pre-construction meeting with contractors and project managers to confirm that noise mitigation procedures are in place;
- Signs shall be posted at the construction sites that include permitted construction days and hours, a day and evening contact number for the job site, and a contact number in the event of problems;
- The public will be kept informed of the construction hours and days;
- List contact information for complaints and respond to noise complaints; and
- An on-site complaint and enforcement manager shall respond to and track complaints and questions related to noise.

Mitigation Measure NOISE-2. Reclamation will ensure a pre-construction noise survey will be completed during daytime and nighttime periods at multiple locations across the project area, including identified sensitive receptors, to establish background noise levels at those times. During construction, noise will be monitored weekly at these locations to assess any increases in noise levels that exceed the local noise ordinances. If noise levels are recorded exceeding the background noise level by 10 dBA between 6:00 p.m. and 10:00 p.m. or by 5 dBA between 10:00 p.m. and 7:00 a.m. or if noise complaints are received, an investigation will be conducted to determine the source of the noise. After the investigation, noise will be reduced using all feasible measures, including mitigation at the receiver impacted by the noise. Potential mitigation at the receiver would include building envelope improvements and acoustical window treatments.

Mitigation Measure NOISE-3. SCVWD will ensure the pump station at Pacheco Reservoir will be completely enclosed or shielded with a solid barrier, allowing for an 8 dBA reduction of noise levels (FHWA 2006).

All mitigation requirements will be included in bid documents and construction contracts.

4.10.9 Significant Unavoidable Impacts

Alternative 2 (tunnel option), Alternative 4, and Alternative 5 would have significant effects associated with short-term and temporary construction activities that would exceed the local noise ordinances, resulting in a significant and unavoidable impact. The Lead Agencies evaluated other potential mitigation measures but determined that given the large construction area across which noise would be generated would not be feasible given their incompatibility with uses at the receptors. Given the magnitude of the construction actions and the extensive mitigation measures already proposed, no additional feasible mitigation measures were identified to reduce these impacts to a less than significant level.

4.11 Traffic and Transportation

4.11.1 Assessment Methods

For each project alternative, anticipated short-term construction-related and long-term operations-related trip generation were identified. These additional trips were assigned to roadways located in the vicinity of the service areas (the San Luis Reservoir Region for Alternatives 2, 4, and 5 and the SCVWD Service Area for Alternative 3) to determine traffic operations and Level of Service (LOS) under various project alternatives.

Appendix F provides detailed information about traffic flow assessment methods, trip generation, and roadway operations under the action alternatives. LOS thresholds for various jurisdictions shown in Appendix F were used to identify traffic impacts. For roadways within Merced County, LOS value was determined using criteria for different types of roadways provided in Appendix F. For roadways in Santa Clara County, guidelines provided in the Transportation Impact Analysis Guidelines, Santa Clara Valley Transportation Authority (VTA)

Congestion Management Program were used to evaluate potential traffic impacts. Freeway segments were evaluated using the LOS criteria provided in Appendix F.

Traffic safety effects were analyzed by identifying potentially hazardous areas (areas where slow-moving traffic would need to merge with fast-moving traffic) or roads/intersections that were not designed to adequately handle the proposed construction traffic. Safety hazards include blind corners or turnouts and sharp turns or areas where slow construction traffic might conflict with high roadway speed limits. Any potential routes where increases in construction traffic would conflict with existing public transit routes and their operations were analyzed. Construction and operations effects were analyzed to identify conditions that could result in inadequate emergency access.

4.11.2 Significance Criteria

Impacts related to traffic and transportation would be considered significant if they result in one or more of the following conditions or situations: (1) conflict with a program, plan, ordinance or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities; (2) increase traffic substantially in relation to the existing traffic load and capacity of the street system; (3) substantially increase hazards due to a geometric design feature or incompatible uses; or (4) result in inadequate emergency access. The significance criteria apply to all transportation systems that could be affected by the project. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-13.

4.11.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

The No Action/No Project Alternative would result in no change to existing and future “no build” traffic volumes or air traffic patterns. **The No Action/No Project Alternative would have no impact on traffic and transportation.**

Table 4-13. Traffic and Transportation Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Conflict with a program plan, ordinance or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities	Evaluation of whether construction or operation of the alternatives would generate traffic that would conflict with any goals or objectives of a program, plan, ordinance or policy addressing the circulation system	1	NI	--	Section 4.11.3
		2	NI	None	Section 4.11.4
		3	NI	None	Section 4.11.5
		4	NI	None	Section 4.11.6
		5	NI	None	Section 4.11.7
Cause a substantial increase in traffic in relation to the existing traffic load and capacity of the street system	Comparison of alternative's contribution to local traffic conditions during and after construction based on level of service changes	1	NI	--	Section 4.11.3 Appendix F
		2	Construction – LTS Operation - LTS	None	Section 4.11.4 Appendix F
		3	Construction – LTS Operation - LTS	None	Section 4.11.5 Appendix F
		4	Construction – LTS Operation - NI	None	Section 4.11.6 Appendix F
		5	Construction – LTS Operation - LTS	None	Section 4.11.7 Appendix F
Substantially increase traffic hazards due to a geometric design feature or incompatible use.	Consideration of the alternative's potential to alter the transportation network that would increase traffic hazards.	1	NI	--	Section 4.11.3
		2	S, LTS	TR-1	Section 4.11.4
		3	S, LTS	TR-1	Section 4.11.5
		4	S, LTS	TR-1	Section 4.11.6
		5	S, LTS	TR-1	Section 4.11.7
Result in inadequate emergency access.	Evaluation of whether construction activities could impede emergency response vehicle access on site or along study area roadways	1	NI	--	Section 4.11.3
		2	S, LTS	TR-1	Section 4.11.4
		3	S, LTS	TR-1	Section 4.11.5
		4	S, LTS	TR-1	Section 4.11.6
		5	S, LTS	TR-1	Section 4.11.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.11.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction-related traffic under Alternative 2 would not conflict with the goals and objectives of any applicable programs, plans, ordinances, or policies that establish roadway performance standards and would not result in a substantial increase in traffic in relation to the existing traffic load and roadway capacity.

Trip generation and roadway operations during construction of Alternative 2 are presented in Appendix F. For daily operations, the added construction-related trips would not change the LOS at any of the study roadway segments in Merced County. The added construction-related trips would not change the LOS during the 7:00 to 9:00 a.m. or 4:00 to 6:00 p.m. peak hours at any of the study roadway segments in Merced County, except on the Basalt Road northbound and southbound segments (a.m. and p.m. peak hours) and on SR 152 eastbound at SR 33 (p.m. peak hour). Even though the LOS increases after the construction-related trips are added, it does not exceed the threshold of significance (LOS C) for rural roadways. The minimal increase in traffic would not increase traffic hazards during operations. In Santa Clara County, none of the study roadway segments need to be evaluated because the added construction trips would be less than 1 percent of the respective roadway capacities (the VTA threshold for freeway segment evaluation). **This impact would be less than significant.**

Construction equipment and construction worker vehicle trips would increase hazards at dangerous intersections including Fifield Road near SR 152, Gonzaga Road, Basalt Road, and Dinosaur Point Road. For safety reasons, Reclamation, DWR, and CDPR personnel must be able to access areas around the reservoir and dam at all times. Construction traffic has the potential to limit or slow this emergency access. **Construction of Alternative 2 would increase the potential for traffic hazards at intersections and potentially conflict with emergency vehicles, resulting in a significant impact.** Developing a site-specific Health and Safety Plan, installing caution signs, implementing dust control measures, and implementing construction traffic management actions, included in **Mitigation Measure TR-1, described below in Section 4.11.8, would reduce the severity of this impact to less than significant.**

4.11.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Construction-related traffic under Alternative 3 would not conflict with the goals and objectives of any applicable programs, plans, ordinances, or policies that establish roadway performance standards and would not result in a substantial increase in traffic in relation to the existing traffic load and roadway capacity.

Trip generation and roadway operations during construction of Alternative 3 are presented in Appendix F. Alternative 3 would generate construction-related traffic that would be less than the VTA recommended threshold for roadway evaluation (1 percent of roadway capacity). With minimal increase in traffic, operations of Alternative 3 would not result in changes to existing LOS on roadways or substantially increase traffic hazards in the area of analysis. **This impact would be less than significant.**

Heavy construction vehicles and increased traffic from worker commutes could result in traffic safety hazards. Construction traffic has the potential to limit or slow emergency access. **Construction of Alternative 3 would increase the potential for traffic hazards at intersections and potentially conflict with emergency vehicles, resulting in a significant impact.** By installing caution signs, implementing dust control measures, and implementing construction traffic management actions, **Mitigation Measure TR-1, described below in Section 4.11.8 would reduce the severity of this impact on traffic safety to less than significant**

4.11.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Construction-related traffic under Alternative 4 would not conflict with the goals and objectives of any applicable programs, plans, ordinances, or policies that establish roadway performance standards and would not result in a substantial increase in traffic in relation to the existing traffic load and roadway capacity.

Trip generation and roadway operations during construction of Alternative 4 are presented in Appendix F. For daily operations, the added construction-related trips would not change the LOS at any of the study roadway segments in Merced County. The added construction-related trips would not change the LOS during the a.m. and p.m. peak hours at any of the study roadway segments in Merced County, except on the Basalt Road northbound segment in the a.m. peak hour and southbound segment in the p.m. peak hour, and on SR 152 eastbound at SR 33 (p.m. peak). Even though the LOS increases after the construction-related trips are added on these three segments, it does not exceed the threshold of significance (LOS C) for rural roadways. In Santa Clara County, none of the study roadway segments need to be evaluated because the added construction trips would be less than 1 percent of the respective roadway capacities (the VTA threshold for freeway segment evaluation). **Construction of Alternative 4 would have a less than significant short-term impact on traffic flow.**

During operations of Alternative 4, roadway operations would remain similar to those under No Action/No Project Alternative conditions. No long-term additional trips would be associated with the operations of Alternative 4. **Operations of Alternative 4 would have no long-term impact on traffic flow.**

Construction equipment and construction worker vehicle trips would increase hazards at dangerous intersections, including Fifield Road near SR 152, Gonzaga Road, Basalt Road, and Dinosaur Point Road. For safety reasons, Reclamation, DWR, and CDPR personnel must be able to access areas around the reservoir and dam at all times. Construction traffic has the potential to limit or slow this emergency access. To reduce the potential for adverse traffic safety interactions between this construction truck and worker traffic and other vehicle traffic, temporary traffic signals would be installed at the junctions of SR 152 with Basalt Road and the Romero Visitor Center access road for use during the 8- to 12-year construction schedule. **Construction of Alternative 4 would increase the potential for traffic hazards at intersections and potentially conflict with emergency vehicles, resulting in a significant impact.** Developing a site-specific Health and Safety Plan, installing caution signs, implementing dust control measures, and implementing construction traffic management actions included in **Mitigation Measure TR-1, described below in Section 4.11.8, would reduce the severity of this impact to less than significant.**

4.11.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction-related traffic under Alternative 5 would not conflict with the goals and objectives of any applicable programs, plans, ordinances, or policies that establish roadway performance standards and would not result in a substantial increase in traffic in relation to the existing traffic load and roadway capacity.

Trip generation and roadway operations during construction of Alternative 5 are presented in Appendix F. For daily operations, the added construction-related trips would not change the LOS at any of the study roadway segments in Merced County. The added construction-related trips would not change the LOS during the a.m. and p.m. peak hours at any of the study roadway segments in Merced County, except on SR 152 eastbound at I-5 and SR 33 northbound at I-5 segments in the a.m. and p.m. peak hours. Although the LOS increases after the construction-related trips are added, it does not exceed the threshold of significance (LOS C) for rural roadways. In Santa Clara County, none of the study roadway segments need to be evaluated, because the added construction trips would be less than 1 percent of the respective roadway capacities (the VTA threshold for freeway segment evaluation). With minimal increase in traffic, operation of Alternative 5 would not result in changes to future no-build LOS on study area roadways. The minimal increase in traffic would not increase traffic hazards during operations. **This impact would be less than significant.**

Construction equipment and construction worker vehicle trips would increase hazards at dangerous intersections, including El Toro near SR 152. For safety reasons, emergency personnel must be able to access areas around the reservoir and dam at all times. Construction traffic has the potential to limit or slow this emergency access. **Construction of Alternative 5 would increase the potential for traffic hazards at intersections and potentially conflict with emergency vehicles, resulting in a significant impact.** Developing a site-specific Health and Safety Plan, installing caution signs, implementing dust control measures, and implementing construction traffic management actions, included in **Mitigation Measure TR-1, described below in Section 4.11.8, would reduce the severity of this impact to less than significant.**

4.11.8 Mitigation Measures

The following mitigation measures would reduce the severity of the traffic and transportation impacts.

Mitigation Measure TR-1. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 3 and 5, will ensure the following construction management actions are documented in a traffic control plan, which will be developed by the contractor as a requirement in the construction contract. The temporary traffic control plan will be submitted for Caltrans review and approval during the Encroachment Permit process. Construction contractors shall install signage at intersections identified as dangerous in accordance with the California Manual on

Uniform Traffic Control Devices guidelines warning motorists of slow moving construction traffic and lane closures. Roadways with signage would include SR 152, Basalt Road, and the Romero Visitor Center access road under Alternatives 2 and 4, Camden Avenue and Graystone Lane under Alternative 3, and SR 125 and El Toro under Alternative 5. Signage shall also be posted at these intersections one month in advance to allow motorists time to plan for delays or alternate routes. Construction contractors shall implement dust abatement and perform proper construction traffic management actions, including signage warning motorists of construction activity and traffic controls like flaggers or temporary traffic lights where construction equipment will be entering roadways, to reduce conflicts during periods of high traffic volume in and around each construction site and to avoid conflicts with emergency responders entering and existing the area during an emergency.

In addition to the temporary traffic control plan, prior to the initiation of any construction actions, construction contractors shall develop and adhere to a health and safety plan outlining all applicable OSHA requirements, important traffic safety plans including identification of emergency access routes in and through construction areas that would will need to be kept clear at all times during construction. The health and safety plan shall include coordination with emergency service personnel to ensure adequate mitigation for all impacts.

4.12 Hazards and Hazardous Materials

4.12.1 Assessment Methods

The following qualitative evaluation focuses on two types of impacts associated with hazardous materials: (1) the potential to encounter hazardous materials, contaminated soil and/or groundwater, at existing active hazardous materials sites near proposed construction, and (2) accidental release of hazardous materials during construction and operations, including accidental releases during transportation to/from sites related to construction and operations. Other hazard risk considerations evaluated include proximity of the alternatives to wildlands, airports, and schools, and conflicts with emergency evacuation plans.

4.12.2 Significance Criteria

Hazards and hazardous materials impacts would be considered significant if the project would: (1) create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials; (2) create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment; (3) emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school; (4) be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government code Section 65962.5 and, as a result would it create a significant hazard to the public or the environment; (5) result in a safety hazard for people residing or working in the project area for a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport; (6) impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan; (7) expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires; or (8) if located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the project: (a) substantially impair an adopted emergency response plan or emergency evacuation plan, (b) due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire, (c) require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment, (d) expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-14.

4.12.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

The No Action/No Project Alternative includes the most likely future conditions in the absence of the project. No construction nor impacts related to hazards and hazardous materials would occur. No changes to the types or extent of the hazards are underway that would change the character of hazards or hazardous materials in the future. **There would be no impact.**

4.12.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Some hazardous materials (motor oil, gasoline, diesel fuel, solvents, and degreasers) would be used on-site during construction and operation of Alternative 2. Development of a SWPPP, as described in Section 4.1, would require safety measures and BMPs to be implemented when transporting, storing, or using hazardous materials and would describe actions to prevent a release of hazardous materials and procedures in case of an accidental spill or release of hazardous materials. **Impacts related to hazardous materials during construction and operation of Alternative 2 would be less than significant.**

There are no schools within one-quarter mile of construction zone. **There would be no impact for local school children and school staff from exposure to hazardous materials.**

Table 4-14. Hazards and Hazardous Materials Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Increase the risk of exposure from hazardous materials to the public and construction workers during alternative construction onsite, during the transport, use or disposal of hazardous materials offsite, and during long-term operations and maintenance activities.	Consideration of the types of waste materials generated by the alternatives onsite, the transportation routes to any disposal sites and the need for interaction with or generation of hazardous materials as a part of operation and maintenance of the alternatives	1	NI	--	Section 4.12.3
		2	LTS	None	Section 4.12.4
		3	LTS	None	Section 4.12.5
		4	Construction – S, LTS Operation - NI	HAZ-5	Section 4.12.6
		5	Construction – S, LTS Operation - NI	HAZ-5	Section 4.12.7
Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment	Consideration of the potential for foreseeable upset and accident conditions involving the release of hazardous materials into the environment.	1	NI	--	Section 4.12.3
		2	LTS	None	Section 4.12.4
		3	LTS	None	Section 4.12.5
		4	LTS	None	Section 4.12.6
		5	LTS	None	Section 4.12.7
Increase the potential for exposure to hazardous materials to local school children and staff with construction located within one-quarter mile of an existing or proposed school	Evaluation of whether of whether construction activities would occur within one-quarter mile of an existing or proposed school	1	NI	--	Section 4.12.3
		2	NI	None	Section 4.12.4
		3	LTS	None	Section 4.12.5
		4	NI	None	Section 4.12.6
		5	NI	None	Section 4.12.7
Interfere with an active remediation site which could create a hazard to the public or the environment if contaminated soil and/or groundwater is encountered and released to the environment.	Evaluation of whether any of the alternative construction sites would be located at or near an active remediation site and whether implementation of the alternatives would interfere with that site	1	NI	--	Section 4.12.3
		2	S, LTS	HAZ-1	Section 4.12.4
		3	LTS	None	Section 4.12.5
		4	S, LTS	HAZ-6	Section 4.12.6
		5	NI	None	Section 4.12.7
Conflict with activities and operations at airports near or within the project area during construction, resulting in safety hazards for pilots or people working and residing in the area.	Evaluation of whether any of the alternative construction sites would be located at or near an airport	1	NI	--	Section 4.12.3
		2	S, LTS	HAZ-3, HAZ-4	Section 4.12.4
		3	NI	None	Section 4.12.5
		4	S, LTS	HAZ-3, HAZ-4	Section 4.12.6
		5	NI	None	Section 4.12.7

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Temporarily interfere with an emergency response plan or emergency evacuation plan for the project vicinity as a result of construction traffic and traffic controls impacting local roads.	Evaluation of how construction generated truck traffic and any construction traffic controls could impact emergency response in the study area	1	NI	--	Section 4.12.3
		2	S, LTS	TR-1	Section 4.12.4
		3	LTS	None	Section 4.12.5
		4	S, LTS	TR-1	Section 4.12.6 Section 4.11.8
		5	S, LTS	TR-1	Section 4.12.7 Section 4.11.8
Increase the risk of wildfire within the vicinity of the project area through the use of mechanical equipment during construction	Evaluation of the proposed construction activities and proposed construction disturbance areas for potential fire risk	1	NI	--	Section 4.12.3
		2	S, LTS	HAZ-2	Section 4.12.4
		3	NI	None	Section 4.12.5
		4	S, LTS	HAZ-2	Section 4.12.6
		5	S, LTS	HAZ-2	Section 4.12.7
if located in or near state responsibility areas or lands classified as very high fire hazard severity zones, (a) substantially impair an adopted emergency response plan or emergency evacuation plan, (b) exacerbate wildfire risks, and thereby expose project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire, (c) require the installation or maintenance of associated infrastructure that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment, (d) expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes.	Evaluation of the location of the alternative in relation to state responsibility areas or lands classified as very high fire hazard severity zones. If within or nearby those areas, evaluation of any potential impairment of an emergency plan, the exacerbation of wildfire risks, or exposure of people or structures to significant risks as a result of construction or operation of the alternative.	1	NI	--	Section 4.12.3
		2	LTS	None	Section 4.12.4
		3	NI	None	Section 4.12.5
		4	LTS	None	Section 4.12.6
		5	LTS	None	Section 4.12.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

One active hazardous materials site under CDPR management is within the San Luis Reservoir SRA along Gonzaga Road near Park Headquarters. Under the oversight of the Central Valley RWQCB the regulatory status is open with an order for continued soil and groundwater monitoring. The site is outside the area of most of the proposed disturbance with exception of a 5-acre staging area south of Gianelli Pumping Plant off of Gonzaga Road. **A significant impact could occur if contaminated soil and/or groundwater was encountered and released during construction.** Mitigation Measure HAZ-1 would require that the contractor prepare a Contaminated Soil/Groundwater Management Plan for implementation, if contamination is encountered during construction, to avoid disturbance to the soil and groundwater remediation site. **Preparation and implementation of a Contaminated Soil/Groundwater Management Plan under Mitigation Measure HAZ-1 would reduce impacts to less than significant levels.**

The construction of Alternative 2 would require the closure of the San Luis Reservoir, including the temporary suspension of all air operations at the San Luis Reservoir Sea Plane Base for duration of between 33 and 47 months. Closure of the base is necessary due to use of cranes during pipeline tunneling or construction, which could pose a height conflict for air operations be a safety hazard to pilots, the general public, and workers, if pilots are unaware of the temporary base closures. **Construction of the project within the San Luis Reservoir Airbase could have significant public safety and hazard impacts.** Mitigation Measure HAZ-3, described below in Section 4.12.8, would require development of a construction safety plan in accordance with *FAA Advisory Circular 150/5370-2F Operational Safety on Airports During Construction* to coordinate construction activities, schedule and notice requirements. Mitigation Measure HAZ-4, would require a NOTAM to be issued to alert pilots of the sea plane base closure prior to use of any impeding construction equipment and to notify pilots of construction activities. **Coordination between the project contractor and Airbase personnel, including issuance of NOTAMs, and other elements described in Mitigation Measures HAZ-3 and HAZ-4 would reduce impacts to less than significant levels.**

SR 152 would be the main site access for trucks, heavy equipment and construction worker access to Dinosaur Point and Basalt staging areas. SR 152 is the main access into the San Luis Reservoir SRA from both directions and would be the main evacuation route from the park in case of an emergency. A CAL FIRE station is located within the SRA on Gonzaga Road near the Park Headquarters. **Potential conflicts with emergency vehicles in the form of traffic slowdowns or temporary roadway blockages during construction would be a significant impact.** Traffic control Mitigation Measure TR-1, described in Section 4.11.8, would be required during construction to allow emergency vehicles through work areas as needed and according to approved traffic control plans. Construction traffic would be held from using emergency vehicle routes until emergency vehicles had left the site. **Therefore, with implementation of traffic control Mitigation Measure TR-1, the impact would be reduced to less than significant.**

Sparks could be generated while using mechanical equipment, which could cause a wildfire. **This increased fire risk would be significant.** Mitigation Measure HAZ-2 requires using equipment with spark arrestors and informing workers of the risk of starting a wildfire and how to avoid it. **Therefore, during construction of the action alternatives, changes to the risk of wildfire could be significant; however, with use of spark arrestors on equipment as**

described in Mitigation Measure HAZ-2, impacts would be reduced to less than significant with mitigation.

San Luis Reservoir is located within a state responsibility area, classified as moderate or high fire hazard severity. Construction and operation of Alternative 2 would not substantially impair or interfere with the goals and plan elements of the Merced County Emergency Operations Plan or the CAL FIRE 2018 Strategic Fire Plan for California. The new intake would not alter the landscape or require the installation of infrastructure that would exacerbate wildfire risk. There would be no increase in exposure of people or structures to significant wildfire related risk as a result of Alternative 2. In addition, emergency fire protection is provided by CAL FIRE, stationed south of Gonzaga Road, which includes fire prevention efforts. **This impact would be less than significant.**

4.12.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Some hazardous materials (motor oil, gasoline, diesel fuel, solvents, and degreasers) would be used on-site during construction and operation of Alternative 3. Development of a SWPPP, as described in Section 4.1, would require safety measures and BMPs to be implemented when transporting, storing, or using hazardous materials and would describe actions to prevent a release of hazardous materials and procedures in case of an accidental spill or release of hazardous materials. There is no existing hazardous material contamination on site or nearby. **Impacts related to hazardous materials during construction and operation of Alternative 3 would be less than significant.**

There are two existing schools within one-quarter mile of the Santa Teresa WTP. The hazardous materials to be used during construction of Alternative 3 would be limited to low toxicity materials associated with construction equipment. In addition, development of a SWPPP would require proper handling, storage, transport, and disposal of all hazardous materials. **This impact would be less than significant.**

There are no airports within 2 miles of the WTP that would be impacted by construction activities. **Alternative 3 would have no impact related to airport safety.**

Since all of the construction work would take place at the WTP site, it is unlikely that contamination from nearby sites would be encountered during construction. **Therefore, construction of Alternative 3 would have a less than significant impact related to hazardous materials because contamination from hazardous waste sites within the vicinity would not be encountered.**

Construction vehicles may use some of same routes used for emergency evacuations to access the WTP during construction. Because the proposed construction sites are within urban areas, public services for emergency response are available nearby. During construction, the contractor would be required to allow emergency vehicles through work areas as needed and according to approved traffic control plans. Construction traffic would be held from using emergency vehicle routes until the emergency had passed. **Therefore, Alternative 3 would have a less than significant impact to emergency response and evacuation plans.**

Santa Teresa WTP is not located in or near a state responsibility area or land classified as very high fire hazard severity zones. Therefore, Alternative 3 would not substantially impair an emergency plan, exacerbate wildfire risks, expose people or structures to significant risks within a state responsibility area or very high fire hazard severity zone. **There would be no impact.**

4.12.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Some hazardous materials (motor oil, gasoline, diesel fuel, solvents, and degreasers) would be used on-site during construction and operation of Alternative 4. Development of a SWPPP, as described in Section 4.1, would require safety measures and BMPs to be implemented when transporting, storing, or using hazardous materials and would describe actions to prevent a release of hazardous materials and procedures in case of an accidental spill or release of hazardous materials. Blasting during construction of Alternative 4 would occur at Basalt Hill and involve the transport, handing, and use of explosives. This would create a hazard for those workers conducting the blasting and those working in proximity to Basalt Hill. **This impact would be significant during construction**. Mitigation Measure HAZ-5 would require a Blasting Plan that with safety measures, including minimum standoff distances, handling procedures, an emergency action plan, and transportation requirement that would reduce impacts. **Impacts related to hazardous materials during construction of Alternative 4 would be less than significant with implementation of Mitigation Measure HAZ-5. Impacts related to hazardous materials during operation of Alternative 4 would be less than significant.**

The closest school to San Luis Reservoir is 1.5 miles away and there are no schools within one-quarter mile of construction zone. **There would be no impact for local school children and school staff from exposure to hazardous materials.**

The project would be constructed near an active remediation site within San Luis Reservoir SRA similar to what is described under Alternative 2. **A significant impact could occur if contaminated soil and/or groundwater was encountered and released during construction.** Ongoing state-mandated soil and groundwater monitoring activities at the contaminated site may be affected. Mitigation Measure HAZ-6 would require that the project contractor prepare a Contaminated Soil/Groundwater Remediation Plan for implementation if contamination is still present based on available monitoring data or if contaminated soil or groundwater is encountered during construction. Reclamation would contact CDPR and the Central Valley RWQCB to determine whether ongoing monitoring of the site is needed during or after construction. **During construction of Alternative 4, release and exposure of hazardous materials could be significant; however, preparation and implementation of a Contaminated Soil/Groundwater Remediation Plan under Mitigation Measure HAZ-6, would reduce this impact to less than significant levels.**

The construction of Alternative 4 would place construction equipment including barge-mounted cranes, at B. F. Sisk Dam throughout the 7-year construction schedule. This would not prevent the use of other portions of the reservoir by the seaplane base. Construction activities at B.F. Sisk Dam could be a safety hazard to pilots, the general public, and workers within the project area, if pilots are unaware of the temporary base closures. Mitigation Measures HAZ-3 and HAZ-4, described under Alternative 2 would be implemented under Alternative 4. **Construction of the project within the San Luis Reservoir Airbase could have significant public safety and hazard impacts; however, coordination between the project contractor and Airbase personnel, including issuance of NOTAMs, and other elements described in Mitigation Measures HAZ-3 and HAZ-4 would reduce impacts to less than significant levels.**

Impacts related to potential conflicts with emergency response and evacuation plans related to use of SR 152 and Basalt Road for construction impacts would be the same as those described in Alternative 2. **Potential conflicts with emergency vehicles in the form of traffic slowdowns or temporary roadway blockages during construction would be a significant impact. Therefore, with implementation of traffic control Mitigation Measure TR-1, the impact would be less than significant.**

San Luis Reservoir is located within a state responsibility area, classified as moderate or high fire hazard severity. Construction and operation of Alternative 4 would not substantially impair or interfere with the goals and plan elements of the Merced County Emergency Operations Plan or the CAL FIRE 2018 Strategic Fire Plan for California. The reservoir expansion would not alter the landscape or require the installation of infrastructure that would exacerbate wildfire risk. There would be no increase in exposure of people or structures to significant wildfire related risk as a result of Alternative 2. **This impact would be less than significant.**

4.12.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

During construction, hazardous materials typically associated with proposed construction activities, such as fuel, oil, explosives and lubricants would be used. Operation of intake valves and gates would require hydraulic fluids, typically oil. Construction and operation of Alternative 5 would comply with relevant statutes and regulations related to hazardous materials and would include the development of a SWPPP, as described in Section 4.1, which would require safety measures and BMPs to be implemented when transporting, storing, or using hazardous materials. There is no existing hazardous material contamination on site or nearby. Blasting during construction of Alternative 5 would occur at Pacheco Reservoir and involve the transport, handing, and use of explosives. This would create a hazard for those workers conducting the blasting and those working in proximity to Pacheco Reservoir. **This impact would be significant during construction**. Mitigation Measure HAZ-5 would require a Blasting Plan that with safety measures, including minimum standoff distances, handling procedures, an emergency action plan, and transportation requirement that would reduce impacts. **Impacts related to hazardous materials during construction of Alternative 5 would be less than significant with implementation of Mitigation Measure HAZ-5. Impacts related to hazardous materials during operation of Alternative 5 would be less than significant.**

There are no active or hazardous materials sites, no existing or proposed schools, and no airports within 5 miles of Pacheco Reservoir. **There would be no impact related to these hazards.**

SR 152 would be the main site access for trucks, heavy equipment and construction workers access to the project area; pipeline improvements are proposed under SR 152. SR 152 is the main access route from both directions and would be the main evacuation route from the project area in case of an emergency. Construction activities on SR 152 could temporarily conflict with emergency response and evacuation plans for the Pacheco Reservoir. **Potential conflicts with emergency vehicles in the form of traffic slowdowns or temporary roadway blockages during construction would be a significant impact.** Traffic control Mitigation Measure TR-1 would be required during construction to allow emergency vehicles through work areas as needed and according to approved traffic control plans. Construction traffic would be held from using emergency vehicle routes until the emergency had passed. **Therefore, with implementation of traffic control Mitigation Measure TR-1, the impact would be less than significant.**

CAL FIRE identified the area surrounding Pacheco Reservoir as a region of high risk for wildfire (CAL FIRE 2007). Sparks could be generated while using mechanical equipment, which could cause a wildfire. **Therefore, during construction of Alternative 5, changes to the risk of wildfire could be significant; however, with the implementation of Mitigation Measure HAZ-2, this impact would be less than significant.**

Pacheco Reservoir is located within a state responsibility area, classified as high or very high fire hazard severity. Construction and operation of Alternative 5 would not substantially impair or interfere with the goals and plan elements of the Santa Clara County Emergency Operations Plan or the CAL FIRE 2018 Strategic Fire Plan for California. The reservoir expansion would not alter the landscape or require the installation of infrastructure that would exacerbate wildfire risk. There would be no increase in exposure of people or structures to significant wildfire related risk as a result of Alternative 5. **This impact would be less than significant.**

4.12.8 Mitigation Measures

In addition to Mitigation Measure TR-1, the following mitigation measures would reduce the severity of the hazard and hazardous materials impacts.

Mitigation Measure HAZ-1. Reclamation will ensure that construction contracts include requirements for the contractor to prepare a Contaminated Soil/Groundwater Management Plan in coordination with CDPR and the Central Valley RWQCB to avoid disturbance to any active hazardous waste or contaminated site during construction. In support of this Contaminated Soil/Groundwater Management Plan, pre-construction sediment sampling in all areas where disturbance would occur will be completed to fully characterize the scope of site contamination. All construction buffer and contaminated soil/groundwater handling requirements will be incorporated into the construction contracts.

A buffer will be required around the limits of each hazardous waste or contaminated site. Construction fencing shall be placed around the perimeter of the buffer prior to the beginning of construction where work is proposed in the vicinity of a hazardous waste or contaminated site. The size of the buffer will be determined based on the extent of the contamination. If contamination is encountered during construction, the contractor shall implement the Contaminated Soil/Groundwater Remediation Plan in coordination with CDPR, Central Valley RWQCB, and/or San Francisco Bay RWQCB which includes: notification, sampling and analysis, proper handling, storage, transport and disposal procedures. Dust control measures, groundwater collection, treatment and discharge procedures shall also be included in the plan.

Mitigation Measure HAZ-2. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will include requirements in all construction contracts requiring the use of spark arrestors on all construction equipment. The contract shall also include requirements for the contractor to educate all construction workers about the risk of starting a wildfire and how to avoid it and who to contact in case a wildfire is started. In addition, under Alternative 4, restrictions shall be placed on smoking and campfires for any personnel utilizing Basalt Campground.

Finally, the construction contractor shall prepare a Fire Prevention Plan to prevent a fire from occurring. The plan must include (U.S. Department of Labor, OSHA 2018):

- A list of all major fire hazards, proper handling and storage procedures for hazardous materials, potential ignition sources and their control, and the type of fire protection equipment necessary to control each major hazard.
- Procedures to control accumulations of flammable and combustible waste materials.
- Procedures for regular maintenance of safeguards installed on heat-producing equipment to prevent the accidental ignition of combustible materials.
- The name or job title of employees responsible for maintaining equipment to prevent or control sources of ignition or fires.
- The name or job title of employees responsible for the control of fuel source hazards.

Mitigation Measure HAZ-3. Reclamation will ensure the construction contracts include requirements for the contractor to prepare a construction safety plan prior to any construction activities in collaboration with airbase personnel to coordinate construction activities including: a schedule, coordination of personnel with aviation radios, and notice requirements. Also, consistent with Mitigation Measure TR-1, the contractor shall coordinate with emergency service personnel to ensure adequate mitigation for all impacts.

Mitigation Measure HAZ-4. Reclamation, in coordination with the construction contractor, shall notify the San Luis Airbase administrator when a NOTAM is required to be issued prior to the commencement of construction activities within the airbase and when high profile equipment will be used within safety zones.

Mitigation Measure HAZ-5. Reclamation, under Alternatives 4, and SCVWD, under Alternative 5, will ensure that the construction contractor prepares and follows a Blasting Plan for construction that includes the following:

- Identification of blast officer;
- Scaled drawings of blast locations, and neighboring buildings, streets, or other locations which could be inhabited;
- Blasting notification procedures, lead times, and list of those notified. Public notification to potentially affected vibration and nuisance noise receptors describing the expected extent and duration of the blasting;

- Description of means for transportation and on-site storage and security of explosives in accordance with local, State and Federal regulations;
- Minimum acceptable weather conditions for blasting and safety provisions for potential stray current (if electric detonation);
- Traffic control standards and traffic safety measures (if applicable);
- Required personal protective equipment;
- Minimum standoff distances and description of blast impact zones and procedures for clearing and controlling access to blast danger;
- Procedures for handling, setting, wiring, and firing explosives; and procedures for handling misfires per Federal code;
- Type and quantity of explosives and description of detonation device.
- Methods of matting or covering of blast area to prevent flyrock and excessive air blast pressure;
- Description of blast vibration and air blast monitoring programs;
- Dust control measures in compliance with applicable air pollution control regulations (to interface with general construction dust control plan);
- Emergency Action Plan to provide emergency telephone numbers and
- directions to medical facilities. Procedures for action in the event of injury;
- Material Safety Data Sheets for each explosive or other hazardous materials to be used;
- Evidence of licensing, experience, qualifications of blasters, and description of insurance for the blasting work
- A sound attenuation plan shall be prepared outlining sound control measures that would include the use of blasting mats or sound walls;
- If vibration results in damage to any nearby structures or utilities, or scenic rock faces, blasting shall immediately cease. The stability of segmental retaining walls, existing slopes, creek canals, etc. shall be monitored and any evidence of instability due to blasting operations shall result in immediate termination of blasting;
- Explosive materials shall be delivered in specially built vehicles marked with United Nations (UN) hazardous materials placards. Explosives and detonators shall be delivered in separate vehicles or be separated in compartments meeting Department of Transportation (DOT) rules within the same vehicle. Vehicles shall have at least two ten-pound Class-A fire extinguishers and all sides of the vehicles display placards displaying the UN Standard hazard code for the onboard explosive materials. Drivers shall have commercial driver licenses (CDL) with Hazmat endorsements, and drivers shall carry bill-of-lading papers detailing the exact quantities and code dates of transported explosives or detonators;
- The contractor must comply with U.S. Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) table-of-distance requirements (CFR 27, U.S. Department of Justice, Alcohol, Tobacco, Firearms and Explosives Division Part 555) that restrict explosive quantities based

on distance from occupied buildings and public roadways. Employees must also comply with the security requirements of the Safe Explosives Act (Title XI, Subtitle C of Public Law 107-296, Interim Final Rule), implemented in March 2003. These requirements require background checks for all persons that use, handle or have access to explosive materials; and responsible persons on a now required Federal explosives license must submit photographs and fingerprints with the application to ATF.

Mitigation Measure HAZ-6. Reclamation will ensure the construction contract will include requirements for the coordination with the CDPR and the Central Valley RWQCB to review existing monitoring data of the San Luis Reservoir SRA LUST Cleanup Site to evaluate the potential for interacting with hazardous soil contamination during construction. If the contractors determine that interaction with contaminated soil cannot be avoided and these construction actions could generate a release of this soil to nearby water bodies or elsewhere offsite the contractors shall prepare a Contaminated Soil/Groundwater Remediation Plan. This remediation plan will detail the nature of the contaminants on site, measures required to avoid interaction with these contaminants including if necessary a pre-construction cleanup of the site, and a response action plan in the event of an inadvertent release of contaminated soils from the construction site. This plan will be submitted to the CDPR and the Central Valley RWQCB for review and approval prior to any construction taking place.

4.13 Aquatic Resources

4.13.1 Assessment Methods

Project-related fisheries resources impacts would fall into two categories: (1) short-term construction-related impacts and (2) long-term operations-related impacts. Short-term construction-related impacts would include the temporary loss of fish habitat from disturbance and increased sedimentation, release, and exposure of construction-related contaminants. Long-term operational impacts would be triggered by changes in hydrology associated with changes in operations.

4.13.1.1 Operational Impacts to Delta Fishes

Extensive modeling of hydrologic conditions was performed using CalSim II to provide a quantitative basis from which to assess potential operational effects of the project alternatives on fisheries resources and aquatic habitats in the Delta. Hydrologic indicators (or parameters) for habitat quality in the Delta that were used in this analysis include Sacramento River flow, Delta outflow, Delta inflow, low salinity zone (X2), Old and Middle River flows, and Delta exports (see Section L2.1.1 of Appendix L2 for details on the analysis).

4.13.1.2 Operational Impacts to Pacheco Creek Steelhead

Habitat suitability modeling was performed to evaluate the impact of the expanded Pacheco Reservoir operations on South-Central California Coast Steelhead critical habitat located in Pacheco Creek. Suitability modeling evaluated the impact of expanded Pacheco Dam flow releases on steelhead habitat quality for all life stages (adult migration to juvenile outmigration) present in Pacheco Creek. The model considered a range of environmental factors important for steelhead, including flow, temperature, and macro-habitat features (see Section L2.1.2 of Appendix L2 for details on the analysis).

4.13.2 Significance Criteria

Impacts of an alternative on fisheries and aquatic ecosystems would be significant if project implementation would do any of the following: (1) have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW, USFWS, or NMFS; (2) interfere substantially with the movement of any native resident or migratory fish or aquatic-dependent species or with established native resident or migratory corridors, or impede the use of native nursery sites; (3) conflict with any local policies or ordinances protecting fisheries resources; or (4) conflict with the provisions of an adopted Habitat Conservation Plan (HCP), Natural Community Conservation Plan, or other approved local, regional, or State HCP. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-15.

4.13.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

The No Action/No Project Alternative includes the most likely future conditions in the absence of the project. The No Action/No Project Alternative would leave the current operations at San Luis Reservoir and Pacheco Reservoir unchanged. Therefore, no new construction would occur. There would be no impacts on fish migration corridors, and no conflicts with habitat conservation plans or other local plans or policies. **Because the No Action/No Project Alternative does not entail construction, there would be no related impacts on special-status fish species or their habitat.**

4.13.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction of Alternative 2 could result in temporary impacts on aquatic habitats for fish species from clearing, grading, staging of equipment, and other ground-disturbing activities. However, there are no special-status fish species present in the San Luis Reservoir. **As a result, changes in aquatic habitat due construction activities would result in no impacts to special-status fish.** In addition, to further minimize impacts Mitigation Measure BIO-1 would be implemented to avoid or reduce impacts on watercourses, wetlands, riparian areas, and other sensitive habitats during construction. Construction of Alternative 2 would not interfere with the movement on any native resident or migratory fish or aquatic-dependent species, or with established native resident or migratory corridors, or impede the use of native nursery sites.

Table 4-15. Aquatic Resources Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW, USFWS, or NMFS	Evaluate how construction of new infrastructure or later through operation of the alternatives could potentially impact any species identified as a candidate, sensitive, or special-status species through direct effects or through habitat modification	1	NI	--	Section 4.13.3 Appendix L2
		2	Construction – NI Operation (Delta) - LTS	BIO-1	Section 4.13.4 Appendix L2
		3	Construction –NI Operation (Delta) - LTS	BIO-1	Section 4.13.5 Appendix L2
		4	Construction –NI Operation (Delta) - LTS	BIO-1	Section 4.13.6 Appendix L2
		5	Construction – S, LTS Operation (Delta) – LTS Operation (Pacheco Creek/Pajaro River) – S, LTS	BIO-1, BIO-2	Section 4.13.7 Appendix L2
Interfere substantially with the movement of any native resident or migratory fish or aquatic-dependent species or with established native resident or migratory corridors, or impede the use of native nursery sites	Evaluate how implementation of the alternatives through the placement of equipment or development of new infrastructure during construction or through changes in water flow or availability during operation, could interfere with the movement of any native resident or migratory fish or aquatic-dependent species or with established native resident or migratory corridors, or impede the use of native nursery sites	1	NI	--	Section 4.13.3
		2	NI	None	Section 4.13.4
		3	NI	None	Section 4.13.5
		4	NI	None	Section 4.13.6
		5	LTS	None	Section 4.13.7
Conflict with any local policies or ordinances protecting fisheries resources	Evaluate how implementation of the alternatives could conflict with policies or ordinances protecting fisheries resources	1	NI	--	Section 4.13.3
		2	NI	None	Section 4.13.4
		3	NI	None	Section 4.13.5
		4	NI	None	Section 4.13.6
		5	NI	None	Section 4.13.7
Conflict with the provisions of an adopted HCP, Natural Community Conservation Plan, or other approved local, regional, or State HCP	Evaluate how implementation of the alternatives could conflict with HCPs or Natural Community Conservation Plan	1	NI	--	Section 4.13.3
		2	NI	None	Section 4.13.4
		3	NI	None	Section 4.13.5
		4	NI	None	Section 4.13.6
		5	NI	None	Section 4.13.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

Operation of Alternative 2 would allow the San Felipe Division to draw water from San Luis Reservoir at the same elevation as the Gianelli Intake. Operations of the reservoir would be generally the same as under the No Action/No Project Alternative. CalSim II modeling results indicate that, on average, there are very slight changes (less than 1 percent) to Delta hydrology, hydrodynamics, and water quality resulting from changes in Delta operations of the CVP and SWP compared to the No Action/No Project Alternative, which could affect Delta fishes, their habitats, or impact their migration. Operation of Alternative 2 would comply with the policies established in the San Luis Reservoir SRA RMP/GP (Reclamation and CDPR 2013). There are no HCPs or local tree protection ordinances that cover the San Luis Reservoir Region. Operation of Alternative 2 would not interfere substantially with the movement of any native resident or migratory fish or aquatic-dependent species, or with established native resident or migratory corridors, or impede the use of native nursery sites. **As a result, operational impacts would be less than significant for special-status fish, HCPs, and local ordinances.**

4.13.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Construction of Alternative 3 would occur at the existing Santa Teresa WTP and within areas already disturbed by development. There would be no construction activities within or near aquatic habitats. **Therefore, construction of Alternative 3 would have no impact on sensitive habitats for special status fish species or the movement of any native resident or migratory fish species.** In addition, to further minimize impacts Mitigation Measure BIO-1 would be implemented to avoid or reduce impacts on watercourses, wetlands, riparian areas, and other sensitive habitats during construction. Although the area of construction would be covered under the Santa Clara Valley Habitat Plan, the plan does not cover aquatic species, and consistency with that plan is therefore not a concern for aquatic resources.

Operation of Alternative 3 would be similar to Alternative 2. CalSim II modeling results indicate that, on average, there are very slight changes (less than 1 percent) to Delta hydrology, hydrodynamics, and water quality resulting from changes in Delta operations of the CVP and SWP compared to the No Action/No Project Alternative, which could affect delta fishes, their habitats, or impact their migration. Operation of Alternative 3 would comply with the policies established in the San Luis Reservoir SRA RMP/GP (Reclamation and CDPR 2013). **Operational impacts would be less than significant.**

4.13.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Construction of Alternative 4 could result in temporary impacts on aquatic habitats for fish species from clearing, grading, and other ground-disturbing activities associated with construction of an expanded Sisk Dam. As discussed above, there are no special-status fish species present in San Luis Reservoir. **As a result, changes in aquatic habitat due to construction activities would result in no impacts to special-status fish.** In addition, to further minimize impacts Mitigation Measure BIO-1 would be implemented to avoid or reduce impacts on watercourses, wetlands, riparian areas, and other sensitive habitats during construction.

Operation of Alternative 4 would comply with the policies established in the San Luis Reservoir SRA RMP/GP (Reclamation and CDPR 2013). There are no HCPs or local tree protection ordinances that cover the San Luis Reservoir Region. Operation of Alternative 4 could result in changes to CVP and SWP operations in the Delta, which, in turn, could result in changes to hydrological indicators for habitat. These changes are described below.

4.13.6.1 Sacramento River Flow

Simulated Sacramento River flow at Hood would decrease by less than one percent on average in all months of all water-year types (See Section L2.2.1.3.1 of Appendix L2) for Alternative 4 compared to the No Action/No Project Alternative. During most years Sacramento River flows would be unchanged.

There would be no discernable Sacramento River flow-related effects on special-status fish species under Alternative 4, relative to the No Action/No Project Alternative. Functional flows for fish species would be unchanged, leading to no discernible impact to Delta fishes, their habitat, or their migration. **Therefore, Sacramento River flow-related effects on special-status fish species would be less than significant.**

4.13.6.2 Low Salinity Zone (X2)

Modeling simulations predict that operation of the proposed project would result in small changes to the X2 position[4] (see Section L2.2.1.3.2 of Appendix L2 for a summary of this analysis). X2 would not change by more than 0.02 kilometers (km) during February through May or September through November, periods when special-status fish species use the low salinity zone (LSZ) for rearing. During most months of most years, the position of the LSZ would be unchanged. Additionally, all operations would be guided by Reasonable and Prudent Alternative (RPA) Actions established by NMFS and USFWS Biological Opinions (BOs) to manage the position of X2 and reduce any adverse effects to special-status fish species. There would be no discernable effects related to changes in the position of the LSZ (X2) on special-status fish species under Alternative 4, relative to the No Action/No Project Alternative. **Therefore, changes in the position of the LSZ (X2) on special-status fish species would be less than significant.**

4.13.6.3 Delta Outflow

Simulated Delta outflow would decrease by less than 1 percent in all months of all water-year types (see Section L2.2.2.1.3.3 of Appendix L2 for a summary of this analysis). During most months of most years Delta outflows would be unchanged.

Any potential small effects attributed to changes in Delta outflow would be further minimized because CVP and/or SWP operations would be guided by any real-time operations and operational actions identified in the RPAs established by the NMFS and USFWS BOs to reduce any impacts to special-status fish species. There would be no discernable Delta outflow-related effects on special-status fish species under Alternative 4, relative to the No Action/No Project

[4] The “X2” water quality parameter represents the distance from the Golden Gate Bridge to the location of 2 parts per thousand salinity concentration in the Delta.

Alternative. Functional flows for fish species would be unchanged, leading to no discernible impact to Delta fishes, their habitat, or their migration. **Therefore, Delta outflow-related effects on special-status fish species would be less than significant.**

4.13.6.4 Old and Middle River Flows

Modeling simulations predict that operation of Alternative 4 would result in small changes to Old and Middle rivers reverse flows for most months of most year types (see Section L2.2.1.3.4 of Appendix L2 for a summary of this analysis). While even small adverse changes in reverse flows could be considered significant, the Smelt Working Group and the Delta Operations for Salmonids and Sturgeon (DOSS) group work with USFWS, NMFS, DWR, CDFW, and Reclamation to manage reverse flows to avoid reaching the actual take limits for the federally listed fish species at the CVP and SWP facilities. Reclamation and DWR reduce or stop reverse flows to avoid hitting the take limits that are established by USFWS and NMFS in the BOs and by CDFW in the longfin smelt incidental take permit (ITP). Functional flows for fish species would be nearly unchanged, leading to no discernible impact to Delta fishes, their habitat, or their migration. **Therefore, this impact would be less than significant.**

4.13.6.5 Delta Exports

Except for two model periods, simulated Delta exports would increase by less than 2 percent in all months of all water-year types (see Section L2.2.1.3.5 of Appendix L2 for a summary of this analysis). While any potential effect could be considered significant, the Smelt Working Group and the DOSS group work with USFWS, NMFS, DWR, CDFW, and Reclamation to avoid reaching the actual take limit at the CVP and SWP facilities. Reclamation and DWR reduce or stop exports to avoid hitting the take limits established by USFWS and NMFS in the BOs and by CDFW in the longfin smelt ITP. **Therefore, this impact would be less than significant.**

4.13.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction of Alternative 5 could result in temporary impacts on aquatic habitats for fish species from clearing, grading, and other ground-disturbing activities associated with construction of an expanded Pacheco Dam. The use of heavy machinery traversing aquatic habitat and riparian areas for access to Pacheco Creek could result in disturbance of aquatic habitats. In addition, hazardous materials associated with construction equipment (fuel, oil) could be released to the environment and could adversely affect water quality in aquatic habitats. As was noted in Section 2.2.5, the North Fork Dam is currently being operated under the terms of a DWR Division of Safety of Dams order requiring that the upstream and downstream outlet controls be maintained in the fully open position to maximize releases and maintain the lowest possible surface elevation in Pacheco Reservoir given the current condition of its spillway (DWR 2018). To support construction of the new dam, a temporary cofferdam would be constructed with a bypass structure to ensure that flows in Pacheco Creek are maintained consistent with the current conditions throughout construction.

Construction activity could temporarily cause direct or indirect substantial adverse impacts to South-Central California Coast Steelhead, their habitat, and their movement in Pacheco Creek. If

Alternative 5 is selected for implementation, during the pre-construction design phase, Reclamation would initiate consultation with NMFS under Section 7 of ESA. **This impact is significant**. **Mitigation Measure BIO-1 would be implemented to avoid or reduce impacts on watercourses, wetlands, riparian areas, and other sensitive habitats during construction.** This measure would minimize the amount of construction disturbance to aquatic habitats for South-Central California Coast Steelhead in Pacheco Creek by minimizing erosion, preventing entrainment through screening of intakes, and minimizing removal of woody debris and riparian vegetation. **As a result, changes in aquatic habitat for this species, and its ability to migrate through Pacheco Creek, due to construction activities would be less than significant after mitigation.**

4.13.7.1 Operational Impacts on Delta Fishes

Operations of the San Luis Reservoir would be generally the same as under the No Project. CalSim II modeling results indicate that, on average, there are very slight changes (<1 percent) to Delta hydrology, hydrodynamics, and water quality resulting from changes in Delta operations of the CVP and SWP compared to the No Action/No Project Alternative, which could impact Delta fisheries and habitats. **Therefore, operational impacts on special-status fish species in the Delta would be less than significant.**

4.13.7.2 Operational Impacts on Pacheco Creek and Pajaro River Fishes

Changes to suitable habitat for South-Central California Coast Steelhead in Pacheco Creek under Alternative 5 were evaluated through the use of the Pacheco Creek Steelhead Habitat Suitability Model (See Section L2.1.2 of Appendix L2 for a summary of this analysis). The model was used to simulate with- and without-Project conditions across the 1922-2003 simulation period. The Lead Agencies assumed in this modeling that absent construction of the Pacheco Reservoir Expansion Alternative that the dam safety issue requiring this DWR Division of Safety of Dams order would be addressed and that future operation of the reservoir would return to the experimental flow regime developed in the *Comprehensive strategy and instructions for operation of Pacheco Reservoir* (Micko 2014) that was implemented between 2014 and 2018. When compared to this No Action/No Project Alternative condition, the Pacheco Creek Habitat Suitability Model predicted improved viability of steelhead populations through improved habitat conditions in Pacheco Creek in all water year types under Alternative 5. The model predicted an average percentage increase in steelhead cohort scores of 270 percent across all water year types.

Increases in carryover storage in Pacheco Reservoir under Alternative 5 could also further limit the occurrence of harmful cyanobacteria blooms in the reservoir. As was detailed in Section 4.1.7, the experimental operations plan for the existing Pacheco Reservoir implemented in 2014, limited the occurrence of cyanobacteria blooms that occur during periods of low storage levels by increasing carryover storage. The expanded Pacheco Reservoir would be operated similarly to limit mid-summer cyanobacteria blooms that are toxic to fish downstream by increasing reservoir storage and water releases downstream in Pacheco Creek (Smith 2007, Micko 2014, Smith 2014). Introduction of Delta water that passes through San Luis Reservoir prior to delivery into Pacheco Creek and the Pajaro River Watershed downstream has the potential to introduce invasive aquatic species not currently present into Pacheco Creek or the Pajaro River, and potentially impact the imprinting behavior of steelhead. While the expanded Pacheco Reservoir would be primarily filled using natural inflows from the North and East Forks of Pacheco Creek, supplemental flows to the expanded reservoir would arrive from SCVWD's share of contracted CVP water supply pumped from San Luis Reservoir. During years when SCVWD water supplies exceed the water demands in SCVWD's service area and excess storage capacity is available in the expanded reservoir, SCVWD would convey CVP supplies from San Luis Reservoir through the Pacheco Conduit into the expanded Pacheco Reservoir.

Inter-basin water transfers are recognized as one of the major pathways of freshwater invasion (Gallardo and Aldridge 2018). Transferred water can provide a direct link between previously isolated catchments and may modify the habitat conditions of the receiving waters such that they become more favorable for the establishment of invasive species (Gallardo and Aldridge 2018). The introduction of CVP water into the Pajaro River Watershed has the potential to introduce harmful invasive fish species, including striped bass, that may compete or prey upon listed South-Central California Coast Steelhead. Also, the release of CVP water could cause the introduction of non-native invertebrates (clams, mussels) or aquatic plant species that may alter the food-web of Pacheco Creek or Pajaro River. However, introductions of Delta species that are adapted to tidally-influenced, large river channels and sloughs may not be able to successfully colonize the small, coastal river systems of Pacheco Creek or Pajaro River, limiting the impact of their introductions. The potential introduction of non-native predators to Pacheco Creek like striped bass that are currently present in San Luis Reservoir could however negatively impact native fish populations on the creek including South-Central California Coast Steelhead.

Philopatry (i.e., homing) to natal sites is a fundamental life-history trait of most anadromous salmon and trout (Keefer and Caudill 2014). Homing increases the likelihood that reproductive-age fish will find mates and locate habitats that are favorable for both adult spawning and juvenile survival. (Keefer and Caudill 2014). Water chemistry of the natal river system of an up-migrating salmonid may be of particular importance given the use of olfaction for route finding and home site recognition (Keefer and Caudill 2014). Therefore, the introduction of out-of-basin CVP water from the Delta may hinder the imprinting of juvenile steelhead on water from Pacheco Creek or Pajaro River, thereby affecting the homing behavior of adults returning to spawn. However, this impact is expected to be limited since the Pacheco Reservoir would be primarily filled with natural inflows from the Pacheco Creek Watershed, with CVP inputs only occurring as capacity in the Pacheco Conduit allows in advance of anticipated low point water supply interruptions or later during low point water supply interruptions when the water couldn't otherwise be accepted by the SCVWD WTPs. As is noted in Appendix B, the expanded Pacheco Reservoir would increase San Felipe Division CVP M&I deliveries by 3,000 AF while increasing average available total local surface storage volumes by 97,000 AF. This difference between imported CVP supply and storage of local runoff are anticipated to limit the influence of the imported CVP supplies on salmonid imprinting.

While the introduction of Delta water into Pacheco Creek may negatively impact South-Central California Coast steelhead downstream by potentially affecting the imprinting of juveniles or through the introduction of non-native invasive species, the improved habitat quality resulting from the increased releases on Pacheco Creek proposed under Alternative 5 are anticipated to outweigh any potential negative impacts from imprinting. Under current conditions, Pacheco

Reservoir may not fill completely in dry years, leading to inadequate flow releases in Pacheco Creek in spring and summer months (with some stretches of Pacheco Creek going dry), making habitat unsuitable for rearing steelhead (Smith 2007). Even in wet years, flow releases can be inadequate to support steelhead rearing in Pacheco Creek by mid-summer (Smith 2007). As the results from the Pacheco Creek Steelhead Habitat Suitability Model show, increased water deliveries under Alternative 5 would greatly increase the suitability of habitat downstream of the expanded Pacheco Reservoir, likely leading to enhanced viability of Pacheco Creek steelhead.

Increased water deliveries into Pacheco Creek, and ultimately the Pajaro River, under Alternative 5 would likely provide beneficial habitat impacts to other California State species of concern that are present in the Pajaro River. Pacific lamprey is an anadromous species that, like steelhead, migrate into freshwater to spawn, occurring slightly later than steelhead during March – May. Therefore, increased winter and springtime flows under Alternative 5 would likely expand spawning habitat and increase habitat connectivity for migrating adult lamprey. Other California species of concern, the Monterey roach and Monterey hitch, can tolerate a wide range of habitat types and water temperature ranges, but both are most frequently found in large, low-gradient pools. Increased flow deliveries into the Pajaro River would likely expand the occurrence of pool habitat, particularly during the summer months which would benefit these species. It is anticipated that these improved habitat conditions with improvements in the reliability and frequency of flows in Pacheco Creek would also offset any impacts to channel form evolution, floodplain inundation rates and duration, and vegetation community composition and density along the creek from the expanded reservoir's potential increased attenuation of flood flows on Pacheco Creek. **Given the potential for the introduction of invasive aquatic species not currently present into Pacheco Creek, operational impacts on special-status fish species in or their migration through Pacheco Creek and the Pajaro River would be significant.** Mitigation Measure BIO-2 would be implemented to limit the potential for the introduction of invasive aquatic species through the storage of CVP water in he expanded Pacheco Reservoir. This measure would require the installation of a screen or treatment system capable of preventing the conveyance of fish, larvae and eggs from San Luis Reservoir to the expanded Pacheco Reservoir. **As a result, operational impacts on special-status fish species in or their migration through Pacheco Creek and the Pajaro River would be less than significant after mitigation.**

Operation of Alternative 5 would be consistent with the policies established in the Santa Clara Valley Habitat Plan, a Habitat Conservation Plan/Natural Communities Conservation Plan developed for Santa Clara County (Santa Clara Valley Habitat Agency 2012). **Therefore, operations would not conflict with ordinances or HCPs, resulting in no impact.**

4.13.8 Mitigation Measures

Mitigation Measure BIO-1: Aquatic and Terrestrial Resource Construction Requirements. The following construction requirements will be implemented by Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 3 and 5, to help mitigate adverse aquatic resource impacts and adverse terrestrial resource impacts (see Section 4.14). Many of these construction requirements were modified from those listed in the SCVWD Best Management Practices Handbook, as noted (SCVWD 2014).

1. **Biological Resources Awareness Training**

   Before any ground-disturbing work (including vegetation clearing and grading) occurs in the construction area, a qualified biologist shall conduct biological resources awareness training as a mandatory requirement for all construction personnel and the construction foreman. This training will inform the crews about special-status species and habitat that could occur on site. The training will consist of a brief discussion of the biology and life history of the special-status species; how to identify each species, including all life stages; the habitat requirements of these species; their status; measures being taken for the protection of these species and their habitats; and actions to be taken if a species is found within the project area during construction activities, and penalties for noncompliance. Identification cards will be issued to shift supervisors; these cards will have photos, descriptions, and actions to be taken upon sighting of special-status species during construction. Upon completion of the training, all employees will sign an acknowledgment form stating that they attended the training and understand all protection measures. Such training will be repeated for new construction personnel added to the project after the initial training, and an updated training program will be given to construction personnel in the event that a change in special-status species occurs or other new important information arises regarding sensitive biological resources at the project site.

2. **General Requirements for Construction Personnel**

   a. The contractor will clearly delineate the construction limits and prohibit any construction-related traffic outside these boundaries. Construction crews will be required to maintain a low speed on all unpaved roads to reduce the chance of wildlife being harmed if struck by construction equipment.

   b. All food-related trash items such as wrappers, cans, bottles, and food scraps generated during construction, subsequent facility operation, or permitted operations and maintenance activities of existing facilities will be disposed of in closed containers only and removed at least once a week from the site. The identified sites for trash collection will be fenced to minimize access from wildlife.

   c. No deliberate feeding of wildlife will be allowed.

   d. No pets will be allowed on the project site.

   e. No firearms will be allowed on the project site.

   f. Any worker who inadvertently injures or kills a Federal or State listed species, bald eagle, or golden eagle, or finds one dead, injured, or entrapped will immediately report the incident to the construction foreman or biological monitor. The construction foreman or monitor will notify Reclamation under Alternatives 2 and 4 and SCVWD under Alternative 3 and 5 within 24 hours of the incident.

3. **Minimize Access Impacts**

   Existing access ramps and roads to waterways will be used where possible. If temporary access points are necessary, they will be constructed in a manner that minimizes impacts:

   a. Temporary project-access points will be created as close to the work area as possible to minimize running equipment in waterways and will be constructed so as to minimize adverse impacts.

   b. Any temporary fill used for access will be removed upon completion of the project. Site topography and geometry will be restored to pre-project conditions.

   c. Off-road vehicular access routes will be surveyed and flagged by a qualified biologist prior to use to avoid where possible sensitive plants, animal burrows, wetlands and vernal pools, or other sensitive habitat. Whenever possible, routes should be not more than 15 feet wide. Personnel and vehicles are required to stay within marked access areas (SCVWD 2014).

4. **Remove Temporary Fills as Appropriate**

   Temporary fills, such as for diversion structures or cofferdams, will be removed upon finishing the work (SCVWD 2014).

5. **Assess Pump/Generator Set Operations and Maintenance**

   Pumps and generators will be maintained and operated in a manner that minimizes impacts to water quality and aquatic species.

   a. Pumps and generators will be maintained according to manufacturers' specifications to regulate flows to prevent dry-back or washout conditions.

   b. Pumps will be operated and monitored to prevent low water conditions, which could pump muddy bottom water, or high water conditions, which creates ponding.

   c. Pump intakes will be screened to prevent uptake of fish and other vertebrates.

   d. Sufficient back-up pumps and generators will be onsite to replace defective or damaged pumps and generators.

   e. Pumps and generators that operate within the bankfull channel will be placed in a suitable containment structure to prevent the accidental release of hydrocarbons into area waterways.

6. **Minimize Impacts on Vegetation Whenever Clearing (or Trimming) is Necessary**

   Cutting vegetation will be limited to the minimum length, width, and height necessary for safely accessing survey locations, and completing the cross-section surveys. Tree pruning will conform to International Society of Arboriculture pruning standards. No trees with a 4 inch or greater diameter at breast height (DBH) will be removed; and, no branches greater than 4" diameter will be removed.

Woody vegetation (i.e. trees and shrubs) which require pruning for equipment access, construction operations, etc., shall be pruned correctly such that health status is maintained and no post-construction impacts accrue. Woody material (including live leaning trees, dead trees, tree trunks, large limbs, and stumps) will be retained on site, unless it is threatening a structure or impedes access, in which case it must be moved to a less threatening position (SCVWD 2014).

7. **Minimize Root Impacts on Woody Vegetation**

Construction activities, including cut and fill, will be minimized to the extent practicable within the root zones of existing woody vegetation to remain post project. In general, root extent can be estimated as 2-3 times canopy radius, but vary depending on slope and soil conditions. To the extent practicable, construction setbacks will be calculated using parameters including tree DBH and age class and sensitivity to disturbance (species dependent) per standard guidelines for protection of riparian vegetation. Additionally, mulching the root zone will be employed to provide root protection from unavoidable equipment traffic during construction, which may remain in place after work if approved by a qualified biologist or vegetation specialist (SCVWD 2014).

8. **Invasive Species**

To avoid or reduce impacts on special-status plants and waterways from the introduction of invasive species, construction vehicles, equipment and boats will be cleaned with compressed water or air within a designated containment area to remove pathogens, invasive plant seeds, or plant parts. Use of chemical decontaminants will be used for work in areas with amphibians to prevent the spread of chytrid fungus (Bd).

In addition, any imported soils and fill materials will be selected for compatibility with native soils. Native or seed-free mulch will be used to minimize surface erosion and introduction of non-native plants.

9. **Avoid Animal Entry and Entrapment**

All pipes, hoses, or similar structures less than 12 inches diameter will be closed or covered to prevent animal entry. All construction pipes, culverts, or similar structures, greater than 2 inches diameter, stored at a construction site overnight, will be inspected thoroughly for wildlife by a qualified biologist or by properly trained construction personnel before the pipe is buried, capped, used, or moved.

If inspection indicates presence of sensitive or State- or Federally-listed species inside stored materials or equipment, work on those materials will cease until a qualified biologist determines the appropriate course of action.

To prevent entrapment of animals, all excavations, steep-walled holes or trenches more than 6 inches deep will be secured against animal entry at the close of each day. Any of the following measures may be employed, depending on the size of the hole and method feasibility:

a. Hole to be securely covered (no gaps) with plywood, or similar materials, at the close of each working day, or any time the opening will be left unattended for more than one hour; or

b. In the absence of covers, the excavation will be provided with escape ramps constructed of earth or untreated wood, sloped no steeper than 2:1, and located no farther than 15 feet apart; or

c. In situations where escape ramps are infeasible, the hole or trench will be surrounded by filter fabric fencing or a similar barrier with the bottom edge buried to prevent entry (SCVWD 2014).

10. **Use Exclusion Devices to Prevent Migratory Bird Nesting**

    Nesting exclusion devices will be installed to prevent potential establishment or occurrence of nests in areas where construction activities will occur. All nesting exclusion devices will be maintained throughout the nesting season or until completion of work in an area makes the devices unnecessary. All exclusion devices will be removed and disposed of when work in the area is complete (SCVWD 2014).

Mitigation Measure BIO-2: Invasive Aquatic Species Prevention. Prior to the delivery of any imported water from San Luis Reservoir to an expanded Pacheco Reservoir under Alternative 5, SCVWD will develop a new NMFS, USFWS and CDFW approved screening or treatment facility at the Pacheco Pumping Plant or between the expanded reservoir and its connection to the Pacheco conduit to prevent the potential conveyance of invasive fish, fish larvae and fish eggs.

4.14 Terrestrial Resources

4.14.1 Assessment Methods

The environmental analyses for the Project area are consistent with NEPA and CEQA requirements (40 CFR Parts 1500-1508; California PRC Section 21000 et seq.; California Code of Regulations [CCR] Section 15000 et seq.).

4.14.2 Significance Criteria

Impacts of an alternative on terrestrial resources would be significant if project implementation would do any of the following: (1) have a substantial adverse effect, either directly or through habitat modifications, on any species identified as an endangered, threatened, candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW, NMFS, or USFWS; (2) have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW, NMFS, or USFWS; (3) have a substantial adverse effect on Federally or State protected wetlands (including, but not limited to, marsh, vernal pool, coast, etc.) through direct removal, filling, hydrological interruption, or other means; (4) interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites; (5) conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance; or (6) conflict with the provisions of an adopted HCP, Natural Community Conservation Plan (NCCP), or other approved local, regional, or State conservation plan. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-16.

4.14.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Under the No Action/No Project Alternative, there would be no construction, and no related impacts on terrestrial resources. **The No Action/No Project Alternative would have no impact.**

4.14.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction would result in permanent impacts to wetland and riparian vegetation communities. Potential significant impacts to unmapped sensitive natural communities/habitats and jurisdictional waters of the U.S. and waters of the State could occur from construction. **These impacts would be significant.** During construction Mitigation Measure BIO-1, described above in Section 4.13.8, would be implemented to avoid and reduce impacts to wetlands, riparian communities, and other sensitive habitats and special status species. Mitigation Measures TERR-1 through TERR-17, as described in Section 4.14.8, require the protection of sensitive natural communities, and sensitive habitat and require wetland surveys, avoidance, and compensatory mitigation to address impacts to wetland and riparian habitats, and special status species. Mitigation Measure TERR-16 requires avoiding wetlands whenever practicable, fencing to delineate waters of the U.S. and State within and adjacent to construction areas that would not be filled, and providing for identification of these areas as sensitive habitat before construction to prevent unintended damage to wetland vegetation by construction personnel and equipment. Mitigation Measure TERR-16 further requires that areas disturbed by construction be replanted with native plants to minimize erosion. **With the implementation of mitigation, there would be no long-term loss or modification of wetland habitat, riparian vegetation, or purple needlegrass grassland, and impacts on these communities would be reduced from significant to less than significant.**

Table 4-16. Terrestrial Resources Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as an endangered, threatened, candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW, NMFS, or USFWS	Evaluate how construction of new infrastructure or later through operation of the alternatives could potentially impact any species identified as a candidate, sensitive, or special-status species through direct effects or through habitat modification	1	NI	--	Section 4.14.3
		2	Construction – S, LTS Operation - NI	BIO-1, TERR-1 through TERR-15	Section 4.14.4
		3	Construction –S, LTS Operation - NI	BIO-1 TERR-6	Section 4.14.5
		4	Construction –S, LTS Operation – S, LTS	BIO-1, TERR-1 through TERR-15	Section 4.14.6
		5	Construction – S, LTS Operation – S, LTS	BIO-1, BIO-2 TERR-1 through TERR-15	Section 4.14.7
Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW, NMFS, or USFWS	Evaluate how implementation of the alternatives through the placement of equipment or development of new infrastructure during construction or through changes in water flow or availability during operation, could impact any riparian habitat or other sensitive natural community	1	NI	--	Section 4.14.3
		2	S, LTS	TERR-1, TERR-3, TERR-4, TERR-14, TERR-15, TERR-16, TERR-17	Section 4.14.4
		3	NI	None	Section 4.14.5
		4	S, LTS	TERR-1, TERR-3, TERR-4, TERR-14, TERR-15, TERR-16	Section 4.14.6
		5	S, LTS	TERR-1, TERR-16, TERR-18	Section 4.14.7

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Have a substantial adverse effect on Federally or State protected wetlands (including, but not limited to, marsh, vernal pool, coast, etc.) through direct removal, filling, hydrological interruption, or other means	Evaluate how implementation of the alternatives could through the placement of equipment or development of new infrastructure during construction or over the long term with operations could impact any Federally or State protected wetlands	1	NI	--	Section 4.14.3
		2	S, LTS	TERR-14, TERR-16	Section 4.14.4
		3	NI	None	Section 4.14.5
		4	S, LTS	TERR-14, TERR-16	Section 4.14.6
		5	S, LTS	TERR-16	Section 4.14.7
Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites	Evaluate how implementation of the alternatives could impact wildlife corridors or interfere with a wildlife species use of or a wildlife corridor	1	NI	--	Section 4.14.3
		2	LTS	None	Section 4.14.4
		3	NI	None	Section 4.14.5
		4	S, LTS	TERR-12, TERR-13, TERR-15	Section 4.14.6
		5	S, LTS	TERR-12, TERR-15	Section 4.14.7
Conflict with any local policies or ordinances protecting biological resources, or adopted Habitat Conservation Plan (HCP), Natural Community Conservation Plan (NCCP), or other approved local, regional, or State conservation plan	Evaluate how implementation of the alternatives could conflict with policies or ordinances protecting terrestrial resources such as a tree preservation policy or ordinance, HCPs or Natural Community Conservation Plan	1	NI	--	Section 4.14.3
		2	S, LTS	TERR-1 through TERR-17	Section 4.14.4
		3	S, LTS	BIO-1, TERR-18	Section 4.14.5
		4	S, LTS	TERR-1 through TERR-14, TERR-17	Section 4.14.6
		5	S, LTS	TERR-1, TERR-18	Section 4.14.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

Special-status terrestrial species that could be adversely affected by construction at the San Luis Reservoir include vernal pool fairy shrimp, vernal pool tadpole shrimp, California tiger salamander, California red-legged frog, foothill yellow-legged frog, western pond turtle, San Joaquin whipsnake, white-tailed kite, Swainson's hawk, golden eagle, California condor, northern harrier, western burrowing owl, tricolored blackbird, other migratory birds and raptors, special-status bats, ringtail, San Joaquin kit fox, and American badger. No critical habitat for any listed species would be impacted by construction.

If seasonal wetlands and pools supporting vernal pool crustacean habitat occur within staging areas, construction footprint, and haul roads, construction activities could result in direct mortality or injury to vernal pool fairy shrimp and vernal pool tadpole shrimp. Indirect effects could occur to these species if their habitat is modified through changes in hydroperiod or siltation due to construction. **These impacts would be significant.** Mitigation Measure TERR-14 would avoid pools to the extent practicable, and mitigate for unavoidable impacts, including initiating Section 7 consultation. Mitigation Measure TERR-15 includes worker education by a qualified biologist, which would train workers to avoid impacting wetlands and potential habitat for vernal pool crustaceans. **With the implementation of mitigation, this impact would be reduced to less than significant.**

Clearing and grading of vegetation at construction sites could result in disturbance of nesting raptors (potentially including Swainson's hawk) and other migratory birds. Noise and nighttime lighting during construction activities could also result in disturbance to nesting birds. **Potential significant impacts to nesting migratory birds, including raptors and special-status species, could occur due to construction.** Implementation of Mitigation Measures BIO-1 and TERR-6 through TERR-10 would minimize the potential for adverse effects by requiring pre-construction surveys and species-specific avoidance measures in the event of the identification of nesting migratory birds near the construction areas. **With the implementation of mitigation, this impact would be less than significant.**

Disturbance during construction could temporarily reduce foraging habitat for golden eagle and California condor. Construction would occur in limited areas at the San Luis Reservoir, representing only a small portion of suitable foraging habitat for these species. **Potential significant impacts to golden eagles and California condors could occur due to construction**.

Mitigation Measure BIO-1, which would be implemented during construction, entails the use of nest exclusion devices to ensure migratory bird nesting does not occur in certain construction areas that cannot be avoided. Mitigation Measure TERR-6 would require pre-construction surveys for identifying nesting birds in and near the proposed construction areas and for avoiding any nests discovered during these surveys through the nesting season. Mitigation Measure TERR-8 would require species-specific survey protocols and avoidance measures for golden eagle, bald eagle, and California condor to reduce the potential for significant adverse impacts. **With the implementation of mitigation, this impact would be less than significant.**

During construction, Mitigation Measure BIO-1 would be implemented to avoid or to reduce impacts on special-status plants by training construction workers on avoidance requirements, implementation of limits on vegetation clearing, application of measures to avoid impacts to woody vegetation root zones, and avoidance of invasive species import to the construction site. **However, potential significant impacts to previously unidentified special-status plant species could occur due to construction.** Mitigation Measures TERR-1 and TERR-2 require special-status plant species surveys, species-specific avoidance, and species-specific compensatory mitigation. **With the implementation of mitigation, as appropriate, this impact would be reduced to less than significant.**

San Joaquin kit fox and other terrestrial wildlife species may use the construction site as movement corridors. Fencing utilized during construction would temporarily block corridors through this area. Temporary construction fencing and protective fencing around wetlands, riparian areas, or other sensitive natural communities, special-status plants, or wildlife habitat, would be removed following construction and restoration of disturbed areas. Interference with riparian corridors would be avoided to the maximum extent possible. **Therefore, impacts on wildlife corridors would be less than significant.**

The Merced County General Plan includes objectives and policies to preserve and protect biological resources. These include provisions to preserve existing lands and increase the overall acreage of protected lands in the county, and to protect and designate buffers around wetlands. There are no HCPs or local tree protection ordinances that cover the San Luis Reservoir Region. **Conflicts with local policies and ordinances would be a significant impact, but with implementation of mitigation impacts on consistency with local policies or ordinances protecting biological resources would be less than significant.**

4.14.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Project actions under Alternative 3 would not impact special-status natural communities, wetlands or waters, wildlife corridors or nursery sites, or special-status terrestrial species or critical habitat, other than birds. However, vegetation near the existing Santa Teresa WTP may support nesting migratory birds, including raptors. **Project effects to nesting migratory birds would be significant.** During construction, Mitigation Measure BIO-1 would be implemented to avoid impacts on migratory birds by using exclusion devices to prevent nesting. These actions, along with the implementation of Mitigation Measure TERR-6, would minimize the potential for adverse effects. **This impact would be less than significant after mitigation.**

In addition, if construction of Alternative 3 requires the removal or pruning of protected trees, **this would be a significant impact.** Mitigation Measure BIO-1 would be implemented to prevent impacts to protected trees. In addition, compliance with local tree protection ordinances through implementation of Mitigation Measure TERR-18 would avoid significant impacts to tree species by requiring that protected trees be replanted within the project area or at another location to mitigate for the removal of protected trees. Construction and operation of Alternative 3 would comply with the policies established in the Santa Clara Valley Habitat Plan, a Habitat Conservation Plan/Natural Communities Conservation Plan developed for Santa Clara County (Santa Clara Valley Habitat Agency 2012) and with resource conservation policies of the Santa Clara County General Plan (Santa Clara County 1994). **Conflict with the local tree ordinance would be a significant impact, but with implementation of mitigation, impacts on**

consistency with local policies or ordinances protecting biological resources would be less than significant.

4.14.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

As shown in Table 4-17, most anticipated habitat impacts associated with Alternative 4 are associated with the construction phase (3,113.1 acres).

Table 4-17. Habitat Impacts Associated with Alternative 4

Habitat Type	San Luis Reservoir Expansion Impact (Acres)		
	Construction Footprint	Inundation Footprint	Total Impact
Terrestrial Habitats			
Annual Grassland	2,342.9	304.6	2,647.5
Oak Woodland	29.8	40.8	70.6
Riparian Woodland	0.8	19.4	20.2
Scrub / Chaparral	131.2	15.9	147.1
Ruderal	—	1.7	1.7
Barren	479.4	—	479.4
Developed	100.4	9.5	109.9
Terrestrial Subtotal	**3,084.50**	**391.90**	**3,476.40**
Aquatic Habitats			
Creek / Drainage	1.5	2.6	4.1
Fresh Emergent Wetland	18.6	—	18.6
Seasonal Wetland	8.4	—	8.4
Aquatic Subtotal	**28.5**	**2.6**	**31.1**
Totals	**3,113.1**[1]	**394.4**	**3,507.5**[1]

[1] These totals do not include 626.0 acres of seasonally flooded open water habitat that is within the construction footprint.

Construction of the expanded reservoir would result in permanent impacts to wetland and riparian vegetation communities associated with clearing, soil borrowing, grading, staging of equipment, and other ground-disturbing activities that are proposed within streams and jurisdictional aquatic features. **These impacts would be significant.** These impacts could also be generated during the development of additional camp sites, visitor features, and trails during implementation of Mitigation Measure REC-1 and REC-2, described in Section 4.17.8.

Changes to local topography could alter the surface or subsurface hydrology of these sensitive habitats. In addition, hazardous materials associated with construction equipment (fuel, oil) could be released to the environment and adversely affect water quality in wetland and riparian areas.

Mitigation Measure TERR-16a requires a formal wetland delineation to support resource agency permitting and support the avoidance of sensitive areas. Mitigation Measure TERR-16b defines compensatory mitigation requirements to offset impacts. **With implementation of mitigation,**

impacts to wetland habitat or riparian vegetation at the San Luis Reservoir associated with construction would be less than significant.

The construction activities described above would physically disturb approximately 2,533.3 acres of upland and aquatic habitat within the construction footprint (excludes 479.4 acres of developed areas and 100.4 acres of barren areas on the dam face and historic borrow sites) (Table 4-5).

Seasonal wetlands occur within the staging areas, construction footprint, haul roads, and the inundation footprint. During 2018 surveys, four features were identified below the dam which could provide habitat for listed vernal pool invertebrates, including vernal pool fairy shrimp and vernal pool tadpole shrimp (ESA 2018). **Impacts to vernal pool crustaceans would be significant.** Mitigation Measure TERR-14 would avoid pools to the extent practicable, and mitigate for unavoidable impacts, including initiating Section 7 consultation. **Implementation of mitigation would reduce impacts to listed vernal pool invertebrates to less than significant.**

Impacts to Valley elderberry longhorn beetle (VELB) could occur if host plant elderberries are removed or harmed during construction activities. VELB has been recorded near the San Luis Reservoir, along Los Banos Creek in 1987 (CDFW 2018), and a large mixed stand containing more than 25 elderberry shrubs was identified during 2018 field surveys in the project area northwest of Basalt Quarry. Additional small stands with approximately 10 shrubs were also present in the vicinity. No evidence of VELB was found but not all shrubs could be examined due to vegetation density (ESA 2018). **VELB impacts would be significant.** Mitigation Measure TERR-2 would avoid all potential VELB shrubs with a 100-foot buffer, or mitigate for all unavoidable impacts to VELB habitat, including initiating Section 7 consultation. **Implementation of mitigation would reduce impacts to VELB to less than significant.**

Construction activities could affect special-status amphibians and reptiles including California tiger salamander, California red-legged frog, foothill yellow-legged frog, San Joaquin whipsnake, Coast horned lizard, and western pond turtle. Project construction has the potential to directly affect the California red-legged frog breeding population at the Willow Spring pond and could affect potential habitat for red-legged frog and California tiger salamander in other aquatic areas and inundate upland aestivation sites in seasonal wetlands, drainages or annual grasslands.

Ground clearing and earth-moving activities could directly harm or kill special-status amphibians and reptiles by either collapsing burrows or crushing them with equipment. The removal of terrestrial or aquatic habitat could expose amphibians and reptiles to increased predation and environmental stress. **This impact would be significant.** Implementation of Mitigation Measure TERR-3 would help reduce the potential for these impacts by having a qualified biologist surveying for and avoiding all sensitive amphibian and reptile habitat, including wetlands and grasslands that may provide upland habitat. Amphibians and reptiles found within the work site may be relocated in coordination with wildlife agencies. Mitigation would be provided for unavoidable impacts to habitat, and Section 7 consultation initiated for listed species. Mitigation Measure TERR-4 includes surveys and relocation for western pond turtle, and Mitigation Measure TERR-5 for San Joaquin whipsnake, in coordination with CDFW. **Implementation of mitigation would reduce impacts to special-status amphibians and reptiles to less than significant.** No impacts would occur to designated critical habitat for any listed species.

Western red bat was detected during 2018 field surveys, and roosting habitat was identified for Yuma myotis and Mexican free-tailed bat (ESA 2018). **Impacts to these bat species would be significant.** Mitigation Measure TERR-11 would require surveys for potential bat roost trees for evidence of habitation and evacuation of any resident bats according to an established protocol. **With implementation of mitigation impacts to special-status bats would be less than significant.**

Reservoir expansion and in-watershed facilities would permanently impact approximately 2,647.5 acres of annual grassland and 70.6 acres of oak woodland that provide habitat to San Joaquin kit fox. Though focused surveys have not been performed to ascertain the distribution of San Joaquin kit fox around the San Luis Reservoir, the species was observed near the reservoir in 2005 (CDFW 2018), and the project area scrub and grasslands potentially provide kit fox denning, foraging, or dispersal habitat. Kit fox was not observed during 2018 field surveys.

Kit fox and other terrestrial wildlife migratory corridors may be disturbed by project construction. The existing reservoir and pipeline already restrict movement of kit fox and other wildlife but allow movement in a limited area across the dam. This movement corridor would be impeded during construction. Alternate passage would not be provided because wildlife movement across the site during construction would be hazardous. **The temporary limit to wildlife movement would be less than significant because the existing movement corridor is limited.** Following construction, kit fox and other wildlife would again be able to cross north to south along the dam, and a north-south connectivity program would be established and maintained, according to Mitigation Measure TERR-12. **With implementation of mitigation, impacts to migratory corridors would be further reduced to less than significant.**

Nighttime lighting would be used during the 24-hour construction period. Some reservoir facilities would require nighttime lighting for safety and security, both during and after construction. Existing nighttime lighting occurs within the construction footprint along SR 33 and within 1 mile of the construction footprint within Santa Nella. Nighttime lighting may disturb San Joaquin kit fox or expose them to injury or limit their access to a migratory corridor. **This impact would be significant.** Lighting would be minimized and shielded during construction to reduce disturbance to kit fox. Mitigation Measure TERR-12 includes surveys of potential dens for kit fox and avoidance of all occupied dens with a 200-foot buffer. Nighttime lighting would also be minimized, and speed limits maintained for protection of kit fox. Section 7 consultation would also be initiated for kit fox. Mitigation Measure TERR-15 includes worker education about kit fox and other species and protection measures for the site including avoiding litter, which may attract nuisance wildlife. **With implementation of mitigation, impacts would be reduced to less than significant.**

During 2018 field surveys, an American badger was observed at the junction of Gonzaga Road and Basalt Road, and badger remains were found in the cattail marsh south of the dam (ESA 2018). American badgers could be directly affected by vehicle and construction-related mortality at active construction sites. Reservoir inundation would result in the permanent removal of grassland habitat for American badgers and potentially limit their access to a migratory corridor. **This impact would be significant.** Impacts on badgers within annual grasslands and oak woodland would be minimized through a combination of worker training, preconstruction surveys, and passively or actively relocating animals in coordination with CDFW, as discussed in Mitigation Measures TERR-13 and TERR-15. Habitat loss in grasslands would be compensated according to Mitigation Measure TERR-12. **With the implementation of mitigation, this impact would be less than significant.**

Construction activities could result in direct mortality of nesting birds that are considered special-status (i.e., loggerhead shrike, California horned lark, tricolored blackbird) or are protected under the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, federal or California Endangered Species Act. A tricolored blackbird colony has been repeated documented along Basalt Road in the San Luis Reservoir SRA; however, no active nesting colonies have been documented in the vicinity (CDFW 2018). Special-status raptors including Swainson's hawk, golden eagle, California condor, and bald eagle could be impacted, because 2,473 acres of grassland would be temporarily lost as foraging habitat and the expanded dam footprint would permanently cover 81 acres of annual grassland habitat. **These impacts would be significant.** Mitigation Measures TERR-6, TERR-7, TERR-8, TERR-9, and TERR-10 protect migratory nesting birds, Swainson's hawks, eagles and condors, burrowing owl and tricolored blackbird nests through surveys and avoidance with a buffer appropriate to the species. **With implementation of mitigation, impacts on migratory and special-status birds would be less than significant.**

Construction and expanded reservoir inundation could cause temporary and permanent loss of special-status plants or their habitat. **These impacts would be significant.** Mitigation Measure TERR-1 includes surveys for special-status plants, avoidance measures and relocation measures, if avoidance is not possible. Mitigation Measure TERR-15 includes worker education about special status species and protection measures for the site including avoiding pets onsite and avoiding the spread of plant pathogens. **With implementation of mitigation, there would be a less than significant impact on special-status plants.**

The Merced County General Plan includes objectives and policies to preserve and protect biologic resources in the county. There are no HCPs or local tree protection ordinances that cover the San Luis Reservoir Region. **Conflicts with local policies and ordinances would be a significant impact, but with implementation of mitigation, impacts on consistency with local policies or ordinances protecting biological resources would be less than significant.**

About 394.4 acres of habitat would be subject to inundation (Table 4-5). A 10-foot raise in the reservoir surface elevation coupled with defined construction areas would impact approximately 31.1 acres of Federal and/or State jurisdictional waters. An additional 20.2 acres of riparian woodland habitat would be subject to direct impacts from inundation during reservoir filling (Table 4-5). **These impacts would be significant.** Mitigation Measure TERR-16 includes delineation of wetlands, waters and stream channels, and mitigation for impacts to these areas, in coordination with regulatory agencies, in areas where avoidance is not possible. **With the implementation of mitigation, impacts to wetland habitat or riparian vegetation would be less than significant.**

The expanded reservoir would produce a reduction in prey availability for raptors around the expanded reservoir. **These impacts would be significant.** Mitigation Measure TERR-8 calls for surveying and monitoring nest activity and avoiding commencing construction in nest areas during nest season. In addition, permanent loss of grassland foraging habitat would be mitigated by replacement in coordination with wildlife agencies. **With implementation of mitigation, impacts would be less than significant.**

4.14.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction of the new reservoir would result in impacts to wetland, pond, and riparian vegetation communities associated with clearing, soil borrowing, grading, staging of equipment, and other ground-disturbing activities that are proposed within jurisdictional aquatic features. A formal delineation of wetlands and other waters has not yet been performed for this proposed alternative. In addition, hazardous materials associated with construction equipment (e.g., fuel, oil, etc.) could be released to the environment and adversely affect water quality in wetland and riparian areas. Impacts to vegetation communities under Alternative 5 are shown in Table 4-18 and Figure M1-2b.

Construction activities would physically disturb approximately 1,946 acres of upland and aquatic habitat within the construction footprint (excludes 123 acres of lacustrine habitat in the current reservoir, and also excludes areas downstream of the proposed dam, including the pipeline). The new dam would require the use of materials excavated from borrow areas, and construction would require areas for equipment and materials staging, equipment access, excavation, deconstruction of the dam cap, and reconstruction of the dam. Each of these activities could directly affect special-status species in the project area.

Table 4-18. Habitat Impacts Associated with Alternative 5

Habitat Type	Pacheco Reservoir Region Impact (Acres)[1]	
	Temporary (includes known and potential source areas)	Permanent[2]
Annual Grassland	54.0	101.5
Oak Woodland	188.7	1,120.7
Riparian	0.5	22.8
Scrub / Chaparral	11.4	62.0
Rock	0	1.6
Developed	0.1	0
Pond	0	2.0
TOTAL	**256.3**	**1,432.2**

Notes:

[1] Impacts do not include 123.1 acres of impact to presently inundated lacustrine habitat and impact areas downstream of the proposed dam.

[2] In addition to the expanded reservoir's inundation area, estimates include lands permanently altered as a result of the development of new infrastructure

Following construction, an additional 1,245 acres of habitat would be subject to inundation when the expanded reservoir reaches full capacity. This total includes approximately 2.0 acres of ponds and 22.8 acres of riparian habitat that would be inundated. Wetland communities and sycamore alluvial woodlands would also be inundated. The Santa Clara Valley Habitat Plan vegetation mapping does not show these vegetation types, but the National Wetland Inventory mapping for the Alternative 5 project area shows 1.4 acres of freshwater wetlands and 128 acres of waters permanently impacted, with 0.05 acres of wetland and 2.3 acres of waters temporarily impacted. In addition, sensitive riparian plant communities and the species that use these areas downstream of the new dam, including sycamore alluvial woodland (see Figure MI-2a) would experience altered flow regime following construction of this alternative. The altered flow regime may alter the distribution of plant and animal species. **Impacts to wetlands, jurisdictional waters and riparian habitat would be significant.** Mitigation Measure TERR-16 would include a jurisdictional delineation of wetlands and waters, avoidance, minimization and compensatory mitigation in coordination with regulatory agencies. **With the implementation of mitigation, the loss of wetlands, jurisdictional waters and riparian habitat would be less than significant.**

Most impacts would be to oak woodland habitats, including foothill pine-oak woodland, mixed oak woodland, valley oak woodland and blue oak woodland, in addition to sycamore alluvial woodland in the riparian zone. These are sensitive natural communities in California. Approximately 62.0 acres of scrub and chaparral habitat would be lost permanently from inundation, and annual grassland habitat losses would be approximately 101.5 acres.

In addition to the permanent loss of habitat from inundation, approximately 256.3 acres would be temporarily impacted as borrow and staging areas, including 54.0 acres of annual grassland, 11.4 acres of scrub and chaparral, unknown acreage of sycamore alluvial woodland, and 188.7 acres of oak woodlands. Dam construction would last approximately five years, but additional years may pass before the temporary impact areas are fully revegetated. Wildlife and plant species would be able to re-occupy these habitat areas following construction, from nearby source populations. **Impacts to sensitive natural communities and from tree removal would be significant.** Mitigation Measure TERR-1 and TERR-18 would protect natural communities by surveying work areas, avoiding impacts where possible, and providing compensatory mitigation for unavoidable impacts. **With the implementation of mitigation, impacts to sensitive natural communities and from tree removal would be less than significant.**

In addition, Alternative 5 would include removal of the existing dam following construction of the expanded Pacheco Reservoir dam, and restoration of the channel of Pacheco Creek downstream of the new dam. This reconstruction would incorporate riparian restoration within the channel, and revegetation and erosion control on the slopes of the channel (which are presently inundated and lacking vegetation), a beneficial impact to riparian habitat.

Construction activity within habitat areas and inundation of riparian, shoreline and pond habitat could disturb, injure or kill special-status amphibians, including California red-legged frog and California tiger salamander, foothill yellow-legged frog, or western pond turtle. Construction could also promote invasion of non-native amphibian species or chytrid fungus. Operation of Alternative 5 could modify seasonal amphibian habitat along Pacheco Creek to more permanent aquatic habitat. Less temporary aquatic habitat could reduce habitat for native amphibians such as California red-legged frog, if they would occur along the creek. More permanent aquatic features along the creek could also provide habitat for non-native bullfrogs (*Lithobates* *catesbeianus*) that are predators and competitors of native amphibian species. The import of CVP water from San Luis Reservoir to an expanded Pacheco Reservoir could also introduce non-native predators to Pacheco Creek like striped bass that are currently present in San Luis Reservoir could however negatively impact native amphibians on the creek including California red-legged frog. **Impacts to special-status amphibian species would be significant.** Implementation of Mitigation Measure TERR-3 would help reduce the potential for impacts by having a qualified biologist surveying for and avoiding all sensitive amphibian and reptile habitat, including wetlands and grasslands that may provide upland habitat. Amphibians and reptiles found within the work site, or whose habitat would be flooded by operation of New Pacheco Reservoir, may be relocated in coordination with wildlife agencies. Mitigation would be provided for unavoidable impacts to habitat, and Section 7 consultation initiated for listed species. Mitigation Measure TERR-4 includes surveys and relocation for western pond turtle, in coordination with CDFW, Mitigation Measure TERR-15 would provide worker awareness training and site protection. Mitigation Measure BIO-2 would develop a screening or treatment facility at the Pacheco Pumping Plant or between the expanded reservoir and its connection to the Pacheco conduit to prevent the potential conveyance of invasive fish, fish larvae and fish eggs. **With the implementation of mitigation, impacts to special-status amphibian species and loss of their habitat would be reduced to less than significant.** No impacts would occur to critical habitat for any listed species.

San Joaquin kit fox and American badger may occur within grasslands of the Pacheco Reservoir Region, and be killed, injured or disturbed during construction, and lose grassland habitat or migratory corridors as a result of construction or from expanding Pacheco Reservoir. **Impacts to special-status amphibian species would be significant.** Impacts on badgers within annual grasslands and oak woodland would be minimized through a combination of worker training, preconstruction surveys, and passively or actively relocating animals in coordination with CDFW, as discussed in Mitigation Measures TERR-13 and TERR-15. Habitat loss in grasslands would be compensated according to Mitigation Measure TERR-12. **With implementation of mitigation, impacts on these species would be reduced to less than significant.**

Nesting birds, including raptors, may be found in grassland, scrub, chaparral, oak woodland and riparian habitat in the Pacheco Reservoir Region. Roosting bats may also be found in trees. These species may be harmed or disturbed during construction and may lose habitat from inundation. **These impacts would be significant.** Mitigation Measures TERR-6, TERR-7, TERR-8, TERR-9, and TERR-10 protect migratory nesting birds, Swainson’s hawks, eagles and condors, burrowing owl and tricolored blackbird nests through surveys and avoidance with a buffer appropriate to the species. Mitigation Measure TERR-11 protects roosting bats through surveys and exclusion of bats from trees prior to removal. Mitigation Measure TERR-15 includes worker awareness training and site protection. **With implementation of mitigation, impacts on migratory and special-status nesting birds and bats would be less than significant.**

Construction and operation of Alternative 5 would comply with the policies established in the Santa Clara Valley Habitat Plan, a Habitat Conservation Plan/Natural Communities Conservation Plan developed for Santa Clara County (Santa Clara Valley Habitat Agency 2012), The resource conservation policies of the Santa Clara County General Plan call for minimizing impacts on habitat and preserving areas rich in biodiversity (Santa Clara County 1994). Local tree protection ordinances would be addressed through implementation of Mitigation Measure TERR-18, in order to avoid significant impacts to tree species by requiring that protected trees be replanted within the project area or at another suitable location. **Conflicts with local policies and ordinances would be a significant impact, but with implementation of mitigation impacts on consistency with local policies or ordinances protecting biological resources would be less than significant.**

4.14.8 Mitigation Measures

The following mitigation measures include species specific components that would be implemented for certain special-status species that have unique habitat requirements or require special protections based on their life history, along with identification and compensation measures for potential impacts to wetlands. Although some of the special status species have low potential to occur within the proposed construction areas, pre- construction surveys outlined in these mitigation measures would be implemented and the applicable avoidance and restoration actions described in the mitigation measures will be implemented. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 3 and 5, will implement the following mitigation measures for wetlands, sensitive natural communities, and special-status plant and wildlife species with potential to occur in the area of analysis.

Mitigation Measure TERR-1: Special-Status Plant Species and Sensitive Natural Communities

Prior to construction:

a. Surveys of the project area for special status plant species and purple needlegrass will be conducted during the identifiable blooming period for each. If surveys are conducted during a dry year, additional surveying may be required the following year. Special-status plants with moderate or high potential to occur are listed in Table M2-1.

b. The qualified biologist will ensure avoidance of impacts on special status plant species and sensitive natural communities by implementing one, or more, of the following, as appropriate, per the biologist’s recommendation:

    i. Flag the population or natural community areas to be protected;
    ii. Allow adequate buffers; and/or,
    iii. Time construction or other activities during dormant and/or non-critical life cycle periods (SCVWD 2011).

For unavoidable impacts to special-status plant species and sensitive natural communities, compensatory mitigation may be required based on recommendations of the qualified biologist in coordination with resource agencies. Consultation with the USFWS through the Section 7 process will be required to determine avoidance, conservation, and mitigation measures for potential impacts to federally listed plant species. If deemed necessary based on the type and extent of special-status plant populations or natural communities affected, compensatory mitigation will entail:

c. The protection, through land acquisition or a conservation easement, of a population of equal or greater size and health. Or,

d. If it is not feasible to acquire and preserve a known area of natural community or population of a special status plant to be impacted, suitable, unoccupied habitat capable of supporting the species will be acquired and used to create a new population. For population creation, the following considerations will also be met:

- Prior to unavoidable and permanent disturbance to a population of a special status plant species or a sensitive natural community, propagules of all relevant species shall be collected from the population to be disturbed. This may include seed collection or cuttings, and these propagules will be used to establish a new population on suitable, unoccupied habitat as described above. Transplantation may be attempted but will not be used as the primary means of plant salvage and new population creation.
- Creation of new plant populations and communities will require identifying suitable locations and researching and determining appropriate and viable propagation or planting techniques for the species. It will also require field and literature research to determine the appropriate seed sampling techniques and harvest numbers for acquisition of seed from existing populations.
- A minimum ten-year monitoring plan with adaptive management will be implemented to document the success of creating new plant populations or communities. Adequate funding for compensatory mitigation will be provided on an agreed-to schedule, following a discussion with the appropriate regulatory agencies, to ensure long-term protection and management of lands acquired or placed under conservation easement.

Mitigation Measure TERR-2: Valley Elderberry Longhorn Beetle
Prior to construction and in areas where inundation would occur, surveys for elderberry shrubs would be conducted to determine the number of elderberry shrubs present, their stem diameters, and, if feasible, the presence and number of exit holes formed by VELB as they exit the branch. A 100 foot buffer around construction areas would also be surveyed for elderberry shrubs that could be affected by dust from construction. If elderberry shrubs with stems greater than 1-inch in diameter are found within these areas, they would be protected with fencing and avoided to the extent possible. Consultation with the USFWS through the Section 7 process will be required to determine avoidance, conservation, and mitigation measures for potential impacts to valley elderberry longhorn beetle. If shrubs cannot be avoided, mitigation measures would be implemented, including transplanting trees to a USFWS-approved conservation area and implementing minimization measures at a ratio ranging from 1:1 to 8:1 depending on the diameter of the impacted elderberry stems and habitat type that they were removed from (riparian or non-riparian) under an Elderberry Mitigation Plan approved by USFWS.

Mitigation Measure TERR-3: Special-Status Amphibians

Consultation with the USFWS through the Section 7 process will be required to determine avoidance, conservation, and mitigation measures for potential impacts to special status amphibians.

- Before and during construction: The Proponent shall submit the name and credentials of a biologist qualified to act as construction monitor to USFWS and CDFW for approval at least 15 days before construction work begins. General minimum qualifications are a 4-year degree in biological sciences and experience in surveying, identifying, and handling California tiger salamanders and California red-legged frogs.

- A USFWS and CDFW-approved biologist shall survey the work sites 2 months before the onset of construction. The biologist shall also survey seasonally ponded portions of Pacheco Creek that are expected to be more permanently flooded due to operation of the New Pacheco Reservoir (reducing the seasonal habitat availability or quality). If California tiger salamanders, California red-legged frogs or foothill yellow-legged frogs (or their tadpoles or eggs) are found, the approved biologist shall contact USFWS and CDFW to determine whether moving any of these life-stages is appropriate. If USFWS and CDFW approve moving the animals, the approved biologist shall be allowed sufficient time to move frogs and/or salamanders from the work sites, or Pacheco Creek, before work begins. If these species are not identified, construction can proceed at these sites. The approved biologist shall use professional judgment to determine whether (and if so, when) the California tiger salamanders and/or frogs are to be moved. The biologist shall immediately inform the construction manager that work shall be halted, if necessary, to avert avoidable take of listed species.

- Prior to construction, suitable relocation sites free of bullfrogs or where successful bullfrog control is feasible, will be identified for use in the event relocation of special-status amphibians is necessary. Measures will be taken to avoid the spread of chytrid fungus (*Batrachochytrium dendrobatidis*) to potential relocation sites. Field clothing, boots, and equipment will be cleaned and decontaminated before traveling to relocation sites.

- Work areas will be monitored during construction to identify, capture, and relocate special-status amphibians, if present.

- Areas beneath construction equipment and vehicles shall be inspected daily, prior to operation, for presence of special-status amphibians under tracks/tires and within machinery. If special-status amphibians are found a qualified biologist will capture and relocate animals from work sites.

- If necessary, a detailed amphibian relocation plan will be prepared at least 3 weeks before the start of groundbreaking, and submitted to CDFW and USFWS for review. The purpose of the plan is to standardize amphibian relocation methods and relocation sites.

- A USFWS and CDFW-approved biologist shall be present at the active work sites until special-status amphibians have been removed, and habitat disturbance has been completed. Thereafter, the contractor shall designate a person to monitor onsite compliance with all minimization measures. A CDFW and USFWS-approved biologist shall ensure that this individual receives training consistent with USFWS requirements.

- The project proponent and its contractors shall install frog-exclusion fencing (i.e., silt fences) around all construction areas that are within 100 feet of potential special-status amphibian aquatic breeding habitat.

- Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, shall provide compensation for permanent and temporary impacts on California tiger salamander and California red-legged frog aquatic habitat at a minimum ratio of 1:1 or as established in coordination with resource agencies. Compensatory mitigation shall be provided for the loss of aquatic breeding sites that will be filled or otherwise directly affected by the project (perhaps one site located in the southern arm of San Luis Reservoir, and one site located in the borrow area; number to be confirmed by pre-construction surveys) as well as mitigation for impacts on associated California red-legged frog or California tiger salamander upland habitat and designated critical habitat that contains primary constituent elements (PCEs) through compensatory mitigation. If possible, Compensatory mitigation for areas within designated critical habitat shall be located within a California red-legged frog Recovery Area, as identified in the 2002 *California Red-legged Frog Recovery Plan* (USFWS 2002).

- The total area, size and number of California red-legged frog or California tiger salamander mitigation ponds to be created will be based on a comparable loss of breeding sites (e.g., a minimum 1:1 replacement ratio) as a result of the project. These ponds shall concurrently satisfy wetland mitigation requirements identified in Mitigation Measure TERR-2. To the degree possible, new mitigation ponds that are created for California red-legged frog and California tiger salamander shall be hydrologically self-sustaining and shall not require a supplemental water supply.

Mitigation Measure TERR-4: Western Pond Turtle
Before construction activities begin, a qualified biologist shall conduct western pond turtle surveys within creeks and in other ponded areas affected by the project. Adjacent upland areas shall also be examined for evidence of nests as well as individual turtles. The project biologist shall be responsible for the survey and for the relocation of pond turtles, if found. Construction shall not proceed until a reasonable effort has been made to capture and relocate as many western pond turtles as possible to minimize take. However, some individuals may be undetected or enter sites after surveys, and would be subject to mortality. If a nest is observed, a biologist with the appropriate permits and prior approval from CDFW shall move eggs to a suitable location or facility for incubation, and release hatchlings into the creek system the following autumn. Consultation with the USFWS may also be required.

Mitigation Measure TERR-5: San Joaquin Whipsnake
Before construction activities begin a qualified biologist shall conduct San Joaquin whipsnake surveys 2 weeks prior to construction activities within work sites and within 100 feet of disturbance areas. A qualified biologist shall relocate any San Joaquin whipsnakes to suitable habitat outside of areas of disturbance. There is possibility of snakes to move into the work sites

after pre-construction surveys have checked the area and some individuals could be subject to mortality. If San Joaquin whipsnakes are detected in work sites construction activities and equipment travel shall cease in the immediate area of detection until the snake has left work site or has been relocated out of the area by a qualified biologist.

Mitigation Measure TERR-6: Nesting Bird Surveys
A USFWS-approved biologist would conduct nesting bird surveys prior to construction and avoidance of nests during construction. The generally accepted nesting season extends from February 1 through September 15. If an active nest is found, construction within 300 feet of the nest (500 feet for raptor nests, excluding Swainson's hawk) would be postponed until the nest is no longer active.

Mitigation Measure TERR-7: Swainson's Hawk
Consistent with the Staff Report Regarding Mitigation for Impacts to Swainson's Hawks in the Central Valley of California (CDFG 1994), mitigation shall include the following approach:

- No intensive new disturbances or other project-related activities that could cause nest abandonment or forced fledging shall be initiated within 0.25 mile (buffer zone) of an active nest between March 15 and September 15.

- Nest trees shall not be removed unless no feasible avoidance exists. If a nest tree must be removed, Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, shall obtain a management authorization (including conditions to offset the loss of the nest tree) from CDFW. The tree removal period specified in the management authorization is generally between October 1 and February 1.

- Monitoring of the nest by a qualified biologist may be required if the project-related activity has the potential to adversely impact the nest.

Prior to construction, surveys for active Swainson's hawk nests will be conducted in and around all potential nest trees within 0.5 mile of construction areas. If known or active nests are identified through preconstruction surveys or other means, a 0.5-mile no-disturbance buffer shall be established around all active nest sites if construction cannot be limited to occur outside the nesting season (February 15 through September 15). Buffer sizes may be reduced if approved by CDFW and active nest sites are monitored during construction by a qualified biologist.

Prior to construction, a qualified biologist will determine the need to restore any temporarily disturbed grassland foraging habitat for Swainson's hawk based on the quality and extent of foraging habitat affected. Restoration of grassland foraging habitat for Swainson's hawk will be conducted to restore disturbed areas following construction, based on the recommendations of the qualified biologist and following consultation with CDFW.

Permanent foraging habitat losses (i.e., grasslands) within one mile of active Swainson's hawk nests shall be compensated by preserving in perpetuity suitable foraging habitat at a ratio of 1:1. This includes permanently disturbed construction sites and inundation zones above existing conditions (i.e., +10 feet elevation above existing fill capacity). The CDFW shall approve the location and types of habitats preserved.

Mitigation Measure TERR-8: Bald and Golden Eagles, and California Condor
To ensure that nesting golden eagles and bald eagles are protected, the following measures address potential impacts on nesting eagles in the San Luis Reservoir vicinity. Prior to the initiation of construction, an Eagle Conservation Plan will need to be developed that details eagle protection guidelines specific to the San Luis Reservoir construction area. Consultation with USFWS under the Bald and Golden Eagle Protection Act will be initiated as part of this process. Protections for eagles will include the initiation of pre-construction surveys and monitoring by a USFWS-approved biologist for golden eagles and bald eagles. beginning approximately two years prior to construction and continuing through the construction period.

These surveys will be completed across an area at a 10-mile radius from where impacts from the project occur, including construction and inundation areas. Any nesting sites identified during these surveys would be mapped and monitored for up to ten years, depending on the monitoring specifications identified within the plan. Whenever feasible, construction near recently active nest sites shall start outside the active nesting season. The nesting period for golden eagles is between January 15 and August 15 and bald eagles nest between January 1 and August 15. If groundbreaking activities begin during the nesting period, a qualified biologist shall perform a preconstruction survey 14 to 30 days before the start of each new construction phase to search for eagle nest sites within two miles of proposed activities. If active nests are not identified, no further action is required and construction may proceed. No active or inactive eagle nests would be removed as part of this project. If active nests are identified, the avoidance guidelines identified below shall be implemented. Additional avoidance and minimization guidelines may be recommended by USFWS during the consultation process.

- For golden and bald eagles, construction contractors shall observe CDFW and USFWS avoidance guidelines, which stipulate a minimum 500 foot to 0.5-mile buffer zone depending upon the severity of the activity (e.g., earth-moving versus blasting) (USFWS 2007). Buffer zones shall remain until young have fledged. A qualified biologist will monitor the nest daily for one week to determine whether construction activities are disturbing nest behavior. If nest behavior appears normal, then weekly monitoring will continue until the nest is no longer active. If the nest appears disturbed, the biological monitor will increase the no-work buffer at their discretion to ensure normal nesting behavior. For activities conducted with agency approval within this buffer zone, a qualified biologist shall monitor construction activities and the eagle nest(s) to monitor eagle reactions to activities. If activities are deemed to have a negative effect on nesting eagles, the biologist shall immediately inform the construction manager that work should be halted, and CDFW and USFWS will be consulted.

- CDFW and USFWS often allows construction activities that are initiated outside the nesting season to continue without cessation even if raptors such as eagles choose to nest within 500 feet of work activities. Thus, work at the dam construction site may continue if approved by CDFW and USFWS and a qualified biologist monitors the nest site during construction.

- To compensate for the loss of grassland, which provides suitable foraging habitat for golden eagles and California condors, grasslands shall be enhanced or restored at a minimum ratio of 1:1. Restoration or enhancement of grassland habitat shall be conducted under a USFWS and CDFW-approved restoration/enhancement plan, and may be conducted on lands also used for mitigation for Swainson's hawk and/or San Joaquin kit fox. Habitat restoration will be conducted in coordination with the Santa Clara Valley HCP on lands within its bounds.

Mitigation Measure TERR-9: Burrowing Owl

Prior to construction, surveys for burrowing owls would be conducted in areas supporting potentially suitable habitat. Any occupied burrows shall not be disturbed during the breeding season (February 1 through August 31). A minimum 160 foot-wide buffer shall be placed around occupied burrows during the nonbreeding season (September 1 through January 31), and a 250 foot-wide buffer shall be placed around occupied burrows during the breeding season. Ground-disturbing activities shall not occur within the designated buffers.

The project proponent shall implement the measures listed below for grassland habitats to avoid incidental take of burrowing owls. In advance of construction, a qualified biologist shall follow the current CDFW burrowing owl survey guidance to evaluate burrowing owl use. Measures shall apply to all construction activities near active nests or within potential burrowing owl nesting habitat, to avoid, minimize, or mitigate impacts on burrowing owls.

Breeding season surveys shall be performed to determine the presence of burrowing owls for the purposes of inventory, monitoring, avoidance of take, and determining appropriate mitigation. In California the breeding season begins as early as February 1 and continues through August 31. Under the Burrowing Owl Consortium's multi-phase survey methodology, for areas within 500 feet of construction boundaries, a biologist shall: 1) perform a habitat assessment to identify essential components of burrowing owl habitat, including artificial nest features; 2) perform intensive burrow surveys in areas that are identified to provide suitable burrowing owl habitat, and; 3) perform at least four appropriately-timed breeding season surveys (four survey visits spread evenly [roughly every 3 weeks] during the peak of the breeding season, from April 15 to July 15) to document habitat use.

Pre-construction surveys shall be used to assess the owl presence before site modification is scheduled to begin. Initial pre-construction surveys should be conducted outside of the owl breeding season (February 1–August 31), but as close as possible to the date that ground-disturbing activities will begin. Generally, initial pre-construction surveys should be conducted within 7 days, but no more than 30 days prior to ground-disturbing activities. Additional surveys may be required when the initial disturbance is followed by periods of inactivity or the development is phased spatially and/or temporally over the project area. Up to four or more survey visits performed on separate days may be required to assure with a high degree of certainty that site modification and grading will not take owls. The full extent of the pre-construction survey effort shall be described and mapped in detail (e.g., dates, time periods, area[s] covered, and methods employed) in a biological report that will provided for review to CDFW.

In addition to the above survey requirements, the following measures shall be implemented to reduce project impacts to burrowing owls:

- Construction exclusion areas (e.g., orange exclusion fence or signage) shall be established around occupied burrows, where no disturbance shall be allowed. During the nonbreeding season (September 1 through January 31), the exclusion zone shall extend at least 160 feet around occupied burrows. During the breeding season (February 1 through August 31), exclusion areas shall extend 250 feet around occupied burrows (or farther if warranted to avoid nest abandonment).

- If work or exclusion areas conflict with owl burrows, passive relocation of onsite owls could be implemented as an alternative, but only during the nonbreeding season and only with CDFW approval. The approach to owl relocation and burrow closure will vary depending on the number of occupied burrows. Passive relocation shall be accomplished by installing one-way doors on the entrances of burrows within 160 feet of the project area. The one-way doors shall be left in place for 48 hours to ensure the owls have left the burrow. The burrows shall then be excavated with a qualified biologist present. Construction shall not proceed until the project area is deemed free of owls.

- Unoccupied burrows within the immediate construction area shall be excavated using hand tools, and then filled to prevent reoccupation. If any burrowing owls are discovered during the excavation, the excavation shall cease and the owl shall be allowed to escape. Excavation could be completed when the biological monitor confirms the burrow is empty.

- Artificial nesting burrows will be provided as a temporary measure when natural burrows are lacking. To compensate for lost nest burrows, artificial burrows shall be provided outside the 160-foot buffer zone. The alternate burrows shall be monitored daily for 7 days to confirm that the owls have moved in and acclimated to the new burrow.

Mitigation Measure TERR-10: Tricolored Blackbird
Prior to construction, surveys for tricolored blackbirds would be conducted in areas supporting potentially suitable habitat within 0.25 miles of construction areas. Habitat within 0.25 miles of tricolored blackbird colonies will be avoided during nesting season, which can begin as early as mid-March and extend through August. If colonies cannot be avoided, CDFW shall be consulted to potentially reduce buffer distances with active monitoring by a qualified biologist. Consultation with the USFWS may also be required.

Mitigation Measure TERR-11: Special-Status Bats
Impacts to special-status bats shall be minimized by performing preconstruction surveys and creating no-disturbance buffers around active bat roosting sites.

Before construction activities (i.e., ground clearing and grading, including trees or shrub removal) within 200 feet of trees that could support special-status bats, a qualified bat biologist shall survey for special-status bats. If no evidence of bats (i.e., direct observation, guano, staining, or strong odors) is observed, no further mitigation shall be required.

If evidence of bats is observed, the following measures shall be implemented to avoid potential impacts on breeding populations:

- A no-disturbance buffer of 250-feet shall be created around active bat roosts during the breeding season (April 15 through August 15). Bat roosts initiated during construction are presumed to be unaffected by the indirect effects of noise and construction disturbances. However, the direct take of individuals will be prohibited.

- Removal of trees showing evidence of active bat activity shall occur during the period least likely to affect bats, as determined by a qualified bat biologist (generally between February 15 and October 15 for winter hibernacula, and between August 15 and April 15 for maternity roosts). If the exclusion of bats from potential roost sites is necessary to prevent indirect impacts due to construction noise and human activity adjacent, bat exclusion activities (e.g., installation of netting to block roost entrances) shall also be conducted during these periods. If special status bats are identified in the dam or special allowances must be made to relocate bats, Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will coordinate the effort in advance with CDFW.

Mitigation Measure TERR-12: San Joaquin Kit Fox

San Joaquin kit fox would be affected by construction activities if animals are harmed or killed by equipment or their dens or other habitat is altered or destroyed. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will require contractors to take the following actions. Prior to construction, a qualified biologist will conduct surveys to identify potential dens more than 5 inches in diameter. If dens are located within the proposed work area, and cannot be avoided during construction activities, a USFWS- and CDFW-approved biologist will determine if the dens are occupied. If occupied dens are present within the proposed work, their disturbance and destruction shall be avoided. Consultation with the USFWS through the Section 7 process will be required to determine avoidance, conservation, and mitigation measures for this species. Exclusion zones will be implemented following the latest USFWS procedures (USFWS 2011).

The Proponent shall implement San Joaquin kit fox protection measures. The following measures, which are intended to reduce direct and indirect project impacts on San Joaquin kit foxes, are derived from the *San Joaquin Kit Fox Survey Protocol for the Northern Range* (USFWS 1999a) and the *Standardized Recommendations for Protection of the San Joaquin Kit Fox* (USFWS 1999b). The following measures shall be implemented for construction areas at San Luis Reservoir:

- Preconstruction surveys shall be conducted within 200 feet of work areas to identify potential San Joaquin kit fox dens or other refugia in and surrounding workstations. A qualified biologist shall conduct the survey for potential kit fox dens 14 to 30 days before construction begins. All identified potential dens shall be monitored for evidence of kit fox use by placing an inert tracking medium at den entrances and monitoring for at least 3 consecutive nights. If no activity is detected at these den sites, they shall be closed following guidance established in the USFWS *Standardized Recommendations* document.

- If kit fox occupancy is determined at a given site, the construction manager should be immediately informed that work should be halted within 200 feet of the den and the USFWS contacted. Depending on the den type, reasonable and prudent measures to avoid effects to kit foxes could include seasonal limitations on project construction at the site (i.e., restricting the construction period to avoid spring-summer pupping season), and/or establishing a construction exclusion zone around the identified site, or resurveying the den a week later to determine species presence or absence.

- Nighttime vehicle traffic shall be kept to a minimum. Off-road traffic and equipment movement will be limited to the project footprint.

- To compensate for impacts to grassland, which provides habitat for San Joaquin kit fox, lands shall be acquired and covered by conservation easements or mitigation credits shall be purchased at compensation ratios that have been approved by the USFWS and the CDFW.

- The Proponent will develop a plan to maintain and enhance north-south wildlife connectivity through the San Luis Reservoir – O'Neil Forebay – Santa Nella region. The plan shall provide for no loss of connectivity following construction activities associated with the raising of Sisk Dam and the enlarging of San Luis Reservoir, particularly for San Joaquin kit fox populations.

Mitigation Measure TERR-13: American Badger
Concurrent with other required surveys, during winter/spring months before new project activities, and concurrent with other preconstruction surveys (e.g., kit fox and burrowing owl), a qualified biologist shall perform a survey to identify the presence of active or inactive American badger dens. If this species is not found, no further mitigation shall be required. If badger dens are identified within the construction footprint, they shall be inspected and closed using the following methodology.

When unoccupied dens are encountered outside of work areas but within 100 feet of proposed activities, vacated dens shall be inspected to ensure they are empty and temporarily covered using plywood sheets or similar materials. If badger occupancy is determined at a given site within the work area, work activities at that site should be halted. Depending on the den type, reasonable and prudent measures to avoid harming badgers will be implemented and may include seasonal limitations on project construction near the site (i.e., restricting the construction period to avoid spring-summer pupping season), and/or establishing a construction exclusion zone around the identified site, or resurveying the den at a later time to determine species presence or absence. Badgers may be passively relocated using burrow exclusion (e.g., installing one-way doors on burrows) or similar CDFW-approved exclusion methods. In unique situations it might be necessary to actively relocate badgers (e.g., using live traps) to protect individuals from potentially harmful situations. Such relocation could be performed with advance CDFW coordination and concurrence.

Mitigation Measure TERR-14: Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp
Final project design shall avoid and minimize the fill of potentially occurring seasonal wetlands and pools identified as suitable habitat for vernal pool crustaceans to the greatest practicable extent. If any suitable habitat features are mapped and cannot be avoided, the project proponent may assume presence of the species. Consultation with the USFWS through the Section 7 process will be required to determine avoidance, conservation, and mitigation measures. Measures may include, but are not limited to, compensating for impacts at a minimum of a 2:1 ratio for preservation and 1:1 ratio for creation. Final ratios will be determined through consultation with state and federal agencies.

Mitigation Measure TERR-15: Contractor Environmental Awareness Training and Site Protection Measures
All construction personnel working in biologically sensitive areas shall attend an environmental education program delivered by a qualified biologist prior to starting work. The training shall include an explanation as how to best avoid the accidental take of special-status plants and wildlife. The field meeting shall include species identification, life history, descriptions, and habitat requirements. The program shall include an explanation of Federal and State laws protecting endangered species, and avoidance and minimization methods being implemented to protect these species. The program will also include training in measures to avoid the spread of exotic species and diseases, including plant pathogens in oak woodland, and chytrid fungus in amphibian habitat.

The contractor shall properly dispose of all trash items (e.g., wrappers, cans, bottles, food scraps) in closed containers. Work sites shall be cleaned of litter before closure each day, and placed in wildlife-proof garbage receptacles. Construction personnel shall not feed or otherwise attract any wildlife. No pets, excluding service animals, shall be allowed onsite or in construction areas. Nighttime vehicle traffic shall be kept to a minimum on non-maintained roads with a maximum speed of 15 mph. To minimize disturbance to wildlife, temporary and permanent exterior lighting shall be installed such that:

a. lamps and reflectors are not visible from beyond the project site,
b. reflective glare will be minimized to the extent feasible;
c. illumination of the project and its immediate vicinity is minimized;
d. lighting shall incorporate fixture hoods/shielding, with light directed downward or toward the area to be illuminated;
e. all lighting shall be of minimum necessary brightness consistent with operational safety and security;
f. lights in areas not occupied on a continuous basis (such as maintenance areas) shall have (in addition to hoods) switches, timer switches, or motion detectors so that the lights operate only when the area is occupied, and
g. the plan complies with local policies and ordinances.

Mitigation Measure TERR-16: Mitigation measures for jurisdictional wetlands or waters, and streambeds and banks regulated by CDFW and USACE

Mitigation Measure TERR -16a. Final project design shall avoid and minimize the fill of wetlands and other waters to the greatest practicable extent. The following actions shall be performed to define the location and extent of jurisdictional wetlands:

1. The distribution of federal and State jurisdictional wetlands and waters; streambeds and banks regulated by CDFW; mitigation sites regulated by United States Army Corps of Engineers (USACE); and sensitive habitat regulated by CDFW shall be defined and avoided to the greatest possible extent.

2. At least six months prior to construction, a qualified biologist will delineate the extent of jurisdictional areas to be avoided in the field. Delineation surveys will not be conducted during the dry season. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will designate areas to be avoided as “Restricted Areas” and protect them using highly visible fencing, rope, or flagging, as appropriate based on site conditions. No construction activities or disturbance will occur within restricted areas that are designated to protect wetlands.

3. Minimize the removal of riparian and wetland vegetation. Avoid disturbance of riparian and aquatic habitat north of the access road to the dam.

Mitigation Measure TERR-16b. Where jurisdictional wetlands and other waters cannot be avoided, to offset temporary and permanent impacts that would occur as a result of the project, restoration and compensatory mitigation shall be provided as described below.

A wetland mitigation and monitoring plan shall be developed by a qualified biologist in coordination with CDFW, USACE, and/or RWQCB that details mitigation and monitoring obligations for temporary and permanent impacts to wetlands and other waters as a result of construction activities; and other CDFW jurisdictional areas. The plan shall quantify the total acreage lost, describe mitigation ratios for lost habitat (described below), annual success criteria, mitigation sites, monitoring and reporting requirements, and site specific plans to compensate for wetland losses resulting from the project.

Prior to construction, the aquatic structure of wetland and riparian areas to be disturbed will be delineated according to established USACE and CDFW protocols. Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, will recontour and revegetate disturbed portions of jurisdictional areas in areas temporarily affected by construction prior to demobilization by the contractor at the end of project construction. Creek banks will be recontoured to a more stable condition if necessary. Revegetation will include a palette of species native to the watershed area according to a revegetation plan to be developed by Reclamation, under Alternatives 2 and 4, and SCVWD, under Alternative 5, and submitted to the USACE, CDFW, and RWQCB for approval. Following removal, woody trees would be replanted at a minimum 1:1 ratio, or as determined and agreed upon by the appropriate wetland permitting agencies. Interim vegetation or other measures will be implemented as necessary to control erosion in disturbed areas prior to final revegetation.

Wetland and other waters impacts in the construction area shall be compensated at a ratio of 2:1 or as ratio agreed upon by the wetland permitting agencies. Compensatory mitigation shall be conducted by creating or restoring wetland and aquatic habitat at an agency-approved location on nearby lands or through purchasing mitigation credits at a USACE and/or CDFW-approved mitigation bank (depending on the resource). If mitigation is conducted on- or off-site, a five-year wetland mitigation and monitoring program for onsite and offsite mitigation shall be developed. Appropriate performance standards may include, but are not limited to: a 75 percent survival rate of restoration plantings; absence of invasive plant species; and a viable, self-sustaining creek or wetland system at the end of five years.

A weed control plan for the project to limit the spread of noxious or invasive weeds shall also be developed. This plan would be consistent with current Integrated Pest Management Plans that are already in practice on lands surrounding the reservoir. Noxious or invasive weeds include those rated as “high” in invasiveness by the California Invasive Plant Council. The plan will include a baseline survey to identify the location and extent of invasive weeds in the project area prior to ground-disturbing activity, a plan to destroy existing invasive weeds in the construction area prior to initiation of ground-disturbing activity, weed-containment measures while the project is in progress, and monitoring and control of weeds following completion of construction.

Mitigation Measure TERR-17: San Luis Reservoir Shoreline Restoration
Consistent with Mitigation Measure BIO-1 from the San Luis Reservoir SRA RMP/GP (Reclamation and CDPR 2013), Reclamation will ensure areas disturbed by construction activities at the San Luis Reservoir will be restored following construction through planting and/or seeding of native species collected from the local watershed.

Mitigation Measure TERR-18: Tree Protection Ordinance Compliance
To ensure compliance with local tree protection ordinances, SCVWD will require pre-construction surveys for trees on site to determine whether any tree removal will be required for construction actions proposed in unincorporated Santa Clara County or the City of San Jose. In the event that tree removal is required, the survey will include measurement and taxonomic identification of all potentially impacted trees. Following the survey, SCVWD will secure the appropriate tree removal permits and include provisions in any construction contract for the replacement of impacted trees consistent with the permit requirements.

4.15 Regional Economics

4.15.1 Assessment Methods

Regional economic effects include changes to employment, income, or output as a result of the project alternatives. Impacts to regional economics are determined consistent with NEPA relative to the No Action/No Project Alternative. For the quantitative analysis, the analysis uses 2014 IMPLAN data, an input-output (I-O) database and modeling software, to estimate economic impacts of changes in final demand or spending associated with the project alternatives.

IMPLAN estimates total economic effects that include: (1) direct effects – changes in final demand; (2) indirect effects – changes in expenditures within the region in industries supplying goods and services; (3) induced effects – changes in expenditures of household income. Construction and annual operation and maintenance (O&M) expenditures would create jobs and generate additional economic activity within the region during the period of construction. The regional economic analysis uses engineering estimates of total project costs, including materials and labor costs. IMPLAN is then used to determine indirect and induced effects of construction work.

For M&I water users, water shortages could increase water costs and water rates if contractors must develop alternate supplies or implement additional water conservation measures. These effects are evaluated qualitatively. For the analysis of agricultural economic effects, the Statewide Agricultural Production (SWAP) Model estimates changes in value of production of crops as a result of changes in water supply. Appendix R further described the SWAP agricultural economics model. Change in value of production is a direct effect to the crop industry sectors, which is input into IMPLAN as an industry change to estimate regional economic effects. This section also evaluates effects to visitor spending associated with the alternatives' impacts on recreation facilities. If spending increases or decreases, there would be regional economic effects.

4.15.2 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Under the No Action/No Project Alternative, interrupted San Felipe Division M&I deliveries affect SCVWD's ability to meet treated water demands. SCVWD and retail agencies would implement Water Shortage Contingency Plans that include actions to be taken during water shortages. This would result in implementation costs for SCVWD and retail agencies. Increased costs would ultimately be passed on to the water users through increased water rates. Similarly, SWP contractors in southern California are subject to water shortages due to drought conditions and Delta export restrictions under the No Action/No Project Alternative. Securing alternate water supplies and implementing water conservation measures may be costlier for the agencies than SWP water supplies. An increase in water rates would reduce the disposable income of Santa Clara County and Southern California residents and could result in less spending in the regional economy. Under the No Action/No Project Alternative, agricultural water deliveries would decrease due to Delta export restrictions or drought conditions. Growers would implement actions, such as idling fields or increasing groundwater pumping, to respond to water shortages. Cropland idling would reduce farm incomes, purchases of agricultural inputs, and farm labor, and pumping groundwater would increase costs and reduce farm incomes. Therefore, there would be adverse economic impacts under the No Action/No Project Alternative.

4.15.3 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Increased water supply during low-point years would lessen the need for SCVWD and retail agencies to implement water shortage contingency actions, which would avoid implementation costs. Santa Clara County residents are less likely to be required to implement mandatory conservation measures and avoid economic effects associated with implementing conservation.

Improved water supply reliability would support the long-term economic vitality of the county. Increased water supply as a result of Alternative 2 would be a beneficial economic effect to SCVWD. If water rates to customers are increased to pay for improvements to the reservoir, the resulting economic effect would be a decrease in customers' discretionary income available to spend in the region. This would be an adverse economic effect.

Under Alternative 2, there would be a small reduction in agricultural deliveries to South-of-Delta CVP contractors by about 2,000 acre-feet on average annual basis. These decreases would likely result in increased groundwater pumping and decreased farm revenues. A small amount of acreage may be fallow due to the decreased supply. The regional economic effects would be adverse, but minor.

The construction period for the Tunnel Option of Alternative 2 would be 47 months. Estimated construction costs would be $962.1 million. There would be approximately 100 on-site construction workers during peak times. This analysis assumes 400 construction workers over the construction period. Total economic effects (direct, indirect, induced) would be an increase of 4,396 jobs, $394.3 million in labor income, and $1,438.5 million in output. The construction period for the Pipeline Option of Alternative 2 would last 33 months. Estimated construction costs would be $842.1 million. There would be approximately 100 on-site construction workers during peak times. This analysis assumes 400 on-site construction workers over the construction period. Total economic effects (direct, indirect, induced) would be an increase of 3,998 jobs, $350.0 million in labor income, and $1,273.4 million in output. These would be temporary beneficial economic effects in Santa Clara and Merced counties. O&M costs to implement Alternative 2 would be $2.5 million per year for the pipeline and tunnel options. These effects would be long-term and would occur each year during project operation. Total economic effects would be an increase of 22 jobs, $1.7 million in labor income, and $3.4 million in output.

Temporary closure of recreation facilities at Basalt and Dinosaur Point use areas within the San Luis Reservoir SRA would reduce local spending and revenues in Merced County. During construction of the intake, both use areas would be used for project staging and would be closed to the public during a period of 33 to 47 months, due to potential public safety hazards at the construction site. Combined, the Basalt and Dinosaur Point use areas annually serve approximately 120,000 day use and 8,000 overnight visitors. Visitors that originate outside of Merced County (out-of-region visitors) generate new economic activity for the county because they bring money into the region that would otherwise be spent elsewhere. Because of facility closures, some visitors may choose to recreate at alternate sites in the San Luis Reservoir SRA. This would not result in any economic impacts in Merced County. However, due to crowded conditions at the San Luis Creek use area and limited recreation opportunities at both the Los Banos or Medeiros use areas, visitors may choose to recreate outside of the San Luis Reservoir SRA and outside of Merced County. As a result, the Merced County economy would lose any spending by out-of-region visitors that occurred under the No Action/No Project Alternative. In addition to the above spending, visitors would not pay park entry fees. California SPs would therefore lose revenues. These effects would only occur while the facilities are closed for construction activities. A decline in park fees would reduce funds into the State Treasury. Temporary closures could result in temporary job losses for staff at the recreation areas. These economic effects would be adverse effects for the Merced County economy. Effects would be temporary, and visitation would be expected to restore to levels under the No Action/No Project Alternative after construction is complete.

4.15.4 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Economic benefits associated with increased water supply under Alternative 3 would be the same as those described for Alternative 2. The construction period for Alternative 3 would be approximately 3 years. Capital cost expenditures for Alternative 3 would be approximately $37.0 million over the construction period. There would be an average of approximately 24 on-site construction workers at the site. This analysis assumes a total of 90 on-site construction workers on site over the construction period. Total economic effects of construction would be an increase of 263 jobs, $21.5 million in labor income, and $62.6 million in output. O&M costs to implement Alternative 3 would be $0.3 million per year. These costs include increased power demands, increased chemical demand and one additional full time O&M operator at the treatment plant. Increased power and chemical costs would not have a significant effect on the regional economy. There would be one additional direct job needed for increased O&M at the treatment plant. This additional job would result in some minor positive effects to the regional economy.

4.15.5 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

In addition to increased deliveries during low point years, this alternative would provide SCVWD with increased access to its CVP supplies during non-low point years. In addition to SCVWD, this alternative would increase CVP and SWP water supplies to M&I water service contractors south of the Delta and in the Bay Area. This would be an economic benefit because water contractors would not need to acquire expensive water supplies on the spot water transfer market or implement costly water conservation measures during years with water shortages. It is likely that a portion of project costs would be allocated to CVP and SWP contractors in accordance with the benefits of the project to them, which would likely be passed on to retail agencies or water customers through increased water rates. If water rates to customers are increased, the resulting economic effect is a decrease in customers' discretionary income available to spend in the region. This would be an adverse economic effect.

Increased water supplies for agricultural uses in the San Joaquin Region would increase value of production. Annual value of production would increase by about $2.6 million in dry years, $1.5 million in below normal and critical years, and $1.2 million in wet years. Effects in below normal, critical and wet years would be less than those in dry years because modeling estimated that less water would be provided to agricultural water users in these hydrologic year types. Increased water supply would increase value of production and consequently increase employment, value added, labor income, and output in the crop sectors and the overall regional economy through indirect and induced impacts. Increased water supply under Alternative 4 would have minor positive effects to the agricultural economy.

The construction duration for Alternative 4 would be approximately 8 to 12 years. Capital cost expenditures for Alternative 4 would be approximately $830.0 million over the construction period. There would be 217 workers at San Luis Reservoir. Total economic effects of construction would be an increase of 6,011 jobs, $219.8 million in labor income, and $1,002 million in output. The modifications at B.F. Sisk Dam to increase reservoir storage is expected to increase pumping and consequently energy usage at Gianelli Pumping Plant. All or a portion of these increased pumping costs would be passed on to the rate payers.

During 8 to 12 years of construction of the reservoir, Basalt and Dinosaur Point use areas would be used for project staging and would be closed to the public. This would result in substantial adverse regional economic effect to the Merced County economy and to California SP entry fees collected as discussed for Alternative 2.

4.15.6 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

In addition to increased deliveries during low point years, this alternative would provide SCVWD water supplies during non-low point years. Increased water supply during low point years would lessen the need for SCVWD and retail agencies to implement water shortage contingency actions, which would avoid implementation costs. Santa Clara County residents would not be required to implement mandatory conservation measures and would avoid economic effects associated with implementing conservation. Improved water supply reliability would support the long-term economic vitality of the county in regard to population growth, business development, and employment opportunities. Increased water supply would be a beneficial economic effect to SCVWD. If water rates to customers are increased to pay for the reservoir, the resulting economic effect would be a decrease in customers' discretionary incomes available to spend in the region. This would be an adverse economic effect.

Under Alternative 5, there would be a small reduction in agricultural deliveries to San Felipe Division Contractors by about 100 acre-feet on average annual basis. These decreases would likely result in increased groundwater pumping and decreased farm revenues. A small amount of acreage may be fallow due to the decreased supply. The regional economic effects would be adverse, but minor.

The construction duration for Alternative 5 would be approximately 5 years. Capital cost expenditures would be approximately $1,116.2 million over the construction period. There would be 475 workers at San Luis Reservoir. Total economic effects of construction would be an increase of 9,301 jobs, $717.4 million in labor income, and $1,531.0 million in output. O&M cost of the expanded Pacheco Reservoir includes energy conveyance costs to pump water from San Luis Reservoir to the expanded Pacheco Reservoir. All or a portion of these increased pumping costs would be passed on to the rate payers. Additionally, there would be some non-energy O&M costs associated with civil maintenance and vegetation maintenance at the new facility. These non-energy costs would result in some minor positive effects to the regional economy.

4.16 Land Use and Agricultural Resources

4.16.1 Assessment Methods

Construction and long-term operations of the alternatives could affect land use in the San Luis Reservoir region and in Santa Clara County. Changes in water supply or distribution could lead to changes in agricultural land use. The potential for these effects to occur and their magnitude is evaluated qualitatively within the counties in the area of analysis. Changes in land use could result in incompatible uses and adverse effects.

4.16.2 Significance Criteria

Impacts related to land use and agricultural resources would be considered significant if the project would: (1) physically divide a community; (2) convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use; (3) conflict with existing zoning for agricultural use or a Williamson Act contract; or (4) cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environment effect. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-19. The potential for impacts related to the potential conversion of forestland, conflicts with existing zoning or causing the rezoning of forestland is not evaluated in this EIS/EIR. None of the alternatives under consideration would be located in forested areas or areas zoned as forestland. In addition, the alternatives would not impact either directly or indirectly forested areas inside or outside of the study area.

4.16.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

SCVWD would continue to change operations in an effort to provide adequate water supplies during dry years and low point interruptions. Water supply shortages would occur during summer months and be supplemented, when possible, with other local and imported supplies. These shortages would not change land uses or generate any conflicts with applicable land use plans, policies, or regulations. **The No Action/No Project Alternative would have no impact on land use or agricultural resources.**

Table 4-19. Land Use and Agricultural Resources Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Cause an existing community to be physically divided	Evaluate how implementation of the alternatives could potentially introduce a new land use type that would differ from or conflict with existing land uses that would divide an existing community to be divided	1	NI	--	Section 4.12.3
		2	NI	None	Section 4.12.4
		3	NI	None	Section 4.12.5
		4	LTS	None	Section 4.12.6
		5	LTS	None	Section 4.12.7
Result in the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use	Evaluate how implementation of the alternatives could potentially require the conversion of farmland with new construction or as a result of changes in water supply deliveries	1	NI	--	Section 4.12.3
		2	NI	None	Section 4.12.4
		3	NI	None	Section 4.12.5
		4	LTS	None	Section 4.12.6
		5	LTS	None	Section 4.12.7
Conflict with existing zoning for agricultural use or a Williamson Act contract	Evaluate how implementation of the alternatives could potentially require the conversion lands currently zoned for agricultural use or protected under Williamson Act contract	1	NI	--	Section 4.12.3
		2	NI	None	Section 4.12.4
		3	NI	None	Section 4.12.5
		4	LTS	None	Section 4.12.6
		5	SU, LTS	LU-1	Section 4.12.7
Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project adopted for the purpose of avoiding or mitigating an environment effect	Evaluate how implementation of the alternatives could potentially implement new land uses that would conflict with land use plan, policy, or regulation of an agency with jurisdiction over the project	1	NI	--	Section 4.12.3
		2	NI	None	Section 4.12.4
		3	NI	None	Section 4.12.5
		4	LTS	None	Section 4.12.6
		5	LTS	None	Section 4.12.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.16.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction would occur on lands at the reservoir owned by Reclamation and CDFW and managed by CSP, DWR, and CDFW. Construction activities would be temporary and would not conflict with land use policies of these agencies nor the policies in the San Luis Reservoir SRA RMP/GP. Construction and operation of the alternative would not occur on land designated as Important Farmland. Therefore, there would be no impact to Prime Farmland, Unique Farmland, or Farmland of Statewide Importance or conflict with Williamson Act contracts. Operations of the new facilities would increase supply reliability for SCVWD water users; however, it would not result in changes to land use designations given that the uninterrupted deliveries provided by the alternative would meet existing demand and would not represent a new supply. Construction and operation of the alternative would not affect any of the towns or cities in the county, would not divide a community, and would not affect land use or change land use designations. **Alternative 2 would have no impact on land use or agricultural resources.**

4.16.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Construction of the retrofits at Santa Teresa WTP would occur on existing WTP property and would not affect land use designations, convert agricultural lands, or create conflicts with land use plans. Operations of the new facilities would increase supply reliability for SCVWD water users; however, it would not result in changes to land use designations given that the uninterrupted deliveries provided by the alternative would meet existing demand and would not represent a new supply. There would be no impact to Prime Farmland, Unique Farmland, or Farmland of Statewide Importance or conflict with Williamson Act contracts. Construction and operation of the alternative would not affect any of the towns or cities in the county, would not divide a community, and would not affect land use or change land use designations. **Alternative 3 would have no impact on land use and agricultural resources.**

4.16.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Construction activities would be temporary and would impact lands (non-agricultural) on and directly around the reservoir. Long-term operations of the alternative would increase the water elevation in the reservoir when the expanded storage capacity is filled. The approximately 394 acres of additional land that would be inundated are located within the San Luis Reservoir SRA front country and backcountry zones. The expanded B.F. Sisk Dam would be located on lands in the Administration and Operations Zone. Long-term operations would not require a change to these land management designations and would not result in activities contrary to the existing allowable uses in that zone. Operations of the new facilities would increase supply reliability for water users in SCVWD and the Central Valley and reduce the amount of fallowed or purposefully dryland farmed lands. However, this would not result in the permanent conversion of nonagricultural lands to agricultural. There would be no impact to Prime Farmland, Unique Farmland, or Farmland of Statewide Importance or conflict with Williamson Act contracts. Construction and operation of the alternative would not affect any of the towns or cities in the county, would not divide a community, and would not affect land use or change land use designations. **Alternative 4 would have a less than significant impact to land use and agricultural resources.**

4.16.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activities would be temporary and would impact Ranchlands (used for grazing) around the existing Pacheco Reservoir and land adjacent to San Luis Reservoir. Construction activities would not conflict with relevant land use policies or the policies in the San Luis Reservoir SRA RMP/GP. The newly inundated lands (1,245 acres) would be located on PPWD land and Ranchlands. Implementation of Alternative 5 would require temporary and permanent rights-of-way and acquisitions of private property, which are not designated as Important Farmland. Therefore, there would be no impact to Prime Farmland, Unique Farmland, or Farmland of Statewide Importance. Operations of the new reservoir could increase supply reliability for SCVWD water users but would not result in land use conversions within the SCVWD service area. Construction and operation of the alternative would not affect any of the towns or cities in the county and would not divide a community. Operations of the new facilities would increase supply reliability for SCVWD water users; however, it would not result in changes to land use designations given that the uninterrupted deliveries provided by the alternative would meet existing demand and would not represent a new supply. **Alternative 5 would have a less than significant impact to land use and agricultural resources.**

Operation of Alternative 5 would inundate grazing lands currently covered by Williamson Act contracts. The inundation of this land would conflict with these Williamson Act contracts. **This impact would be significant.** Implementation of Mitigation Measure LU-1, described in Section 4.16.8, would reduce these impacts to a less than significant level by the purchase of a conservation easement or the payment of the agricultural mitigation fee. **Therefore, Mitigation Measure LU-1 would reduce the severity of impacts to a less than significant level.**

4.16.8 Mitigation Measures

The following mitigation measures would reduce the severity of the land use and agricultural impacts.

Mitigation Measure LU - 1: Williamson Act Land Replacement. Agricultural land currently covered by Williamson Act contracts inundated by the operation of Alternative 5 will be replaced by SCVWD through the purchase of a conservation easement at a 1:1 ratio, in accordance with Santa Clara County Local Agency Formation Commission polices. Or, if enacted, SCVWD will pay the agricultural mitigation fee for development that converts viable agricultural land to other uses (Santa Clara County 2018).

4.17 Recreation

4.17.1 Assessment Methods

This analysis assesses impacts to recreation by evaluating closures or access restriction sites at or near the San Luis Reservoir SRA, Pacheco SP, and Anderson Park. This analysis also assesses impacts to recreation by evaluating potential impacts to recreation during operation of each of the project alternatives. If reservoir operations during future low points were to reduce or increase water levels during summer months, water-based recreation such as boating, fishing, and swimming could be affected.

This analysis estimates the potential water storage and surface levels, and their associated effect on recreation facility availability and quality of SLLPIP implementation using the CalSim II and the Water Evaluation and Planning (WEAP) models. See Appendix B for a description of the assumptions and methods used in these models. The recreation facility availability and quality analysis in this chapter relies on the modeling results and therefore contains a degree of uncertainty.

4.17.2 Significance Criteria

For the purposes of the SLLPIP EIS/EIR, effects would be significant if they resulted in: (1) recreational use of trails would be substantially reduced as a result of construction; (2) construction activities would substantially reduce access to or close recreation areas; (3) displaced recreation from sites affected by construction would substantially contribute to overcrowding or exceed the facility capacity at other recreation sites, such that substantial physical deterioration of the facility would occur or be accelerated; or, (4) operational changes to water levels in recreational water bodies would be reduced to an extent that recreational uses would be substantially affected. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-20.

4.17.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

This section describes potential effects of the No Action/No Project Alternative on recreation in the area of analysis. The No Action/No Project Alternative would result in no change in the area of analysis to recreational trail use, access to recreation facilities or opportunities, or visitor use at other local and regional recreation sites. **Under the No Action/No Project Alternative, conditions at all recreation facilities within the area of analysis would be the same as those experienced under existing conditions.**

Table 4-20. Recreation Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Substantially reduce recreational use on trails as a result of project construction	Evaluation of how the alternatives could potentially restrict access to trails in and around proposed construction impact areas with consideration of the capacity of other trails available in the immediate area to offset this effect	1	NI	--	Section 4.17.3
		2	LTS	None	Section 4.17.4
		3	NI	None	Section 4.17.5
		4	LTS	None	Section 4.17.6
		5	NI	None	Section 4.17.7
Substantially reduce access to or close recreation areas as a result of project construction	Evaluation of how the alternatives could potentially require access limits to or close recreation sites near the proposed construction impact areas	1	NI	--	Section 4.17.3
		2	S, LTS	REC-1	Section 4.17.4
		3	NI	None	Section 4.17.5
		4	S, LTS	REC-1	Section 4.17.6
		5	NI	None	Section 4.17.7
Contribute to overcrowding or exceed the facility capacity at other recreation sites by displacing users and substantial physical deterioration of the facility would occur or be accelerated	Evaluation of average visitor numbers at any facilities that would have access limited or be closed by the alternatives, compare those numbers against user rates and any unused capacity at other regional facilities, and further evaluate if an increased number of users would result in substantial physical deterioration of the facility	1	NI	--	Section 4.17.3
		2	LTS	None	Section 4.17.4
		3	NI	None	Section 4.17.5
		4	LTS	None	Section 4.17.6
		5	NI	None	Section 4.17.7
Reduce access to recreation uses through long-term operational changes to water levels in recreational water bodies	Review of CalSim II model results for San Luis Reservoir do determine how each alternative could potentially change storage levels in the reservoir and potentially impact seasonal reservoir access	1	NI	--	Section 4.17.3, Appendix N
		2	NI (non low point years), LTS (low point years)	None	Section 4.17.4, Appendix N
		3	NI (non low point years), LTS (low point years)	None	Section 4.17.5, Appendix N
		4	S, LTS (trail closures), B (water-based rec.)	REC-2	Section 4.17.6, Appendix N
		5	NI (non low point years), LTS (low point years)	None	Section 4.17.7

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; REC = recreation; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.17.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

To implement this alternative, recreational activities within the San Luis Reservoir SRA near the project construction would be closed to the public for safety purposes during construction, including the Basalt and Dinosaur Point use areas. The Basalt Use Area includes two of the three formally designated trails within the San Luis Reservoir SRA, the Basalt Campground Trail and the Lone Oak Trail. There are no formally designated recreation trails at the Dinosaur Point Use Area. Although trails at the Basalt Use Area would be temporarily affected, hiking opportunities within the San Luis Reservoir SRA would still be available for use during project construction. These would include formally designated and primitive trails at both Los Banos Creek and San Luis Creek use areas, and within the designated wildlife use areas. In addition, Pacheco SP, just west of the San Luis Reservoir SRA, offers several public hiking opportunities. **This impact would be less than significant.**

Closure of the Basalt Use Area during the construction period would result in a loss of camping, picnicking, fishing, boating and water sports, swimming, and hiking recreation opportunities. About 2,500 boats are currently launched from the Basalt Use Area boat ramp each year (CDPR 2018). Additionally, 79 campsites with RV accessibility, eight ADA accessible campsites, one of two fish cleaning stations in the SRA, and the only public storage lockers would be unavailable to the public during the construction period (Reclamation and CDPR 2013). Closure of the Dinosaur Point Use Area would result in a loss of fishing, boating and water sports, and swimming opportunities. About 2,000 boats are currently launched from the Dinosaur Point Use Area boat ramp each year (CDPR 2018).

Closure of recreation resources at both the Basalt and Dinosaur Point use areas during construction could be compensated for at the other three use areas within the San Luis Reservoir SRA. In addition, nearby Pacheco SP (immediately adjacent to the San Luis SRA) offers primitive camping opportunities and Henry Coe SP (approximately 15 miles west of San Luis Reservoir) offers both improved and unimproved camping opportunities that would offset this lost capacity. However, the temporary closures would leave the SRA with only two active boat ramps (San Luis Creek on O’Neill Forebay and Los Banos Creek on Los Banos Reservoir) and San Luis Reservoir with no boat ramp access; only six ADA accessible campsites; RV accommodations at only two use areas, Medeiros and San Luis Creek; and no public showers. **Alternative 2 would cause a significant impact by reducing recreation opportunities during construction.** Mitigation Measure REC-1, as described below in Section 4.17.8, would develop new campsites, a fish cleaning station, public storage lockers, and shower facilities and expand the boat launch to further reduce the impacts of the closure of the Basalt and Dinosaur Point use areas. **Therefore, Mitigation Measure REC-1 would reduce the severity of impacts on recreational opportunities in the San Luis Reservoir SRA to a less than significant level.**

Construction activities could displace visitors and substantially contribute to overcrowded conditions at other local and regional recreation sites. Combined, the Basalt and Dinosaur Point use areas annually serve approximately 55,000 day-use and 6,500 overnight visitors and account for over 25 percent of the annual attendance at the San Luis Reservoir SRA (CDPR 2018).

Recreation opportunities at the other three use areas within the San Luis Reservoir SRA, Medeiros, Los Banos Creek, and San Luis Creek, may experience changes in visitor rates during construction, due to the closure of neighboring recreation facilities and increased construction related traffic. The Los Banos Creek Use Area receives approximately 10,000 annual visitors and could accommodate a portion of the displaced visitors (CDPR 2018). The San Luis Creek Use Area currently receives approximately 100,000 annual visitors and currently experiences crowded conditions, which could lead visitors to choose to recreate outside of the San Luis Reservoir SRA during the construction period (CDPR 2018).

Pacheco SP and Henry Coe SP, both located near the San Luis Reservoir SRA, could experience an increase in visitation. Both SPs could supplement some of the hiking and camping opportunities lost by the closure of the Basalt Use Area. Neither Pacheco SP nor Henry Coe SP currently report user capacity issues, and displaced San Luis Reservoir users would not be expected to overcrowd the two SPs. At 87,000 acres and the largest state park in northern California, Henry Coe SP accommodates over 40,000 visitors each year (CDPR 2016). Henry Coe SP offers opportunities for hiking, fishing, and camping. Approximately 2,000 people visit Pacheco SP each year (CDPR 2016). Pacheco SP offers opportunities for hiking and camping. In addition, San Luis National Wildlife Refuge in Merced County is approximately 22 miles from San Luis Reservoir and offers fishing, hunting, nature trails, and wildlife viewing. Water based recreation, camping, hiking, and other activities are offered at Coyote Lake Harvey Bear Ranch County Park and Anderson Lake County Park in Santa Clara County, approximately 35 miles from San Luis Reservoir.

Because the San Luis Creek and Los Banos Creek use areas would remain open during construction of Alternative 2 to offset lost capacity at the Basalt and Medeiros use areas, it is assumed that only a portion of the 55,000 day-use and 6,500 overnight visitors offset at San Luis Reservoir would shift to the other regional recreation area. As a result, the current capacities at these regional recreation areas would not be exceeded. In addition, with a number of similar alternative recreational opportunities nearby, no one recreational area would be expected to experience substantial increase in use such that deterioration of its facilities would occur or be accelerated. **Therefore, Alternative 2 would have a less than significant impact on conditions at other recreation sites and would not increase use that would result in deterioration of the facilities.**

Alternative 2 would generate no change in storage levels in San Luis Reservoir when compared to Alternative 1 in non-low point years. Operational changes under Alternative 2 would only occur in years with low point events and only would result in a less than a 1-foot decrease in reservoir elevation when compared to existing conditions (Alternative 1) and would not significantly affect reservoir-based recreation (see Appendix N for San Luis Reservoir storage level modeling results). **This impact would be less than significant.**

4.17.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Under Alternative 3, construction of treatment upgrades at SCVWD's Santa Teresa WTP would not occur at or interfere with any recreation trails, or temporarily close any recreation facilities.

Moreover, displacement of visitors or overcrowded conditions at other local and regional recreation sites would not occur. Alternative 3 would not cause or accelerate any substantial physical deterioration of any recreational facilities. Operational changes at the San Luis Reservoir under Alternative 3 would be similar to those under Alternative 2 and would not significantly affect reservoir-based recreation. **Alternative 3 would have a less than significant effect on water-based recreation from operational changes at the San Luis Reservoir and no impact to other recreational facilities**.

4.17.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

To implement this alternative, recreational activities within the San Luis Reservoir SRA near the project construction would be closed to the public for safety purposes during construction, including the Basalt and Medeiros use areas. The Basalt Use Area includes two of the three formally designated trails within the San Luis Reservoir SRA, the Basalt Campground Trail and the Lone Oak Trail. There are no formally designated recreation trails at the Medeiros Use Area. Although trails at the Basalt Use Area would be temporarily affected, hiking opportunities within the San Luis Reservoir SRA would still be available for use during project construction. These would include formally designated and primitive trails at both Los Banos Creek and San Luis Creek use areas, and within the designated wildlife use areas. In addition, Pacheco SP, just west of the San Luis Reservoir SRA, offers several public hiking opportunities. **This impact would be less than significant.**

Closure of the Basalt Use Area during the construction period would result in a loss of camping, picnicking, fishing, boating and water sports, swimming, and hiking recreation opportunities. About 2,500 boats are currently launched from the Basalt boat ramp each year, which would be closed during construction (CDPR 2018). Additionally, 79 campsites with RV accessibility, eight ADA accessible campsites, one of two fish cleaning stations in the SRA, and the only public storage lockers would be unavailable to the public during the construction period (Reclamation and CDPR 2013). Closure of the Medeiros Use Area would result in a loss of camping, picnicking, fishing, and swimming opportunities. The Medeiros Use Area has the capacity to support approximately 400 unimproved and unassigned camping sites that would be inaccessible during the construction period.

Closure of recreation resources at both the Basalt and Medeiros use areas during construction could be compensated for at the other three use areas within the San Luis Reservoir SRA. In addition, nearby Pacheco SP (immediately adjacent to the San Luis SRA) offers primitive camping opportunities and Henry Coe SP (approximately 15 miles west of San Luis Reservoir) offers both improved and unimproved camping opportunities that would offset this lost capacity. However, when the two use areas are closed, the SRA would have only three active boat ramps (San Luis Creek on O’Neill Forebay and Los Banos Creek on Los Banos Reservoir, Dinosaur Point on San Luis Reservoir) and only six ADA accessible campsites; RV accommodations at only one use area, San Luis Creek; and no public showers. **Alternative 4 would cause a significant impact by reducing recreation opportunities during construction.** Mitigation Measure REC-1, as described below in Section 4.17.8, would develop new campsites, a fish cleaning station, public storage lockers, and shower facilities and expand the boat launches to further reduce the impacts of the closure of the Basalt and Medeiros use areas. **Therefore, Mitigation Measure REC-1 would reduce the severity of impacts on recreational opportunities in the San Luis SRA to a less than significant level.**

Construction activities could displace visitors and substantially contribute to overcrowded conditions at other local and regional recreation sites. Combined, the Basalt and Medeiros use areas annually serve approximately 60,000 day-use and 17,000 overnight visitors and account for over 38 percent of the annual attendance at the San Luis Reservoir SRA (CDPR 2018).

Recreation opportunities at the other three use areas within the San Luis Reservoir SRA, Dinosaur Point, Los Banos Creek and San Luis Creek, may experience changes in visitor rates during construction, due to the closure of neighboring recreation facilities and increased construction related traffic. The Los Banos Creek Use Area receives approximately 10,000 annual visitors and could accommodate a portion of the displaced visitors. The San Luis Creek Use Area currently receives approximately 100,000 annual visitors and currently experiences crowded conditions, which could lead visitors to choose to recreate outside of the San Luis Reservoir SRA during the construction period (CDPR 2018).

Pacheco SP and Henry Coe SP, both located near the San Luis Reservoir SRA, could experience an increase in visitation. Both SPs could supplement some of the hiking and camping opportunities lost by the closure of both the Basalt and Medeiros use areas. Neither Pacheco SP nor Henry Coe SP currently report user capacity issues, and displaced San Luis Reservoir users would not be expected to overcrowd the two SPs. At 87,000 acres and the largest state park in northern California, Henry Coe SP accommodates over 40,000 visitors each year. Henry Coe SP offers opportunities for hiking, fishing, and camping (CDPR 2016). Approximately 2,000 people visit Pacheco SP each year. Pacheco SP offers opportunities for hiking and camping (CDPR 2016). In addition, San Luis National Wildlife Refuge in Merced County is approximately 22 miles from San Luis Reservoir and offers fishing, hunting, nature trails, and wildlife viewing. Water based recreation, camping, hiking, and other activities are offered at Coyote Lake Harvey Bear Ranch County Park and Anderson Lake County Park in Santa Clara County, approximately 35 miles from San Luis Reservoir.

Because the San Luis Creek, Dinosaur Point, and Los Banos Creek use areas would remain open during construction of Alternative 4 to offset lost capacity at the Basalt and Medeiros use areas, it is assumed that only a portion of the 60,000 day-use and 17,000 overnight visitors offset at San Luis Reservoir would shift to the other regional recreation area. As a result, the current capacities at these regional recreation areas would not be exceeded. In addition, with a number of similar alternative recreational opportunities nearby, no one recreational area would be expected to experience substantial increase in use such that deterioration of its facilities would occur or be accelerated. **Therefore, Alternative 4 would have a less than significant impact on conditions at other recreation sites and would not increase use that would result in deterioration of the facilities.**

During construction of Alternative 4 water levels would be the same as existing conditions (Alternative 1). However, if the shear key option is implemented, the reservoir's water levels would be lowered for two seasons. These lower water levels could impact recreational uses within the reservoir and could potentially make boating access difficult. However, boat access would remain available at San Luis Creek and Los Banos Creek use areas. Water levels at the San Luis Reservoir from the operation of Alternative 4 would slightly increase in non-low point years and in years with low point events (see Appendix N for San Luis Reservoir storage level modeling results). The San Luis Reservoir would experience an average increase of 8 TAF in total storage and a little over 1-foot increase in reservoir elevation over all years. While reservoir expansion would impact trail use at Basalt Use Area, it would have a beneficial effect on water-based recreation, such as boating, fishing, and swimming. **With the inclusion of the shear key option, construction of Alternative 4 would result in a temporary less than significant impact to water-based recreation. However, in the long-term, operation of Alternative 4 would provide beneficial impacts to water-based recreation.**

It is anticipated that surface inundation would increase such that the reservoir would expand slightly in size and reach additional areas in the approximately 14 percent of years that this new storage would be exercised. This would result in the inundation of portions of the Basalt Campground Trail and the Lone Oak Trail, requiring temporary trail closure until water levels recede. These trails traverse loam and clay soil types, which have a low to moderate erodibility. Therefore, after inundation, the trails would remain in good condition and would not require additional maintenance. **Alternative 4 would cause a significant impact by temporarily closing trails and reducing recreation opportunities during times when the reservoir is fully inundated.** Implementation of Mitigation Measure REC-2, described below in Section 4.17.8, would relocate the trails that would be inundated and reduce the long-term impact on trails to a less than significant impact. **Therefore, operational impacts on trails and recreation facilities associated with Alternative 4 would be less than significant with implementation of Mitigation Measure REC-2.**

4.17.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Pacheco Reservoir is not currently utilized for recreation. Therefore, Alternative 5 would not result in any temporary displacement of visitors or any closures of recreational facilities due to construction. Under this alternative, all proposed activities would take place outside of Henry W. Coe SP and the new dam would not be visible from the park. Alternative 5 would not cause or accelerate any substantial physical deterioration of any recreational facilities. Operation of Alternative 5 would allow SCVWD to receive its full allocation of water stored in San Luis Reservoir would generate slight decreases in reservoir storage levels in both low point and non-low point years (see Appendix N for San Luis Reservoir storage level modeling results). Changes in San Luis Reservoir levels would result in impacts similar to those discussed in Alternative 2 and would not significantly affect reservoir-based recreation. **Alternative 5 would have a less than significant effect on recreational facilities from operational changes at the San Luis Reservoir and no impact to other recreational facilities**.

4.17.8 Mitigation Measures

The following mitigation measures would reduce the severity of the recreation impacts.

Mitigation Measure REC - 1: Campsite Replacement.[5] Campsites closed at San Luis Reservoir during construction of an alternative will be replaced by Reclamation at a 1:1 ratio at the San Luis Creek Use Area and then as necessary at the Los Banos Creek Use Area. These new replacement campsites would be developed consistent with the new facilities considered in the San Luis Reservoir SRA RMP/GP and will not exceed the quantities of new facilities considered in the RMP at each use area. Reclamation will include this mitigation requirement in bid documents and construction contracts.

In addition, Reclamation will work with CDPR to implement the following measure. The boat launches at the San Luis Creek and Dinosaur Point use areas would be expanded by addition of a launch lane and a boarding float. In addition, a fish cleaning station, public storage lockers, and shower facilities would be developed at San Luis Creek Use Area.

REC - 2: Trail Relocation.[5] Reclamation will work with CDPR to implement the following measure. Sections of the Basalt Campground Trail and the Lone Oak Trail near the San Luis Reservoir shoreline will be moved upslope to avoid the potential for inundation when an enlarged San Luis Reservoir is forecasted to be filled to capacity.

4.18 Environmental Justice

4.18.1 Assessment Methods

NEPA requires an analysis of social, economic, and environmental justice effects; however, there is no standard set of criteria for evaluating environmental justice impacts. For purposes of this EIS/EIR, the No Action/No Project Alternative is the basis of comparison, as required by NEPA. The CEQ (1997) recommends that the following three factors be considered in the environmental justice analysis to determine whether disproportionately high and adverse impacts may accrue to minority or low-income populations: (1) whether there is or would be an impact on the natural or physical environmental that significantly and adversely affects a minority population, low-income population, or Indian tribe; such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural environment; (2) whether the environmental effects are significant and are having or may be having an adverse impact on minority populations, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and (3) whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

[5] Impacts from implementation of Mitigation Measure REC-1 and REC-2 are evaluated in Section 4.1.6, 4.9.6, and 4.14.6.

Appendix I includes the existing regional and local-level demographic and economic characteristic census data, including race, ethnicity, income, and poverty for the SLLPIP environmental justice area of analysis.

4.18.2 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Under the No Action/No Project Alternative, no construction activities associated with the SLLPIP would occur; therefore, none of the minority or low-income populations would be exposed to adverse effects or hazards from project-related construction. **The No Action/No Project Alternative would not have an adverse or disproportionate effect on minority and low-income populations.**

4.18.3 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

All construction activities under Alternative 2 would take place in Merced County. At the regional level, Merced County has been identified as a minority affected area. At the local level, the communities nearby San Luis Reservoir, including Gustine, Ingomar and Volta (Census Tract 20); San Luis Reservoir SRA and Santa Nella (Census Tract 21); and Los Banos (Census Tracts 22.01, 22.02, 23.01, and 23.02), have also been identified as a minority affected area. Census Tract 22.01 was identified as a low-income affected area in the San Luis Reservoir region. These construction activities would result in significant air quality, noise, and traffic and transportation impacts. However, any potential effects from construction would be temporary and would be reduced by mitigation measures discussed in Sections 4.7.8, 4.10.8, and 4.11.8. Following implementation of the mitigation measures, temporary construction effects associated with construction noise could have an adverse effect on minority populations in the San Luis Reservoir region and low-income population group in Census Tract 22.01. These effects would however be shared across all inhabitants of the communities that all support similar income and minority demographics. As a result, these construction effects would not be disproportionately focused on any low-income and minority affected areas in the study area. Alternative 2 would have a temporarily adverse effect on minority and low-income populations but those effects would not be disproportionately focused on these populations.

4.18.4 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

At the regional level, Santa Clara County has been identified as a minority affected area. At the local level, the Santa Teresa WTP Census Tract 5119.11 has not been identified as a minority affected area. No low-income affected areas were identified at either the regional or local levels. Potential effects from construction associated with Alternative 3 include air quality, noise, and traffic impacts. However, any potential effects from construction would be temporary and would be reduced by mitigation measures discussed in Sections 4.7.8, 4.10.8, and 4.11.8. Following implementation of the mitigation measures, temporary construction effects associated with Alternative 3 would be reduced to a less than significant level and not have an adverse effect on minority populations in Santa Clara County. In addition, these effects would be shared across all inhabitants of the communities that all support similar income and minority demographics. Alternative 3 would not have an adverse effect on minority and low-income populations.

4.18.5 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

At the regional level, Merced County has been identified as a minority affected area. At the local level, the San Luis Reservoir region (Census Tract 20; Census Tract 21; and Census Tracts 22.01, 22.02, 23.01, and 23.02) has also been identified as a minority affected area. Census Tract 22.01 was identified as a low-income affected area in the San Luis Reservoir region. Construction activities under Alternative 4 would result in significant air quality, noise, and traffic and transportation impacts. Potential effects from construction would be temporary and would be reduced by mitigation measures discussed in Sections 4.7.8, 4.10.8, and 4.11.8. Following implementation of the mitigation measures described in these sections, temporary construction effects associated with air quality and noise have an adverse effect on minority populations in the San Luis Reservoir region and low-income population group in Census Tract 22.01. These effects would however be shared across all inhabitants of the communities that all support similar income and minority demographics. As a result, these construction effects would not be disproportionately focused on any low-income and minority affected areas in the study area. Alternative 4 would have a temporarily adverse effect on minority and low-income populations but those effects would not be disproportionately focused on these populations.

4.18.6 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

At the regional level, Santa Clara County has been identified as a minority affected area. At the local level, the Pacheco Reservoir region has not been identified as a minority affected area. Construction activities under Alternative 5 would result in significant air quality, noise, and traffic and transportation impacts. Potential effects from construction would be temporary and would be reduced by mitigation measures discussed in Sections 4.7.8, 4.10.8, and 4.11.8. Following implementation of the mitigation measures described in these sections, temporary construction effects associated with air quality and noise could cause an adverse effect on minority populations in Santa Clara County. These effects would however be shared across all inhabitants of the communities that all support similar income and minority demographics. As a result, these construction effects would not be disproportionately focused on any low-income and minority affected areas in the study area. Alternative 5 would have a temporarily adverse effect on minority and low-income populations but those effects would not be disproportionately focused on these populations.

4.19 Public Utilities Services, and Power

4.19.1 Assessment Methods

Impacts to public services, utilities, and power resources could occur during construction of the action alternatives due to the use of construction equipment. The significance of these impacts is assessed qualitatively. Potential long-term impacts to energy use and power in the area of analysis could result from changes in water supply sources and the operation of water supply facilities. These changes are analyzed based on the energy impact guidance in CEQA Appendix F: Energy Conservation.

4.19.2 Significance Criteria

Impacts related to public utilities, services, and power would be considered significant if the project would: (1) result in substantial adverse physical or environmental impacts associated with the provision of new or physically altered governmental services or facilities including fire protection, police protection, and schools; (2) require or result in the relocation or construction of new or expanded water, wastewater, or stormwater treatment/drainage facilities, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects; (3) result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments; (4) generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals; (5) comply with federal, state, and local management and reduction statutes and regulations related to solid waste; (6) result in adverse effects related to the depletion of local or regional energy supplies; (7) result in significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation; or (8) conflict with or obstruct a state or local plan for renewable energy or energy efficiency. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-21.

4.19.3 Environmental Consequences/Environmental Impacts of Alternative 1 – No Action/No Project Alternative

Under the No Action/No Project Alternative, current operations at the San Luis Reservoir would remain unchanged. No construction activities would result in adverse impacts related to the provision of new or physically altered governmental facilities. The No Action/No Project Alternative would not require new water, wastewater, or stormwater facilities to be constructed. Further, the No Action/No Project Alternative would not produce solid waste and would not result in increased energy use or the need for additional energy supply capacity. **There would be no impacts related to public utilities, services, energy, or power in the area of analysis.**

Table 4-21. Public Utilities, Services, and Power Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Substantial adverse physical or environmental impacts associated with the provision of new or physically altered governmental services or facilities including fire protection, police protection, and schools.	Evaluation of how the alternatives could potentially affect governmental services, such as emergency services during construction	1	NI	--	Section 4.19.3
		2	LTS (Short-term)	None	Section 4.19.4
		3	LTS (Short-term)	None	Section 4.19.5
		4	LTS	None	Section 4.19.6
		5	LTS	None	Section 4.19.7
Require or result in the relocation or construction of new or expanded water, wastewater, or stormwater treatment/drainage facilities, natural gas, or telecommunications facilities	Evaluation of how the alternatives could potentially generate increased water demands, water treatment, or an expansion of wastewater treatment facilities.	1	NI	--	Section 4.19.3
		2	LTS (Short-term)	None	Section 4.19.4
		3	LTS (Short-term)	None	Section 4.19.5
		4	LTS	None	Section 4.19.6
		5	LTS	None	Section 4.19.7
Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments	Evaluation of each alternatives potential to increase wastewater and its effect on the exiting wastewater treatment system.	1	NI	--	Section 4.19.3
		2	LTS (Short-term)	None	Section 4.19.4
		3	LTS (Short-term)	None	Section 4.19.5
		4	LTS	None	Section 4.19.6
		5	LTS	None	Section 4.19.7
Construction activities would generate solid waste, the disposal of which could exceed the capacity of landfills designated to accommodate the project's solid waste disposal needs	Evaluation of each alternative's potential to generate solid waste and compare those numbers against the remaining capacity at the local landfill.	1	NI	--	Section 4.19.3
		2	LTS (Short-term)	None	Section 4.19.4
		3	LTS	None	Section 4.19.5
		4	LTS	None	Section 4.19.6
		5	LTS	None	Section 4.19.7

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Comply with federal, state, and local management and reduction statutes and regulations related to solid waste	Evaluation of whether construction or operation of the alternatives could conflict with or obstruct federal, state, and local management and reduction statutes and regulations related to solid waste	1	NI	--	Section 4.19.3
		2	NI	None	Section 4.19.4
		3	NI	None	Section 4.19.5
		4	NI	None	Section 4.19.6
		5	NI	None	Section 4.19.7
Adverse impacts associated with the use and/or depletion of local or regional energy supplies.	Evaluation of each alternative's potential power demands on the local power supply and compare those demands against the capacity of local medium voltage distribution lines.	1	NI	--	Section 4.19.3
		2	LTS (Short-term)	None	Section 4.19.4
		3	LTS (Short-term)	None	Section 4.19.5
		4	LTS	None	Section 4.19.6
		5	LTS	None	Section 4.19.7
Result in significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation	Evaluation of each alternative's energy consumption against the period of consumption.	1	NI	--	Section 4.19.3
		2	LTS	None	Section 4.19.4
		3	LTS	None	Section 4.19.5
		4	LTS	None	Section 4.19.6
		5	LTS	None	Section 4.19.7
Conflict with or obstruct a state or local plan for renewable energy or energy efficiency	Evaluation of whether construction or operation of the alternatives could conflict with or obstruct a state or local plan for renewable energy or energy efficiency	1	NI	--	Section 4.19.3
		2	NI	None	Section 4.19.4
		3	NI	None	Section 4.19.5
		4	NI	None	Section 4.19.6
		5	NI	None	Section 4.19.7

Key: Alt = alternative; LTS = less than significant; NI = no impact; W = with; WO = without

4.19.4 Environmental Consequences/Environmental Impacts of Alternative 2 – Lower San Felipe Intake Alternative

Construction activities would require the presence of workers and, in the case of an emergency situation, could require emergency services from local fire or police responders. However, emergency response or remediation and containment plans would be implemented, if required, and OSHA standards would be maintained. The construction workforce would be expected to be drawn from the local area and, for some staff, non-local construction workers who would establish temporary residence. Given the short-term construction schedule, the alternative would not generate a considerable influx of new permanent residents. Thus, there would not be substantial adverse impacts related to the need for governmental services or facilities.

Construction activities would not generate increased demands for water supply, would not result in the need for additional water treatment, and would not result in the production of significant amounts of wastewater that would exceed the capacity of existing wastewater treatment facilities. Alternative 2 would require the transport and disposal of approximately 1,200 cubic yards of construction waste at the closest solid waste landfill, the Billy Wright Landfill, which has a remaining capacity of 11,370,000 cubic yards (CalRecycle 2016d). Given the need for less than 1 percent of the remaining capacity at the landfill, there would be adequate capacity to serve solid waste disposal needs for construction of the alternative. The use of the disposal sites would constitute an irreversible and irretrievable commitment of resources. Potable water and wastewater handling capacity demands generated by construction activities and the presence of construction workers would be met by existing local facilities and temporary/portable drinking water and waste disposal facilities brought on site and serviced by the Lead Agencies. The alternative includes stormwater runoff controls if it is expected that runoff after construction would exceed the capacity of the current stormwater drainage system. The implementation of Mitigation Measure WQ-1 would control stormwater runoff and associated soil erosion and would adequately treat anticipated stormwater runoff generated at the reservoir during construction.

Power for construction activities would be provided by portable generators. Thus, construction activities would not cause stress to, or lead to the depletion of existing power supplies at the reservoir. Construction would increase energy consumption in the form of fuel use increases from the operation of construction equipment and vehicle trips to/from the construction sites. Approximately 55 million gallons of diesel fuel and 65,000 gallons of gasoline could be used during construction activities if the tunnel option is selected, whereas 38 million gallons of diesel fuel and 29,000 gallons of gasoline would be used if the pipeline option is selected. Although construction would consume energy resources, construction activities would be temporary and would cease at the end of construction; therefore, there would be no long-term energy impacts associated with construction, construction equipment and vehicles would comply with applicable regulatory requirements that limit energy consumption, and construction would not result in wasteful, inefficient or unnecessary consumption of energy. In addition, implementation of Mitigation Measures AQ-1 and AQ-2, described in Section 4.7.8., would require all on-site equipment and off-site vehicles to meet strict emissions requirements, which would help to avoid potentially wasteful fuel use during construction.

Under the alternative, given the movement of the intake to a lower elevation, water would have to be pumped a greater vertical distance, compared to existing conditions, to reach the Pacheco Pumping Plant to be transported to the San Felipe Division facilities. This increased pumping is necessary to help SCVWD avoid water supply interruptions from low point-generated water quality concerns. Operation of the alternative would include the hypolimnetic aeration system to improve reservoir oxygen levels during low point conditions and is necessary to avoid water supply interruptions. This aeration system would be designed to maximize efficiency and avoid additional power demands that would exceed local supplies. Changes in operation of the Pacheco Pumping Plant and impacts from operation of the hypolimnetic aeration facility would not result in the need for additional energy supplies and would not result in the substantial depletion of local or regional energy supplies. Changes in operation of the Pacheco Pumping Plant would increase electricity use by nearly 2 million megawatts-hours per year. Additionally, impacts from operation of the hypolimnetic aeration facility could increase electricity usage by 360,000 kilowatt-hours per year if air compressors are used or diesel fuel consumption could increase by 711 gallons per year if trucks are used to deliver liquid oxygen. In its *2018 Integrated Resource Plan* (IRP), Pacific Gas & Electric (PG&E) outlined adequate electricity supply and transmission capabilities to meet the needs of its customers through 2030. In its Preferred Scenario, PG&E's projection for its total load is 36,922 GWh by 2030, and its total projected energy supply is 36,922 GWh (PG&E 2018) of which the utility forecasts it will purchase approximately 12,000 GWh in the open power market. The California Energy Commission (CEC) forecasts that total statewide energy demand in 2030 will be between 326,026 and 354,209 GWh (CEC 2018). The Lower San Felipe Intake Alternative would generate on average approximately 2,360 GWh in new demand annually or less than 1% of the total 2030 forecast statewide demand, and an approximately 20% increase in the power planned for purchase by PG&E for its service area in 2030. In 2017, California total system electric generation was 292,039 GWh which is projected to increase to between 333,224 and 360,812 GWh (CEC 2019). This increased capacity would be sufficient to supply the increase in demand generated by the Lower San Felipe Intake Alternative in combination with the statewide demand projections. Therefore, given the new power demand generated by this alternative in comparison to the projected power capacities in the study area noted above, this alternative would not result in the substantial depletion of local or regional energy supplies. Further, operation of this alternative would not result in wasteful, inefficient or unnecessary consumption of energy. **Alternative 2 would have less than significant impacts to public utilities, services, energy, or power in the area of analysis.**

Construction and operation of Alternative 2 would not conflict with the goals and strategies of the California Energy Efficiency Strategic Plan (California Public Utilities Commission 2011). Disposal of construction waste under Alternative 2 would comply with federal, state, and local statutes and regulations related to solid waste. **Alternative 2 would have no impact on federal, state or local plans and regulations related to solid waste or energy efficiency.**

4.19.5 Environmental Consequences/Environmental Impacts of Alternative 3 – Treatment Alternative

Construction activities would require the presence of workers, and in the case of an emergency situation, could require emergency services from local fire or police responders. However, the impact of hazardous conditions during construction would be less than significant with the implementation of safety measures through the National Pollutant Discharge Elimination System (NPDES) permit and BMPs for transporting, storing, or using any hazardous construction materials. In addition, OSHA standards would be maintained during construction to protect worker safety. The construction workforce would be expected to be drawn from the local area and, for some staff, non-local construction workers who would establish temporary residence. Given the short-term construction schedule, the alternative would not generate a considerable influx of new permanent residents. Thus, there would not be substantial adverse impacts related to the need for governmental services or facilities.

Construction activities would not generate increased demands for water supply, would not result in the need for additional water treatment, and would not result in the production of significant amounts of wastewater that would exceed the capacity of existing wastewater treatment facilities. Alternative 3 would require the transport and disposal of approximately 7,000 cubic yards of construction waste at the closest solid waste landfill, the Guadalupe Sanitary Landfill, which has a remaining capacity of 11,055,000 cubic yards (CalRecycle 2016d). Given the need for less than 1 percent of the remaining capacity at the landfill, there would be adequate capacity to serve solid waste disposal needs for construction of the alternative. Potable water and wastewater handling capacity demands generated by construction activities and the presence of construction workers would be met by existing local facilities and temporary/portable drinking water and waste disposal facilities brought on site and serviced by the Lead Agencies and no additional stormwater control structures would be required in the SCVWD service area. In addition, implementation of Mitigation Measure WQ-1 would control stormwater runoff and associated soil erosion would control and treat anticipated stormwater runoff generated during construction.

Construction would be temporary and energy resources used during construction would be supplied by the contractor. Construction and operation of Alternative 3 would increase energy consumption from the use of temporary on-site generators and vehicle fuels and electricity use during operation of the alternative from increased production of ozone onsite. Approximately 16 million gallons of diesel fuel and 12,000 gallons of gasoline would be used during construction activities. Although construction would consume energy resources, construction activities would be temporary and would case at the end of construction; therefore, there would be no long-term energy impacts associated with construction. Energy used during construction and operation of the alternative would not interfere with surrounding residential, commercial, or industrial energy supplies and use.

Alternative 3 would increase total ozone generation capacity at the Santa Teresa WTP which when used to respond to low point-generated water quality concerns would increase total power use. The capacity for this additional ozone generation would be met using existing excess electrical capacity available at the plant through the existing service connection. Alternative 3 would also increase the number of liquid oxygen deliveries to the WTP to support this increase ozone generation which would increase fuel use. Diesel and gasoline fuel use would negligibly increase by nearly 300 and 60 gallons, respectively, during operations.

Final implementation of Alternative 3 includes recommended pilot testing of the raw water ozonation technology. During pilot testing, the electrical system capacity at the Santa Teresa

WTP would be analyzed in greater detail to understand any necessary upgrades. These technologies do not add significantly to the electrical demands of the water treatment processes and would not result in adverse effects related to the depletion of local or regional energy supplies.

Long-term operation of the Santa Teresa WTP would not differ significantly from existing operations at this site. Operations of the alternative would not detrimentally affect public safety or result in increased risks to workers and would not lead to population increases. Implementation of the alternative would not result in the WTP treating a higher volume of water, and there would be no need for additional water or wastewater treatment facilities outside of the technology retrofits. Additionally, long-term operations would not result in a substantial increase in stormwater runoff that would exceed the capacity of the existing stormwater drainage system. Improvements at the WTP include ballasted clarification, resulting in dried sludge recovered through the treatment process, which would be disposed of in a local landfill. There would be adequate landfill capacity to serve solid waste disposal. The use of the disposal sites would constitute an irreversible and irretrievable commitment of resources.

Alternative 3 would allow the San Felipe Division to draw water from the San Luis Reservoir from a lower elevation during conditions of high algae concentrations. This increased pumping is necessary to help SCVWD avoid water supply interruptions from low point generated water quality concerns. Although the exact amount of pumping was not quantified, PG&E indicated in its 2018 IRP that it has adequate electricity supply and transmission capabilities to meet the needs of its customers through 2030. Changes in operation of the Pacheco Pumping Plant and associated facilities, resulting from the ability to withdraw water from a lower elevation, would not result in the substantial depletion of local or regional energy supplies. Also, operation of this alternative would not result in wasteful, inefficient or unnecessary consumption of energy. **Alternative 3 would have less than significant impacts to public utilities, services, energy, or power in the area of analysis.**

Construction and operation of Alternative 3 would not conflict with the goals and strategies of the California Energy Efficiency Strategic Plan. Disposal of construction waste under Alternative 3 would comply with federal, state, and local statutes and regulations related to solid waste. **Alternative 3 would have no impact on federal, state or local plans and regulations related to solid waste or energy efficiency.**

4.19.6 Environmental Consequences/Environmental Impacts of Alternative 4 – San Luis Reservoir Expansion Alternative

Construction activities would require the presence of workers and, in the case of an emergency situation, could require emergency services from local fire or police responders. However, emergency response or remediation and containment plans would be implemented, if required, and OSHA standards would be maintained. It is expected that 25 percent or 54 workers would be non-local construction workers who would establish temporary residence, which would not result in a long-term impact on public schools. Thus, there would not be substantial adverse impacts related to the need for governmental services or facilities.

Construction activities would not generate increased demands for water supply and would not result in the need for additional water treatment or expansion of wastewater treatment facilities. Alternative 4 would require the transport and disposal of approximately 455 cubic yards of construction waste at the closest solid waste landfill, the Billy Wright Landfill, which has a remaining capacity of 11,370,000 cubic yards (CalRecycle 2016d). Given the need for less than 1 percent of the remaining capacity at the landfill, there would be adequate capacity to serve solid waste disposal needs for construction of the alternative. The use of the disposal sites would constitute an irreversible and irretrievable commitment of resources. Potable water and wastewater handling capacity demands generated by construction activities and the presence of construction workers would be met by existing local facilities and temporary/portable drinking water and waste disposal facilities brought on site and serviced by the Lead Agencies. The implementation of Mitigation Measure WQ-1 would control stormwater runoff and associated soil erosion and would adequately treat anticipated stormwater runoff generated at the reservoir during construction. Temporary BMPs would be provided around stockpiles and dust control watering would be managed to avoid excess water from running off site. The alternative includes planned permanent stormwater control structures to be constructed at the dam, the impacts of which are analyzed in other resource sections of this EIS/EIR.

During construction, temporary power facilities would be needed for construction equipment, welding, and trailers. Of these new power demands, only the construction trailers would require connection via temporary distribution lines connected to existing local power supply lines at the Gianelli Pumping Plant and Pacheco Pumping Plant; power for all of the other construction demands would be supported through portable or trailer mounted generators. The new power demand generated by the construction trailers would be similar to a small residential home and would not exceed the capacity of the medium voltage distribution lines that serve power connections in the study area. Thus, construction activities would not cause stress to, or lead to the depletion of existing power supplies at the reservoir. Construction of Alternative 4 would increase energy consumption in the form of fuel use increases. Approximately 138 million gallons of diesel and nearly 2 million gallons of gasoline could be used during construction activities. Although construction would consume energy resources, construction activities would be temporary and would cease at the end of construction and construction equipment and vehicles would comply with applicable regulatory requirements that limit energy consumption; therefore, there would be no long-term energy impacts associated with construction and would not result in wasteful, inefficient or unnecessary consumption of energy. In addition, implementation of Mitigation Measures AQ-1 and AQ-2, described in Section 4.7.8., would require all on-site equipment and off-site vehicles to meet strict emissions requirements, which would help to avoid potentially wasteful fuel use during construction.

Long-term operations of Alternative 4 would not change the water supply processes currently in place at the reservoir. Water exported from the Delta by the CVP and SWP would continue during periods when supply is in excess of demand for delivery later when demand increases would continue. As a result, there would be no long-term impacts to governmental services and facilities, water supply and wastewater infrastructure, or solid waste generation and disposal.

Operation would increase demand on the existing pumps at the Gianelli Pumping Plant in years when the new reservoir space is filled. Overall, changes in operation of the Gianelli Pumping

Plant resulting from the ability to fill an additional 120,000 AF in the San Luis Reservoir would result in the need for additional energy supplies. However, this energy could be partially recaptured when water is released back into the forebay. In addition, the projected frequency of this new storage capacity being filled is infrequent. On average this increase in power demand is projected to be 42,899,932 kWh/yr. In years when it is filled, the existing 10,600 megawatts of production capacity in the Western Area Power Administration (WAPA) system can meet this increased demand. Operation also would increase electricity use at the Pacheco Pumping Plant given the increases in the total amount of water pumped. The increased pumping at the Pacheco Pumping Plant is necessary to help SCVWD avoid water supply interruptions from low point-generated water quality concerns. **Alternative 4 would have less than significant impacts to public utilities, services, energy, or power in the area of analysis.**

Construction and operation of Alternative 4 would not conflict with the goals and strategies of the California Energy Efficiency Strategic Plan. Disposal of construction waste under Alternative 4 would comply with federal, state, and local statutes and regulations related to solid waste. **Alternative 4 would have no impact on federal, state or local plans and regulations related to solid waste or energy efficiency.**

4.19.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Construction activities would require the presence of workers and, in the case of an emergency situation, could require emergency services from local fire or police responders. However, emergency response or remediation and containment plans would be implemented, if required, and OSHA standards would be maintained. It is expected that 25 percent or 119 workers would be non-local construction workers who would establish temporary residence, which would not result in a long-term impact on public schools. Thus, there would not be a substantial adverse impact related to the need for governmental services or facilities.

Construction and operation of Alternative 5 would not generate increased demands for water supply and would not result in the need for additional water treatment or expansion of wastewater treatment facilities. The majority of waste generated from site demolition and modifications would be recycled at a concrete or asphalt batching facility. Additional solid non-recyclable waste generated from construction and contractor activities would be transported to the nearest solid waste facility, the Billy Wright Landfill, which has a remaining capacity of 11,370,000 cubic yards (CalRecycle 2016d). There would be adequate capacity to serve solid waste disposal needs for construction of the alternative. The use of the disposal sites would constitute an irreversible and irretrievable commitment of resources. Potable water and wastewater handling capacity demands generated by construction activities and the presence of construction workers would be met by existing local facilities and temporary/portable drinking water and waste disposal facilities brought on site and serviced by the Lead Agencies. Temporary BMPs would be provided around stockpiles and dust control watering would be managed to avoid excess water from running off site. In addition, the implementation of Mitigation Measure WQ-1 would control stormwater runoff and associated soil erosion and would adequately treat anticipated stormwater runoff generated at the reservoir during construction. No additional stormwater control structures would be required.

Construction of Alternative 5 would increase energy consumption in the form of fuel use increases from the operation of construction equipment and vehicle trips to/from the construction sites. Approximately 20 million gallons of diesel fuel and 2 million gallons of gasoline could be used during construction activities. Although construction would consume energy resources, construction activities would be temporary and would cease at the end of construction and construction equipment and vehicles would comply with applicable regulatory requirements that limit energy consumption; therefore, there would be no long-term energy impacts associated with construction and would not result in wasteful, inefficient or unnecessary consumption of energy. During construction, portable or trailer-mounted generators would be used and would not cause stress to, or lead to the depletion of, existing power supplies. In addition, implementation of Mitigation Measures AQ-1 and AQ-2, described in Section 4.7.8., would require all on-site equipment and off-site vehicles to meet strict emissions requirements, which would help to avoid potentially wasteful fuel use during construction.

Under the alternative, water would have to be pumped a greater vertical distance, compared to existing conditions, to be transported to the Pacheco Reservoir and the San Felipe Division facilities. This increased pumping is necessary to help SCVWD avoid water supply interruptions from low point-generated water quality concerns. The expanded Pacheco Reservoir Pump Station would serve as a two-way pump station that delivers water to and withdraws water from the Pacheco Reservoir. The existing 70 kilovolt (kV) PG&E transmission line would need to be upgraded to support the additional load of 1,960,404 kilowatt hours per year required by the new pump station. This upgrade is further described in Chapter 2 and associated impacts are analyzed throughout this document. The pump station would consist of eleven pumps (10 duty and 1 standby). The pump motors would be sized for the first operating range (higher lift) at 1,250 hp or 932 kW each (13,750 total hp or 10,253 total kW). The existing production capacity in the PG&E system can meet this increased demand, as indicated in the 2018 IRP. Changes in operation of the Pacheco Pumping Plant and Pacheco Reservoir would not result in the substantial depletion of local or regional energy supplies. Further, operation of this alternative would not result in wasteful, inefficient or unnecessary consumption of energy. **Alternative 5 would have less than significant impacts to public utilities, services, energy, or power in the area of analysis.**

Construction and operation of Alternative 5 would not conflict with the goals and strategies of the California Energy Efficiency Strategic Plan. Disposal of construction waste under Alternative 5 would comply with federal, state, and local statutes and regulations related to solid waste. **Alternative 5 would have no impact on federal, state or local plans and regulations related to solid waste or energy efficiency.**

4.20 Cultural Resources

4.20.1 Assessment Methods

Section 106 of the NHPA requires Federal agencies to consider the effects of their undertakings on historic properties, or cultural resources listed or eligible for listing in the NRHP, and affords the ACHP an opportunity to comment on such undertakings. Implementing regulations under 36

CFR Part 800 outline steps that must be taken to comply with Section 106 of the NHPA. The criteria for evaluating cultural resources for listing in the NRHP are defined at 36 CFR Part 60.4. A formal determination of NRHP eligibility is made when the State Historic Preservation Officer (SHPO) concurs with an evaluation made by the Federal Lead Agency. Alternatively, the evaluation of a historic property may be submitted to the Keeper of the NRHP for a formal determination of NRHP eligibility. The analysis of potential impacts to historic properties employs the criteria of adverse effect, which is defined under 36 CFR Part 800.5. Adverse effects can occur when an undertaking alters, directly or indirectly, any of the characteristics of a historic property that qualify it for inclusion in the NRHP in a manner that diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. As outlined under 36 CFR Part 800.6, the resolution of adverse effects to historic properties under Section 106 of the NHPA requires consultation with appropriate parties to seek ways to avoid, minimize, or mitigate adverse effects and calls for the execution of a formal agreement (Memorandum of Agreement or Programmatic Agreement) with the SHPO and other parties to govern implementation of the undertaking.

CEQA requires State and local public agencies to identify potential impacts to historical resources, or cultural resources listed or eligible for listing in the CRHR, and to determine if those impacts would be significant. CEQA further requires State and local public agencies to identify alternatives and mitigation measures that would substantially reduce or eliminate significant impacts to historical resources. Similar provisions are established for unique archaeological resources under PRC Section 21083.2(b) and for tribal cultural resources under PRC Section 21084.3. Pursuant to PRC Section 21084.1, an impact is considered significant if a project would cause a substantial adverse change in the significance of a historical resource. The criteria for evaluating cultural resources for listing in the CRHR are based on NRHP criteria and are defined at PRC Section 5024.1. A resource is listed in the CRHR once an eligibility nomination has been reviewed by the SHPO and approved by the California State Historical Resources Commission.

4.20.2 Significance Criteria

For the purposes of the SLLPIP EIS/EIR, impacts would be significant if they would result in adverse effects to historic properties listed or eligible for listing in the NRHP; result in substantial adverse changes to historical resources, unique archaeological resources, or tribal cultural resources listed or eligible for listing in the CRHR; or disturb human remains, including those interred outside of formal cemeteries. These criteria, associated significance determinations, mitigation measures, and references to the location of supporting evaluations for these determinations are detailed in Table 4-22.

Table 4-22. Cultural Resources Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Result in adverse effects to historic properties listed or eligible for listing in the NRHP, and/or substantial adverse changes to historical resources, unique archaeological resources, or tribal cultural resources listed or eligible for listing in the CRHR or result in the disturbance of human remains	Evaluation of how implementation of the alternatives would adversely affect or change known or previously undiscovered significant cultural resources	1	NI	-	Section 4.20.3
		2	S, SU	CR-1, CR-2, CR-3	Section 4.20.4 Appendix K
		3	NI	None	Section 4.20.5 Appendix K
		4	S, SU	CR-1, CR-2, CR-3	Section 4.20.6 Appendix K
		5	S, SU	CR-1, CR-2, CR-3	Section 4.20.7 Appendix K

Key: Alt = alternative; B = beneficial; LTS = less than significant; NI = no impact; S = Significant; SU = significant and unavoidable; W = with; WO = without

4.20.3 Environmental Consequences/Environmental Impacts of Alternative 1 - No Action/No Project Alternative

Under Alternative 1, the Project would not be implemented, and no impacts associated with new or expanded facilities would occur. SCVWD would continue O&M of its existing facilities, and current operations at the San Luis Reservoir would remain unchanged. Alternative 1 would have **no impact** on cultural resources (including historical resources, unique archaeological resources, tribal cultural resources, or human remains).

4.20.4 Environmental Consequences/Environmental Impacts of Alternative 2 - Lower San Felipe Intake Alternative

Archival and records searches and inventory surveys revealed 16 archaeological sites (some of which may also be tribal cultural resources and contain human remains) or built environment resources within the Alternative 2 APE, including eight historic period roads (CA-MER-487H, CA-MER-488H, CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, CA-MER-495H, and P-24-001822); two historic period debris scatters (CA-MER-485H and CA-MER-490H); a historic period industrial site (CA-MER-492H) associated with construction of the B.F. Sisk Dam; a historic period transmission pole alignment and debris scatter (CA-MER-484H); a historic period earthen dam (CA-MER-486H); a historic period earthen dam and stock pond with a prehistoric lithic scatter (CA-MER-26/H); a prehistoric lithic scatter with midden and human remains (CA-MER-94); and a commemorative historical plaque (P-24-000643/CHL 829). Inventory surveys failed to reveal surface evidence of a historic period district (P-24-001856/San Luis Gonzaga Rancho Historic District) and a prehistoric district (P-24-000489/San Luis Gonzaga Archaeological District) that overlapped portions of the Dinosaur Point staging area and access road. Three previously recorded cultural resources were not relocated because they were inundated (CA-MER-8 and CA-MER-17) or capped with fill soil (CA-MER-27). The San Luis Gonzaga Archaeological District (P-24-000489) has been listed in the NRHP and CRHR, and the historical plaque (P-24-000643/CHL 829) is listed in the CRHR.

Certain areas within the Alternative 2 APE remained inaccessible to inventory survey due to inundation or extreme slope, and those portions of the APE would likely not be used as staging or stockpiling locations. Also, inundated portions of the APE at Gate Shaft Island would likely not be used during construction of the vertical shaft. Cultural resources within stockpile or staging areas can likely be avoided and would not be subject to direct impacts, while cultural resources that comprise or are situated near roads would likely be impacted as a result of road use or improvement under Alternative 2. The presence or location of cultural resources within the Alternative 2 APE for the new intake structure and underwater pipeline or tunnel option areas cannot be determined, as these areas are and would remain inundated.

The implementation of Alternative 2 is expected to impact eight historic period roads (CA-MER-487H, CA-MER-488H, CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, CA-MER-495H, and P-24-001822) and one historic period debris scatter adjacent to a road (CA-MER-490H) that have all been recommended not eligible for listing in the NRHP and CRHR (see Appendix K). The CRHR-eligible historical plaque (P-24-000643/CHL 829) would be avoided by construction of the proposed aeration facility. One prehistoric site (CA-MER-94) recommended eligible for listing in the NRHP and CRHR and one site with prehistoric and historic period components (CA-MER-26/H) that could not be fully evaluated without further information lie within staging or stockpiling areas. The prehistoric site (CA-MER-94), though not previously identified as such, may be considered a tribal cultural resource per PRC Section 20174 based on the presence of known human remains. Both sites can likely be avoided and have a low likelihood of being impacted by Alternative 2.

The proposed Alternative 2 intake would be constructed while the base of the San Luis Reservoir remains inundated. Known and unknown cultural resources within the underwater pipeline or tunnel option areas cannot currently be identified, evaluated, or mitigated. One prehistoric resource that could not be relocated (CA-MER-8) was recorded near the proposed intake structure associated with the underwater pipeline or tunnel option; it has not been evaluated for listing in the NRHP or CRHR.

Compared to existing conditions and the No Action/No Project Alternative, **impacts to cultural resources (including historical resources, unique archaeological resources, tribal cultural resources, and/or human remains) would be significant due to substantial adverse effects** under Alternative 2. These **impacts would be reduced through implementation of Mitigation Measure CR-1, CR-2, and CR-3,** though these **impacts would be significant and unavoidable** despite mitigation efforts (see Section 4.20.8).

4.20.5 Environmental Consequences/Environmental Impacts of Alternative 3 - Treatment Alternative

No new or expanded facilities are proposed under Alternative 3, and all technological retrofits would be made within the existing footprint of the Santa Teresa WTP. An archival and records search and an inventory survey revealed no archaeological or built environment resources within the Alternative 3 APE, and the likelihood of encountering previously undiscovered cultural resources during implementation of the alternative is considered extremely low (see Appendix K). Compared to existing conditions and the No Action/No Project Alternative, there would be **no impacts** to known historic properties, historical resources, or other cultural resources under Alternative 3.

4.20.6 Environmental Consequences/Environmental Impacts of Alternative 4 - San Luis Reservoir Expansion Alternative

Archival and records searches and inventory surveys revealed 28 archaeological sites (some of which may also be tribal cultural resources and contain human remains) or built environment resources within the Alternative 4 APE, including the B.F. Sisk Dam and its key features; three sites associated with the construction (CA-MER-492H and CA-MER-509H) or maintenance (CA-MER-520H) of the dam; eight historic period roads (CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, CA-MER-495H, CA-MER-513H, CA-MER-519H, and P-24-001822); transmission line poles with a debris scatter (CA-MER-484H); two historic period livestock watering locales (CA-MER-511H and CA-MER-521H); three earthen dams with impound ponds (CA-MER-515H, CA-MER-516H, and CA-MER-518H); a concrete equipment pad (CA-MER-510H); a helicopter pad (CA-MER-512H); a historic period ditch (CA-MER-514H); six prehistoric midden sites (CA-MER-15, CA-MER-28, CA-MER-82, CA-MER-83, CA-MER-130, and CA-MER-517), most with lithics and groundstone; and a prehistoric district (P-24-000489/San Luis Gonzaga Archaeological District). Eleven cultural resources previously recorded in Alternative 4 APE were not relocated during inventory surveys. These included seven prehistoric sites along the reservoir shoreline (CA-MER-20, CA-MER-21, CA-MER-22, CA-MER-23, CA-MER-27, CA-MER-29, and CA-MER-41); two prehistoric sites (CA-MER-136 and CA-MER-137) in the Cottonwood Bay area, which was inaccessible in 2016; and one historic period ranch complex (CA-MER-451H), which was in an area added to the APE after the 2016 inventory survey was completed. The prehistoric San Luis Gonzaga Archaeological District (P-24-000489) and one of its contributing sites (CA-MER-130) are listed in the NRHP and CRHR. The other prehistoric sites noted above that were relocated have not been evaluated pending further investigation. The B.F. Sisk Dam and its key features have been recommended eligible for listing in the NRHP and CRHR (JRP 2018). Seven historic period resources (CA-MER-510H, CA-MER-511H, CA-MER-512H, CA-MER-513H, CA-MER-514H, CA-MER-520H, and CA-MER-521H) have been determined not eligible for listing in the NRHP and CRHR while the remaining historic period resources noted above have all been recommended not eligible for inclusion in either register (see Appendix K).

Some areas within the Alternative 4 APE remained inaccessible to inventory survey in 2016 because of safety constraints, inundation, or a lack of access permissions while other areas were added to the APE subsequent to the inventory survey. Also, those portions of the APE that remained inundated would likely not be used as staging, stockpiling, or borrow locations under Alternative 4, though some areas (e.g., along the base of the existing dam) may be capped by fill materials or subject to stabilization measures. Cultural resources within potential construction staging areas may be avoided and would have a low likelihood of being impacted, though resources located within the Basalt Hill borrow area, Borrow Area 6, Cottonwood Bay levee modification and levee raise areas, the Dinosaur Point boat launch modification area, fill impact areas, and haul road or Highway 152 impact areas would have a higher likelihood of being impacted (see Appendix K). Cultural resources along the expanded reservoir shoreline, particularly those with portable surface artifacts, may be impacted by wave action and fluctuating water levels under Alternative 4.

The B.F. Sisk Dam, which has been recommended eligible for listing in the NRHP and CRHR as a part of a historic district, would be expanded under Alternative 4. The expansion of the dam is not expected to remove, alter, or add elements to the B.F. Sisk Dam or its associated features that are incongruent with its current setting or use, and JRP (2018) concluded that modifications to the dam would result in no adverse effects to the historic district or its contributing elements. Two historic period industrial resources associated with construction of the dam would be impacted by use of the Basalt Hill borrow area (Basalt Hill Quarry/CA-MER-509H) and a potential construction staging area (CA-MER-492H). Both resources have been recommended not eligible for listing in the NRHP and CRHR, and both are regarded as non-contributing elements to the B.F. Sisk Dam/San Luis Reservoir Historic District. The implementation of Alternative 4 also is expected to impact seven historic period road segments (CA-MER-489H, CA-MER-491H, CA-MER-493H, CA-MER-494H, CA-MER-495H, CA-MER-519H, and P-24-001822) that would likely be used or improved to support Project construction. Each has been recommended not eligible for listing in the NRHP and CRHR. The debris scatter associated with the historic period transmission pole alignment (CA-MER-484H) is located along the reservoir shoreline and would be susceptible to increased wave action and fluctuating water levels with the expansion of the San Luis Reservoir. Three historic period earthen dams with impound ponds (CA-MER-515H, CA-MER-516H, and CA-MER-518H) are also located along the reservoir shoreline. Each is recommended not eligible for inclusion in the NRHP and CRHR. Given the nature of their construction, they should not be impacted by implementation of Alternative 4.

Six prehistoric sites along the reservoir shoreline, including five that have not been evaluated (CA-MER-15, CA-MER-28, CA-MER-82, CA-MER-83, and CA-MER-517) and one (CA-MER-130) that has been listed in the NRHP and CRHR as a part of the San Luis Gonzaga Archaeological District (P-24-000489), are located along the reservoir shoreline and would be susceptible to increased wave action and fluctuating water levels following expansion of the San Luis Reservoir. None of these sites have been previously identified as tribal cultural resources, and none are known to contain human remains. Further research in the form of subsurface testing and/or consultation may indicate that one or all of these sites meet the definition of a tribal cultural resource per PRC Section 20174.

Compared to existing conditions and the No Action/No Project Alternative, **impacts to cultural resources (including historical resources, unique archaeological resources, tribal cultural resources, and/or human remains) would be significant due to substantial adverse effects** under Alternative 4. These **impacts would be reduced through implementation of Mitigation Measure CR-1, CR-2, and CR-3,** though these **impacts would be significant and unavoidable** despite mitigation efforts (see Section 4.20.8).

4.20.7 Environmental Consequences/Environmental Impacts of Alternative 5 – Pacheco Reservoir Expansion Alternative

Archival and records searches and inventory surveys revealed 18 archaeological sites (some of which may also be tribal cultural resources and contain human remains) or built environment resources within the Alternative 5 APE[6]. These included nine prehistoric sites (CA-SCL-682, CA-SCL-683, CA-SCL-684, CA-SCL-685, CA-SCL-686, CA-SCL-687, PL-Pacheco-CRP-010, PL-Pacheco-CRP-012, PL-Pacheco-CRP-015, and PL-Pacheco-CRP-022), most with midden, lithics, and groundstone; four prehistoric lithic scatters (PL-Pacheco-CRP-013, PL-Pacheco-CRP-017, PL-Pacheco-CRP-019, and PL-Pacheco-CRP-023); a prehistoric bedrock milling site (PL-Pacheco-CRP-007); two multi-component sites (CA-SCL-679/H and CA-SCL-680/H) with prehistoric and historic period materials; and a historic period bridge (PL-Pacheco-CRP-009). The North Fork Dam is being examined as a part of an architectural field survey. Four previously recorded cultural resources that have not been relocated are in areas for which access permissions have not yet been granted. They include three prehistoric archaeological sites (CA-SCL-116, CA-SCL-121, and CA-SCL-322) and one historic period farmhouse and barn (P-35-000236), all associated with the PG&E transmission line. None of the resources within the

[6] The Alternative 5 APE includes the existing North Fork Dam, a proposed dam and reservoir, new pipelines and tunnels, inlet/outlet facilities, a pump station, borrow areas, temporary haul roads, and a new transmission line (2,269 acres). Pacheco Creek downstream of the construction effect area is not included in the Alternative 5 APE given as was noted in Section 4.4, Alternative 5 would reduce downstream flood flows and corresponding flood stages along Pacheco Creek, by storing and regulating the release of peak flows during storm events. With these reductions in peak flows and release volumes over the course of the year that would not exceed existing peak flows, no increase in streambank or streambed erosion downstream of Pacheco Dam would be anticipated from implementation of this alternative.

Alternative 5 APE have been evaluated for listing in the NRHP and/or the CRHR (see Appendix K).

Cultural resources within the footprint for the proposed dam, the proposed tunnel or pipeline, proposed haul roads, and potential staging or source material areas would have a high likelihood of being impacted under Alternative 5. The historic period North Fork Dam, which incidentally intersects the proposed tunnel or pipeline, would be demolished. Material excavated from the dam, if suitable for earth fill, would be used for construction of the temporary cofferdam (see Appendix K). Cultural resources along the 16-mile long PG&E transmission line would have a low likelihood of being impacted, as Project activities would consist of replacing existing transmission poles to support increased circuit load requirements. One historic period built environment resource (P-35-000236) has been recorded within the Alternative 5 APE for transmission line improvements, but as the resource comprises standing structures it would be avoided during these improvements.

One prehistoric site (CA-SCL-682) intersects a potential borrow area and haul road under Alternative 5 and has a high likelihood of being impacted; though not previously identified as such, it may be considered a tribal cultural resource per PRC Section 20174 based on the presence of known human remains at the site. Six known prehistoric resources (CA-SCL-680/H, CA-SCL-683, CA-SCL-684, CA-SCL-685, CA-SCL-686, and CA-SCL-687) and one multi-component site (CA-SCL-679/H) within the Alternative 5 APE overlap the proposed reservoir expansion footprint and would be fully or partially inundated if Alternative 5 is implemented. Similar to resources along the expanded reservoir shoreline under Alternative 4, these sites would be subject to the effects of increased wave action and fluctuating water levels as well as effects from inundation. Three of these sites (CA-SCL-679/H, CA-SCL-684, and CA-SCL-685) are known to contain human remains and, though not previously identified as such, may be considered tribal cultural resources per PRC Section 20174. Three additional prehistoric archaeological sites (CA-SCL-116, CA-SCL-121, and CA-SCL-322), if extant, may be affected by pole replacement activities associated with the PG&E transmission line, particularly if expanded pole footprints are required to support increased circuit loads.

Some areas within the Alternative 5 APE remained inaccessible to inventory survey in 2018 or 2019 because of safety constraints, inundation, or a lack of access permissions. It is assumed that portions of the APE that remained inundated would not be used as staging, stockpiling, or borrow locations under Alternative 5. Cultural resources within potential construction staging areas can be avoided and would have a low likelihood of being impacted, though resources located along the haul roads or proposed tunnel/pipeline would have a higher likelihood of being impacted (see Appendix K). Cultural resources along the expanded reservoir shoreline, particularly those with portable surface artifacts, may be impacted by wave action and fluctuating water levels under Alternative 5.

Compared to existing conditions and the No Action/No Project Alternative, **impacts to cultural resources (including historical resources, unique archaeological resources, tribal cultural resources, and/or human remains) would be significant due to substantial adverse effects** under Alternative 5. These **impacts would be reduced through implementation of Mitigation Measure CR-1, CR-2, and CR-3,** though these **impacts would be significant and unavoidable** despite mitigation efforts (see Section 4.20.8).

4.20.8 Mitigation Measures

4.20.8.1 NEPA Only Mitigation Measures

A reasonable and good faith effort has been made to identify historic properties within the APE for the SLLPIP action alternatives through archival research and inventory surveys on lands accessible to the lead agencies. Additional inventory survey efforts are needed, however, to identify historic properties within the APE for Alternatives 4 and 5 and to assess the effects of the project on those properties. These efforts cannot be practically completed at this time. If Congress authorizes funding for final design and construction of an action alternative identified in the companion Feasibility Report and in this EIS/EIR, an agreement document outlining a process for completing identification efforts and resolving adverse effects to historic properties will be negotiated with the SHPO to satisfy NHPA Section 106 compliance requirements.

Following Congressional authorization, but prior to the release of a Final EIS/EIR and the signing of a ROD to implement the project, Reclamation will complete all remaining historic property identification and evaluation efforts required by the negotiated agreement document. Adverse effects to historic properties will be resolved through the completion of the Section 106 process, which will satisfy Federal Lead Agency requirements with respect to the NHPA as well as NEPA. A process to avoid, minimize, and/or mitigate adverse effects to historic properties will be formalized in the agreement document in compliance with 36 CFR Part 800.6(c).

4.20.8.2 CEQA and NEPA Mitigation Measures

Mitigation Measure CR-1: Complete Cultural Resource Survey and Evaluation Efforts. Following Congressional authorization but prior to the release of a Final EIS/EIR and the signing of a ROD to implement the project, Reclamation for Alternatives 2 and 4, or SCVWD for Alternatives 3 and 5 will ensure that cultural resource identification and evaluation efforts for the preferred alternative are completed, consistent with the Section 106 agreement document. These efforts will be directed by an archaeologist meeting the Secretary of the Interior's Professional Qualifications Standards for archaeology and will include the inventory survey of all accessible areas within the APE for the selected action alternative that have not been examined to date (see Appendix K). The survey methodology will be consistent with that used in prior inventory surveys conducted for the SLLPIP (see Appendix K). Resources located during the survey will be recorded on appropriate California Department of Parks and Recreation (DPR) 523 forms, photographed, mapped using a GPS receiver, and plotted on USGS 7.5-minute topographic maps. The significance of cultural resources within the APE for the selected alternative will be evaluated using CRHR and NRHP criteria (see Appendix C). A technical report detailing the identification and evaluation efforts will be produced and forwarded to the CHRIS.

Mitigation Measure CR-2: Implement Avoidance or Mitigation Measures. Once identification and evaluation efforts have been completed, Reclamation for Alternatives 2 and 4 or SCVWD for Alternatives 3 and 5 will ensure that measures to avoid, minimize, or mitigate impacts to significant cultural resources, including tribal cultural resources and/or resources with human remains, are implemented consistent with the Section 106 agreement document, CEQA Guidelines Section 15126.4(b), and PRC Section 21084.3. Significant cultural resources that can be avoided by project ground disturbing activities will be marked for exclusion on project plans and/or on the ground using flagging, fencing, or appropriate signage. Where identified as appropriate in the technical report (see Mitigation Measure CR-1), a qualified archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards for archaeology will monitor project ground disturbing activities to ensure the avoidance of significant cultural resources. Other methods to ensure preservation in place (e.g., capping or incorporation within an open space or permanent easement) will be used, if identified as appropriate, following completion of the inventory survey. Where data recovery through excavation is the only feasible form of mitigation, a data recovery plan will be prepared that provides for the recovery of significant information from the resource; for tribal cultural resources, the data recovery plan will be prepared in consultation with the culturally-affiliated tribe. Studies and reports resulting from excavations will be deposited with the CHRIS. If human remains are encountered, procedures under California Health and Safety Code Section 7050.5 and PRC Section 5097.98 will be implemented.

Mitigation Measure CR-3: Implement a Detailed Inadvertent Discovery Plan. Prior to initiating construction of the selected alternative, Reclamation for Alternatives 2 and 4 or SCVWD for Alternatives 3 and 5 will ensure that a detailed, project-specific Inadvertent Discovery Plan consistent with the Section 106 agreement document is prepared for the project by a qualified archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards for archaeology. The Inadvertent Discovery Plan will outline cultural resource training procedures for construction personnel and the protocols to follow if cultural materials or human remains are discovered during project ground disturbing activities. In the event of an inadvertent discovery, construction will halt in the vicinity of the find and work will be directed elsewhere while its significance is evaluated by a qualified archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards for archaeology. If the discovery is significant, additional measures identified in the Inadvertent Discovery Plan (e.g., avoidance, capping beneath a layer of sterile soil, or data recovery excavations, including consultation with the culturally-affiliated tribe for suspected tribal cultural sources) will be implemented consistent with CEQA Guidelines Section 15126.4(b) and PRC Section 21084.3. If human remains are encountered, procedures under California Health and Safety Code Section 7050.5 and PRC Section 5097.98 will be implemented.

4.20.9 Significant and Unavoidable Impacts Under CEQA

No mitigation measures are available under CEQA that would reduce potential adverse impacts to known or unknown cultural resources within the Alternative 2 intake area. Because the intake area is and would remain inundated during construction, it is inaccessible to inventory survey. Known and unknown cultural resources that may be eligible for listing in the NRHP and/or the CRHR may lie within the intake area APE that cannot be observed, recorded, evaluated, or mitigated. Any impacts to such resources would remain significant and unavoidable.

Under Alternatives 4 and 5, the capacity of existing reservoirs would be expanded, and known and unknown cultural resources that may be eligible for listing in the NRHP and/or the CRHR would be subject to mechanical and biochemical impacts associated with inundation and/or increased wave activity. Resources that lie within the expanded reservoir footprint cannot be avoided. Capping could lessen impacts from mechanical activity but would not diminish biochemical impacts to cultural resources. Data recovery excavations could be implemented for cultural resources within the expanded reservoir area for Alternatives 4 or 5, but impacts would remain significant because it may not be possible to reduce those impacts to a level that is less than significant.[11]

4.21 Population and Housing

4.21.1 Assessment Methods

This analysis considers whether an action alternative would result in a substantial increase in population, and if there would be sufficient housing available to accommodate this population increase. Table 4-23 presents the number of construction workers who would be needed during peak construction, including the estimated number of local workers and the number of non-local workers for each of the action alternatives. For purposes of the analysis, it is assumed that one housing unit would be required per non-local worker and that this housing would be provided by the existing housing stock and that no new housing would be constructed for these workers.

4.21.2 Significance Criteria

For purposes of the EIS/EIR, impacts on population and housing would be considered significant if they would: (1) induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure); or (2) displace substantial numbers of people or existing people or housing, necessitating the construction of replacement housing elsewhere. These criteria, the associated significance determinations, mitigation and references to the location of supporting evaluations for these determinations are detailed in Table 4-24.

4.21.3 Environmental Impacts of No Action/No Project Alternative

The impact of not implementing the SLLPIP and not conducting the associated construction or operational activities would not change current or future population or housing trends. Population and housing growth would continue at a rate similar to existing conditions. **Therefore, the No Action/No Project Alternative would have no impact on population growth or housing resulting from growth inducement.**

4.21.4 Environmental Impacts of Action Alternatives

Under each alternative, no more than 119 non-local workers would be required during construction, as shown in Table 4-23. This small number of workers would temporarily increase populations in the surrounding communities during construction. As shown in Tables 3-3, 3-7, and 3-10 in Chapter 3, there are an adequate number of housing units available for rent and for sale in the surrounding communities to provide accommodations for the non-local workers; no new housing would be required. Operations for each alternative would not require any increase in non-local workers and impacts would be similar to the No Action/No Project Alternative. The action alternatives would not induce development growth or remove a barrier for growth because they do not provide a reliable source of water that could be used to approve specific development projects by local agencies. The action alternatives would not result in new housing, utilities, services, or permanent employment that could induce growth in the region, the action alternatives would not result in any impacts that would require the provision of new housing, utilities, services, or permanent employment. Therefore, the action alternatives would not induce growth. **Impacts on population and housing from growth inducement or displacement would be less than significant for Alternatives 2, 3, 4 and 5.**

Table 4-23. Construction Workers by Alternative

Alternative		Maximum Construction Workers	Number of Local Workers (75%)	Number of Non-Local Workers (25%)	Months of Construction
Lower San Felipe Intake Alternative	Pipeline	**37**	28	9	33
	Tunnel	**119**	89	30	47
Treatment Alternative		**50**	37	13	36
San Luis Reservoir Expansion Alternative		**217**	163	54	96–144
Pacheco Reservoir Expansion Alternative		**475**	356	119	60

Table 4-24. Population and Housing Effect Analysis Summary

Significance Criteria	Assessment Methodology	Alt.	Significance Determination (W/O Mitigation, W Mitigation)	Mitigation	Evaluation Support
Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)	Evaluation of census population trends and the local housing market to assess how the alternative would impact the population and housing needs in the area of analysis.	1	NI	-	Section 4.21.3
		2	LTS	None	Section 4.21.4
		3	LTS	None	Section 4.21.5
		4	LTS	None	Section 4.21.6
		5	LTS	None	Section 4.21.7
Displace substantial numbers of people or existing people or housing, necessitating the construction of replacement housing elsewhere.	Evaluation of the local housing market to determine whether each alternative would require construction of new housing units.	1	NI	-	Section 4.21.3
		2	NI	None	Section 4.21.4
		3	NI	None	Section 4.21.5
		4	NI	None	Section 4.21.6
		5	NI	None	Section 4.21.7

Key: Alt = alternative; LTS = less than significant; NI = no impact; W = with; WO = without

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Chapter 5 Cumulative Effects

This chapter provides an analysis of cumulative effects of the action alternatives taken together with other past, present, and reasonably foreseeable probable future projects (or actions) as required by NEPA implementing regulations (40 CFR 1508.7) and CEQA guidelines (Section 15130). A full detailed cumulative analysis is presented in Appendix S.

5.1 Methods and Assumptions

This section provides an overview of the methodology used to analyze cumulative effects.

5.1.1 Area of Analysis

Table 5-1 describes the specific cumulative effects area of analysis for each resource area.

Table 5-1. Cumulative Effects Area of Analysis

Section	Resource	Area of Analysis
4.1	Water Quality	San Luis Reservoir; Sacramento/San Joaquin River Delta, Pacheco Reservoir; and Santa Teresa WTP in San Jose.
4.2	Surface Water Supply	Same as Water Quality with the addition of the California Aqueduct and South-of-Delta CVP Contractors (SLDMWA).
4.3	Groundwater Resources	San Joaquin Valley/Tulare Lake Hydrologic Region, San Francisco Bay Hydrologic Region, South Lohantan Hydrologic Region, Colorado River Hydrologic Region, South Coast Hydrologic Region
4.4	Flood Control	Merced, San Benito, and Santa Clara counties
4.5	Geology, Seismicity, and Soils	Merced and Santa Clara counties
4.6	Indian Trust Assets	Merced and Santa Clara counties
4.7	Air Quality	Merced County and the San Joaquin Valley Air Basin; and, Santa Clara County and the San Francisco Bay Area Air Basin.
4.8	Greenhouse Gases	Regional and Global
4.9	Visual Resources	San Luis Reservoir and O'Neill Forebay; Pacheco Reservoir; sightlines in relation to properties associated with the Santa Teresa WTP in the SCVWD Service Area.
4.10	Noise and Vibration	San Luis Reservoir, Merced County; Pacheco Reservoir and Santa Teresa WTP, Santa Clara County.
4.11	Traffic and Transportation	Roadways in Santa Clara and Merced counties as well as local roads in the cities of Gustine, Los Banos, Gilroy, San Jose, and the village of Santa Nella.
4.12	Hazards and Hazardous Materials	San Luis Reservoir and the SRA; Pacheco Reservoir; SCVWD facilities where construction is proposed.
4.13	Aquatic Resources	San Luis Reservoir and the associated SRA, SCVWD service area, Pacheco Reservoir and Pacheco Creek, Sacramento/San Joaquin River Delta.

Table 5-1. Cumulative Effects Area of Analysis

Section	Resource	Area of Analysis
4.14	Terrestrial Resources	Santa Clara Basin; Pacheco Reservoir; San Luis Reservoir and the SRA
4.15	Regional Economics	Santa Clara County, Merced County
4.16	Land Use	San Luis Reservoir, Merced County, including the SRA, O'Neill Forebay, Los Banos Creek Reservoir, San Luis Wildlife Area, Pacheco State Park, and Cottonwood Creek Wildlife Area; Pacheco Reservoir; and, CVP agricultural contractors receiving water from the San Felipe Division (counties include Santa Clara, Monterey, Santa Cruz, and San Benito).
4.17	Recreation	San Luis Reservoir and the SRA; Pacheco Reservoir.
4.18	Environmental Justice	Communities close to San Luis Reservoir and the SRA including Volta, Trent, Los Banos, Ingomar, Gustine, and unincorporated Santa Nella; Santa Clara County and the City of San Jose.
4.19	Public Utilities, Services, and Power	San Luis Reservoir, Merced County; Pacheco Reservoir, Santa Clara County; SCVWD service area including Santa Teresa WTP in San Jose; and San Felipe Division Facilities.
4.20	Cultural Resources	San Luis Reservoir, Merced County, Pacheco Reservoir, Santa Clara County, San Benito County
4.21	Population and Housing	The cities of Los Banos, Newman, Gilroy, Gustine, and San Jose.

Key: CVP = Central Valley Project; SCVWD = Santa Clara Valley Water District; SLDMWA = San Luis & Delta-Mendota Water Authority; SRA = State Recreation Area; WTP = Water treatment plant

5.1.2 Timeframe for Cumulative Effects Analysis

The timeline for the cumulative effects analysis with the exception of greenhouse gasses and traffic and transportation, is 8 to 12 years for all short-term construction-related impacts. These impacts would be temporary and would only occur during construction. The timeframe for all long-term impacts is 20 years, which represents the planning horizon addressed in this EIS/EIR. The analysis in Section 5.2.6 relies on a 30-year timeframe for long-term impacts consistent with the BAAQMD emission amortization guidelines. The analysis in Section 5.2.10 utilizes a 25-year timeframe for long-term impacts consistent with the Merced County and Santa Clara Valley Transportation Authority analysis guidelines.

5.1.3 Identifying Past, Present, and Future Actions and Projects Contributing to Cumulative Effects

CEQA Guidelines Section 15130(b)(1) identifies two methods that may be used to analyze cumulative impacts:

1. "A list of past, present, and probable future projects producing related or cumulative impacts, including, if necessary, those projects outside the control of the agency," and/or

2. "A summary of projections contained in an adopted local, regional, or statewide plan or related planning document, that describes or evaluates conditions contributing to the cumulative effect. Such plans may include: a general plan, regional transportation plan, or plans for the reduction of greenhouse gas emissions. A summary of projections may also be contained in an adopted or certified prior environmental document for such a plan. Such

projections may be supplemented with additional information such as a regional modeling program. Any such document shall be referenced and made available to the public at a location specified by the Lead Agency."

This EIS/EIR analyzes cumulative impacts using both CEQA methods identified above. These methods are sufficient to satisfy NEPA and CEQA requirements for identifying past, present, and future actions and projects that may contribute to cumulative effects. Most EIS/EIR resources use one method or the other, but several resource areas use a combination of both methods.

A variety of Federal, State, county, and local government sources were reviewed to identify and collect information on past, present, and reasonably foreseeable actions in the project area that could contribute to cumulative effects. These include

- City and county general plans;
- Future population, housing, traffic, and other projections found in existing city and county general plans;
- Published reports, documents, and plans;
- Biological Management Plans (BOs, HCPs, etc.);
- Environmental documents (such as EIS/EIRs).
- Scoping comments; and
- Consultation with Federal, State, and local agencies.

Sections 5.1.4 and 5.1.5 below describe the projects and projections considered for this cumulative effects analysis.

5.1.4 Cumulative Projects Considered for All Resources

This section describes the past, present, and reasonably foreseeable future cumulative actions and projects considered in this cumulative effects analysis.

Addendum to the Agreement for Coordinated Operation of the CVP and SWP

In December 2018, Reclamation and DWR amended four key elements of the Coordinated Operation Agreement as follows:

- Article 6(c) of the Agreement is amended to share the responsibility for meeting Sacramento Valley inbasin use with storage withdrawals during balanced water conditions;
- Article 10(b) of the Agreement is amended to have the State transport CVP water through the California Aqueduct and provide available capacity at the Banks Pumping Plant to the CVP;
- Article 10(i) is added to the Agreement to share the applicable export capacity when exports are constrained; and
- Article 14(a) of the Agreement is amended to have the U.S. and the State review and revise the Agreement (Reclamation 2018a).

Bay-Delta Conservation Plan/California Water Fix/Delta Conveyance

The *Bay Delta Conservation Plan* (BDCP)/California Water Fix is being prepared by Reclamation and DWR, along with Kern County Water Agency, Metropolitan Water District of Southern California, SLDMWA, SCVWD, State and Federal Water Contractors Agency, Westlands Water District, and Zone 7 Water Agency (referred to as Potential Authorized Entities).

The BDCP/California WaterFix planning process began in 2006 when updates to the SWP and coordinated operations of the CVP were initially proposed as the BDCP. The BDCP envisioned updating the SWP by adding new points of diversion in the north Delta and by providing for large-scale species conservation through a 50- year HCP/natural communities conservation plan (NCCP). The HCP/NCCP was intended to comply with Section 10 of the federal Endangered Species Act and to achieve compliance with the California Endangered Species Act through the California Natural Community Conservation Planning Act. A Draft EIS/EIR was released in December 2013.

Following release of the Draft EIS/EIR, Reclamation and DWR issued a Supplemental Draft EIS/Partially Recirculated Draft EIR that included for consideration three additional alternatives that would update the SWP without the large-scale conservation efforts in an HCP/NCCP. The lead agencies proposed that one of these non-HCP alternatives, known as California WaterFix Alternative 4A, be identified as the preferred alternative in replacement of the BDCP alternative (DWR and Reclamation 2015). The preferred WaterFix alternative (4A) consists of three new diversion points in the north Delta, tunnel conveyance and ancillary facilities, operational elements, restoration measures, and an adaptive management program (DWR and Reclamation 2015). The Supplemental Draft EIS/Partially Recirculated Draft EIR also included updates to the BDCP alternative as well as other revisions and updates to the 2013 Draft EIR/EIS analyses. In addition, the state proposed as a separate program, California EcoRestore, to provide restoration efforts for species conservation independent of the SWP facility upgrades.

The Final EIS/EIR for the BDCP/California WaterFix that identified the California WaterFix for implementation was released in December 2016 (DWR and Reclamation 2016). Biological Opinions for the California WaterFix were release in June 2017 and a Notice of Determination (NOD) was filed in July 2017. In July 2018, DWR released a Draft Supplemental EIR/EIS for California WaterFix, which analyzes several proposed changes designed to reduce the project's footprint and costs, and minimize impacts on environmental resources in the Delta (DWR and Reclamation 2018). In May 2019, the California Water Fix effort was halted to allow for a new environmental evaluation of a modified Delta Conveyance Project that would shift from a previously proposed two conveyance tunnels down to one tunnel (DWR 2019). That evaluation is currently underway by DWR in coordination with the Delta Conveyance Design and Construction Authority (DWR 2019).

Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta

The State Water Resources Control Board adopted Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta in December 2018, which is designed to restore water flows through the Lower San Joaquin River and its tributaries. The plan sets a starting point for increased flows but also makes allowances for reduced river flows on tributaries where stakeholders have reached voluntary agreements to pursue a combination of flow and "non-flow" measures that improve conditions for fish and wildlife, such as habitat restoration and reducing predation (SWRCB 2018). The update includes improved instream flows February through June, the critical months for migrating fish on the Stanislaus, Tuolumne and Merced rivers, and a revision of the salinity standard for the southern Delta (SWRCB 2018).

B.F. Sisk Safety of Dams Modification Project

Reclamation and DWR are evaluating alternatives for the B.F. Sisk Dam Safety of Dams (SOD) Modification Project to address dam stability and safety concerns at B.F. Sisk Dam. These concerns are associated with several sections of the B.F. Sisk Dam and select foundation materials in the event of seismic activity. The analyzed alternatives for the B.F. Sisk Dam SOD Modification Project would help prevent destabilization of the dam embankment, reduce safety concerns and maintain water supply deliveries to state and federal contractors. Reclamation and DWR released a Draft EIS/EIR for public review in May 2019 that identified a Crest Raise Alternative as the Proposed Action (Reclamation and DWR 2019). The Crest Raise Alternative would raise sections of the B.F. Sisk Dam crest by 12 feet and develop stability berms along sections of the embankment. The San Luis Reservoir Expansion Alternative evaluated in this EIS/EIR is as was noted in Chapter 2, would build upon and is a connected action under NEPA to the B.F. Sisk Dam SOD Modification Project Crest Raise Alternative. As a connected action the the B.F. Sisk Dam SOD Modification Project Crest Raise Alternative to effects generated by the San Luis Reservoir Expansion Alternative reported in this chapter already include the cumulative contribution of that connected action. The B.F. Sisk Dam SOD Modification Project Crest Raise Alternative’s contribution to the other alternatives are detailed in this chapter.

California High Speed Rail Project

The CHSRA and United States Department of Transportation Federal Railroad Administration completed a programmatic EIS/EIR for the San Francisco to Central Valley portion of an approximately 800 mile long high speed rail network connecting San Francisco to San Diego. The track alignments considered in the EIS/EIR included one configuration traversing Pacheco Pass adjacent to SR 152 and San Luis Reservoir. The railway is being designed to support train speeds in excess of 125 miles per hour and would construct both at grade and tunnel sections through Pacheco Pass (CHSRA 2010).

The Final Partially Revised Programmatic EIS/EIR was released by the CHSRA April 6, 2012. The EIS/EIR identified the Pacheco Pass Network Alternative as the preferred alternative for consideration in future project level engineering and environmental compliance (CHSRA 2012).

The San Jose to Merced project section is part of the first phase of the California High-Speed Rail System that will provide a critical rail link between the Silicon Valley and the Central Valley. The approximately 84-mile project section would travel between stations in San Jose and Gilroy and (after passing through the Central Valley Wye) north to Merced or south to Fresno (CHSRA 2017). The Pacheco Pass tunnels and the extension to Merced will be the last link of the Silicon Valley to Central Valley Line to be constructed, with geotechnical analysis, environmental review, design, and right-of-way acquisition to be completed by 2022 (CHSRA 2018).

CVP Municipal & Industrial Water Shortage Policy

Allocation of CVP water supplies for any given water year is based upon forecasted reservoir inflows and Central Valley hydrologic conditions, amounts of storage in CVP reservoirs, regulatory requirements, and management of Section 3406(b)(2) resources and refuge water supplies in accordance with implementation of the Central Valley Project Improvement Act. In some cases, M&I water shortage allocations may differ between CVP divisions due to regional CVP water supply availability, system capacity, or other operational constraints (Reclamation 2015).

The purposes of the M&I Water Shortage Policy (WSP) are to:

- Define water shortage terms and conditions applicable to all CVP M&I contractors;
- Establish a water supply level that (a) with M&I contractors' drought water conservation measures and other water supplies will sustain urban areas during droughts, and (b) during severe or continuing droughts will, as far as possible, protect public health and safety; and
- Provide information to help M&I contractors develop drought contingency plans (Reclamation 2015).

The M&I WSP and implementation guidelines are intended to provide detailed, clear, and objective guidelines for the distribution of CVP water supplies during water shortage conditions, thereby allowing CVP water users to know when, and by how much, water deliveries may be reduced in drought and other low water supply conditions (Reclamation 2015). This increased level of predictability is needed by water managers and the entities that receive CVP water to better plan for and manage available CVP water supplies, and to better integrate the use of CVP water with other available non-CVP water supplies.

While the specific future policy and shortage allocation process is currently under evaluation, it is likely that both agricultural and M&I water service contractors will receive reduced allocations during shortage conditions. Reclamation will periodically reassess both the availability of CVP water supply and CVP water demand (Reclamation 2015).

San Luis Reservoir State Recreation Area Resource Management Plan/General Plan

The CDPR, in partnership with Reclamation, manages the majority of the San Luis Reservoir SRA. The CDPR planning process is integrated with Reclamation's Resource Management Planning Process. The CDPR, in partnership with Reclamation, has developed and adopted the San Luis Reservoir SRA RMP/GP (Reclamation and CDPR 2013), in order to direct the future development, operations and maintenance of the SRA. The plan was officially adopted in 2013 and has a life expectancy of 25 years. CDPR and Reclamation continue to collaborate on the San Luis Reservoir SRA RMP/GP to guide future growth.

The plan area consists of 27,000 acres owned by Reclamation and includes the water surfaces of San Luis Reservoir, O'Neil Forebay, Los Banos Reservoir, and adjacent recreation lands in the vicinity of Los Banos, California. The project area was built as part of the water storage and delivery system of reservoirs, aqueducts, power plants, and pumping stations operated under the

SWP and CVP. Lands managed by CDPR for recreation are part of the State Park system and comprise the SRA.

The plan's primary objective is to identify general areas in which future development may occur for recreation management. The plan includes an overview of existing conditions, including a summary of opportunities and constraints, a plan for future use and management of the project area, and the associated environmental analysis pursuant to NEPA and CEQA (Reclamation and CDPR 2013).

Los Vaqueros Reservoir Expansion Project, Phase 2

Expansion of Los Vaqueros Reservoir, owned and operated by Contra Costa Water District (CCWD), is being conducted in two phases. A Final EIS/EIR was completed in 2010 and served as the basis for Phase 1 construction, which was completed in 2012. A draft Supplement to the Final EIS/EIR (Supplement) was released to the public in July of 2017 to reflect changes since the 2010 Final EIS/EIR, including refined alternatives being considered for a Phase 2 expansion (Reclamation 2018b). In 2018, a Draft Feasibility Report was release evaluating the feasibility of expanding Los Vaqueros Reservoir from the recently expanded size of 160,000 acre-feet to 275,000 acre-feet and adding new conveyance facilities. The expansion could improve water supply reliability and water quality for San Francisco Bay Area water users, including through emergency storage (Reclamation 2017).

Pacheco Reservoir Reoperation Project

The Resource Conservation District of Santa Cruz County (RCDSCC), in cooperation with the SBCWD, PPWD, NMFS, and CDPR, developed operational guidelines for Pacheco Reservoir to improve water supply reliability through conjunctive management of surface water and groundwater supplies and to provide in stream flows to protect all life stages of steelhead downstream of Pacheco Reservoir (SBCWD 2013). Guidelines for Pacheco Reservoir were developed by constructing a watershed system simulation model which was used to evaluate environmental and water supply outcomes associated with alternate operation strategies. The guidelines were developed and finalized in 2015 (NOAA 2018).

San Luis Transmission Project

The San Luis Transmission Project will develop approximately 95 miles of new transmission lines connecting the Tracy Substation and the Dos Amigos Substation with segments crossing O’Neill Forebay and connecting to the San Luis Substation. Additional components of the San Luis Transmission Project will include two new 500-kV substations, substation improvements, communication facilities, improvements to existing access roads, and new permanent access roads (WAPA and SLDMWA 2015). The Final EIS/EIR for the San Luis Transmission Project was released in March 2016 with construction scheduled for 2021 (Linares 2018).

San Luis Solar Project

The San Luis Solar Project would allow a 30-year Land Use Authorization to access, install, operate, maintain, and remove a 26-megawatt alternating current solar facility. The project would be constructed on three sites adjacent to the San Luis Reservoir SRA, to the northwest of the SR 152/SR 33 interchange. The three sites will cover a total of 159 acres and consist of solar photovoltaic panels, racks to hold the panels, and electrical infrastructure (Reclamation 2018c).

The Final Environmental Assessment (EA) and Plan of Development for the San Luis Solar Project was released in May 2018, with construction scheduled for 2018.

Upper Guadalupe River Flood Control Project

The *Upper Guadalupe River Flood Control Project* follows upon the completed Downtown, and Lower Guadalupe River Projects. The project would provide flood protection along a 5.7 mile stretch of the Guadalupe River, from I-280 to Blossom Hill Road in the City of San Jose. In May 2010, construction began on the portion of the project from I-280 to the Union Pacific Railroad crossing just downstream of Willow Street. The project includes flood protection, habitat restoration, and fish passage components. Pending available Federal funds, remaining reaches of the Upper Guadalupe River may be completed by 2021 (SCVWD 2012).

Young Ranch Residential Project

In 2017, the Santa Clara County Planning Office prepared a Draft EIR for the Young Ranch Residential Project, a cluster subdivision consisting of 30 lots and a 4,000 square foot community center. The subdivision would be located on a 2,150 acre site southeast of downtown San Jose along Coyote Ridge, east of Highway 101. The project would develop 79 single-family homes and 16 secondary units and designate 1,947 acres as open space (Santa Clara County 2017).

Blanchard Road Warehouse/Distribution Center

An EIR is currently being prepared for the Blanchard Road Warehouse/Distribution Center, which would consist of a 415,000 square foot industrial warehouse on a 29.92 acre site on Blanchard Road in the Coyote Valley area south of San Jose. The site will be paved and would include 196 parking stalls for employee and visitors. Although the warehouse operator has not been identified, it is not anticipated that hazardous materials would be stored or distributed. Construction would take approximately nine months and would cover all site improvements as well as construction of the building. Blanchard Road would be widened to provide access to the site (City of San Jose 2016).

5.1.5 Cumulative Projections Considered for All Resources

This section describes the specific projections shown in Table 5-2 that have been used for the cumulative effects analysis.

Table 5-2. Summary of Projections Used in Cumulative Effects Analysis

Author	Document Title	Projections Used	Document Date
Merced County	Merced County General Plan – Revised Draft, Demographics & Economics. Background Report	Population Employment	2012
County of Santa Clara	Santa Clara County General Plan – Housing Element Update 2015-2022	Housing	2014
LAFCO Santa Clara County	Cities Service Review	Population	2015
County of Stanislaus	Stanislaus County General Plan and Airport Land Use Compatibility Plan Update Draft Program EIR	Population	2016

Source: Merced County 2013, Santa Clara County 2014, LAFCO of Santa Clara County 2015, and Stanislaus County 2016.

Notes: LAFCO = Local Area Formation Committee

Merced County General Plan – Background Report

The Background Report for the 2030 *Merced County General Plan* was released in December 2013. This document presents population and employment projections through 2030. The projections have been developed by the California Department of Finance (DOF).

Table 5-3 shows both past and projected population estimates from the General Plan's projections from 2013. The current DOF (2017) population projection for Merced County in 2030 has been revised downward, to 326,574, but the use of a higher population projection provides a more conservative cumulative impact analysis. Additionally, the table also displays average annual growth rates for each time period. As indicated in Table 26-3, the county's population had an average annual growth rate of 3.1 percent from 2000 to 2005 and 2.7 percent from 2005 to 2010 and a projected growth rate of 2.6 percent from 2010 to 2030 (Merced County 2013). Utilizing these population projections, the Background Report identifies an estimated population increase from 2010 to 2030 of approximately 141,000 people that will require housing within the county (Merced County 2013).

Table 5-3. Past and Projected Population Estimates Merced County and California (2000-2030)

	Merced County	
Year	Population	Average Annual Growth Rate
2000	210,544	--
2003	225,115	2.3 percent
2005	243,700	4.1 percent
2010	276,200	2.7 percent
2020	340,800	2.3 percent
2030	417,200	2.2 percent

Source: Merced County 2013

Employment growth projections presented in the Background Report identified approximately 27,600 jobs that would be added in Merced County between 2005 and 2030. Table 5-4 shows these employment projections for both unincorporated and incorporated areas within the county from 2005 to 2030.

Table 5-4. Past and Projected Employment Estimates Merced County (1990-2030)

Year	Observed/ Projected	Total Jobs	Average Annual Growth Rate
1990	Observed	77,300	--
2004	Observed	86,500	0.9 percent
2005	Projected	87,400	1.0 percent
2030	Projected	115,000	2.1 percent

Santa Clara County General Plan – Housing Element Update 2015-2022

The Housing Element Update 2015-2022 of the *County of Santa Clara General Plan* was adopted June 10, 2014 and certified on July 25, 2014. This document presents job growth projections through 2025. The projections have been developed by the Association of Bay Area Governments (ABAG).

Table 5-5 shows job growth trends from ABAG's Projections 2009. It projects that during the 2015 to 2025 period, Santa Clara County will add 196,290 jobs, growing an average of two percent annually. The projections for the unincorporated County also forecast an increase in employment of approximately 11 percent from 2015 to 2025. However, these projections and ABAG's methodology do not adequately take into account annexation of urban islands into the cities over time. For example, most of the islands with non-residential use patterns have been annexed into San Jose over the last several decades. Annexations are expected to continue.

Table 5-5. Santa Clara County Job Growth Trends

Job Growth Projections	2010	2015	2020	2025
Countywide Santa Clara County	906,270	981,230	1,071,980	1,177,520
Unincorporated Santa Clara County	50,400	53,590	56,670	59,690

Source: ABAG Projections 2009 in City of San Jose 2012

Local Area Formation Commission of Santa Clara County – Cities Service Review

The Local Area Formation Commission (LAFCO) of Santa Clara County completed a Cities Service Review that developed population, household, income, and employment projections for Santa Clara County through 2040. Table 5-6 shows the population projections.

Table 5-6. LAFCO Projections – Growth and Population Trends (2015-2040)

City	2015	2040	25-Year Growth	Average Annual Growth
Campbell	41,857	48,100	14.9%	0.60%
Cupertino	59,756	71,200	19.2%	0.77%
Gilroy	53,000	61,400	15.8%	0.63%
Los Altos	30,036	32,800	9.2%	0.37%
Los Altos Hills	8,341	8,600	3.1%	0.12%
Los Gatos	30,505	32,600	6.9%	0.27%
Milpitas	72,606	109,100	50.3%	2.01%
Monte Sereno	3,451	3,700	7.2%	0.29%
Morgan Hill	41,779	50,800	21.6%	0.86%
Mountain View	77,914	100,000	28.3%	1.13%
Palo Alto	66,932	84,600	26.4%	1.06%
San Jose	1,016,479	1,334,100	31.2%	1.25%
Santa Clara	120,973	156,500	29.4%	1.17%
Saratoga	30,799	32,700	6.2%	0.25%
Sunnyvale	148,028	194,300	31.3%	1.25%
Cities population and growth projections	1,802,456	2,320,500	28.7%	1.15%
Unincorporated	87,182	123,000	41.1%	1.64%
Countywide population and growth projections	1,889,638	2,443,500	29.3%	1.17%

Source: LAFCO of Santa Clara County 2015

5.2 Cumulative Effects Analysis

5.2.1 Water Quality

Implementation of the California WaterFix/California EcoRestore, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in long-term changes to Delta region operations and habitat health with the implementation of conservation and restoration measures designed to improve the health of the Delta ecosystem while also improving water supply and water quality conditions. Future improved conditions in the Delta region could result in increased south-of Delta exports. Changes in Delta water quality, South-of-Delta export of CVP and SWP water, and Delta outflow would result in a less than one percent change compared to existing conditions under all of the action alternatives and impacts would be minimal. **Therefore, cumulative impacts in combination with other projects in the Delta region would not result in significant cumulative impacts on water quality.**

Construction activities associated with the B.F. Sisk Dam SOD Modification Project would involve earth moving and construction projects at and similarly, the California High Speed Rail Project and near the San Luis Reservoir and the Pacheco Reservoir. Construction of trails, campgrounds, and wells identified in the San Luis SRA General Plan would involve earth moving and construction near the shore of the San Luis Reservoir. One cumulative project that could impact water quality in Alternative 3 vicinity is the Upper Guadalupe River Flood Control Project. Other construction is projected to occur in Merced and Santa Clara counties due to projected population growth. Construction of the action alternatives would involve earth moving activities that could introduce pollutants into the water and compromise water quality. Together, these projects could result in significant cumulative short-term effects associated with potential contaminants causing water quality degradation in nearby water bodies. However, the cumulative projects would be required to implement BMPs and mitigation measures to reduce impacts. **In addition, mitigation measures would be implemented under all of the alternatives to reduce impacts to water quality to a less than significant level and the alternatives' contribution, although cumulatively considerable pre-mitigation, would not be cumulatively considerable post-mitigation.**

5.2.2 Water Supply

Water supplies in California are currently constrained by hydrologic and regulatory conditions, and the CVP and SWP cannot deliver adequate supplies to meet demands in the Central Valley and Southern California. The California Delta Conveyance Project, the 2018 Addendum to the Coordinated Operation Agreement, the 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta, the CVP M&I WSP, Los Vaqueros Reservoir Expansion Project, the B.F. Sisk Dam SOD Modification Project and the Pacheco Reservoir Reoperation Project could result in short- and long-term changes in water supply availability. Projected growth in the area of analysis also could result in cumulative impacts and water demand. The WaterFix, the Addendum to the Coordinated Operation Agreement, and the M&I WSP would change the delivery patterns of CVP and SWP supplies, and population growth would increase water demands. The 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could change the availability of exported water supply south of the Delta. The Los Vaqueros Reservoir Expansion Project would improve San Francisco Bay Area water supply reliability, along with increased Level 4 Refuge supplies. The B.F. Sisk Dam SOD Modification Project could potentially impact operations at San Luis Reservoir during construction activities on the dam crest. The Pacheco Reservoir Reoperation Project would improve water supply reliability for water users downstream of Pacheco Reservoir. New state regulations set to enact indoor and outdoor water use efficiency requirements in 2019, along with many county general plan provisions incorporate conservation efforts that would reduce the cumulative contribution associated with population growth.

Alternatives 2 through 5 would all produce beneficial impacts on water supply reliability within the SCVWD service area that would help offset potential cumulative water supply reliability effects under the cumulative condition and would help to reduce the significant cumulative water supply effects described above for SCVWD. Alternatives 2 and 3 result in small reductions to South-of-Delta agricultural deliveries to CVP contractors, and Alternatives 4 and 5 result in small reductions to SWP contractors. These reductions would be minimal and only evident in some water years. **Alternatives 2 through 5 would not have cumulatively considerable incremental contributions to a significant cumulative impact to water supply.**

Alternative 4, with the shear key option, would result in a short-term significant impact to CVP and SWP water supply deliveries due to construction. As discussed in Section 4.2.6, Reclamation evaluated the potential use of groundwater banking as an option to replace the lost storage in San Luis Reservoir and determined that given the availability of capacity in existing groundwater banks, the time necessary and complexity of developing a new groundwater bank with the capacity to reduce this impact to a less than significant level, that this option would not be feasible. Similarly, the use of water transfers to mitigate this impact was evaluated and was determined to be unable to meaningfully offset this impact given uncertainty with the availability of willing sellers of sufficient amounts of water and the availability of conveyance capacity to transfer those supplies at the time they are needed. The development of new surface storage at a different location to offset the lost capacity at San Luis Reservoir was determined to be infeasible given the potential for numerous significant environmental effects potentially generated by that action and the time necessary to develop this new storage facility. Given the environmental and technological limits and the time necessary to implement other potential options to offset this impact during the two water years that the Shear Key Option would restrict reservoir operations no feasible[1] mitigation has been identified to reduce these impacts to a less than significant level. **Cumulative water supply impacts would be significant and the temporary reduction under Alternative 4 during construction of the optional shear key would be cumulatively considerable.**

5.2.3 Groundwater Resources

SGMA requires those high and medium priority basins to be managed under a groundwater sustainability plan (GSP) by January 31, 2020. It requires all other groundwater basins designated as high or medium priority basins to be managed under a GSP by January 31, 2022. The GSP must achieve groundwater basin sustainability within 20 years of plan implementation and maintain sustainable yield for the following 50 years. A Groundwater Sustainability Agency (GSA) is a local entity tasked with developing the GSP and associated rules and regulations. The GSP will include provisions to avoid chronic lowering of groundwater levels, along with

[1] As defined in CEQA Guidelines Section 15364

avoiding significant and unreasonable degradation of water quality and land subsidence. When the GSP is in place and the basins are managed according to that GSP, the groundwater basin will be operated sustainably for the long term and not be subject to additional degradation of conditions. Any long-term lowering of water levels in the basin is also expected to slow after January 2020, when the GSP is required to be implemented. None of the alternatives would result in groundwater quality impacts. In addition, the GSP will also require the long-term sustainable management of water quality in the basin.

The decrease in deliveries to CVP agricultural contactors due to Alternative 2, Alternative 3, and Alternative 5's uninterrupted M&I deliveries to SCVWD during low point events could result in long-term supply shortages to agricultural contractors. Water supply shortages under the action alternatives could result in increases in groundwater pumping by these agricultural contractors in addition to existing groundwater pumping. This includes increase pumping from multiple groundwater aquifers that have been identified by DWR as critically overdrafted (DWR 2016). Therefore, given the critical overdraft of these aquifers, **Alternative 2, Alternative 3, and Alternative 5's incremental long-term contribution to this significant cumulative effect would be a cumulatively considerable impact.** No feasible mitigation has been identified to reduce these cumulative impacts to a less than significant level.

There would be no negative impacts to groundwater resources resulting from the construction and operation of Alternative 4 in the Santa Clara subbasin or Llagas subbasin, **therefore there would be no cumulative impacts.**

5.2.4 Flood Protection

The cumulative projects (new trails and facilities at San Luis Reservoir in the San Luis Reservoir SRA RMP/GP, construction and operation of the San Luis Transmission Project, San Luis Solar Project and California High Speed Rail Project Pacheco Pass segment) would have less than significant impacts to drainage flow and capacity, flood flows and increased flood hazard risk with implementation of mitigation measures. The B.F. Sisk Dam SOD Modification Project would improve flood risk conditions downstream of San Luis Reservoir during potential seismic events. Construction and operations of new facilities under Alternatives 2, 3, 4 and 5 would result in less than significant short-term impacts to drainage patterns and capacity, flood flows and increased flood hazard risk. **Overall, the action alternatives in combination with other cumulative projects would not result in a cumulative significant impact related to drainage, runoff, or flood flows or increase the risk of flood hazards.**

5.2.5 Geology and Soils

Of the cumulative projects considered for all resources, the San Luis Reservoir SRA RMP/GP (Reclamation and CDPR 2013), the California High Speed Rail Project, the B.F. Sisk Dam SOD Modification Project, San Luis Transmission Project and San Luis Solar Project are considered for cumulative geology, seismicity, and soils effects. Projected growth in the area of analysis could result in cumulative impacts to geology and soils. Development and construction in Merced and Santa Clara counties related to projected population growth would not likely occur near the alternatives and would not add to potential geology and soil effects. Construction projects related to projected growth would require individual geotechnical assessments to ensure soil stability and short- and long-term safety of people and structures. Construction activities, under all alternatives, would not directly influence earthquake activity. In the event of an earthquake, construction activities would follow the safety requirements of OSHA to reduce the potential for harm to construction workers or equipment. Similarly, construction of cumulative projects proposed would be subject to the same safety requirements. These cumulative projects, similar to all alternatives, however are not proposing permanent structures for human habitation. The California High Speed Rail Project would be designed to include safeguards to stop train traffic in the event of seismic activities to prevent any accidents caused by impacts to the tracks. The visitor facilities proposed under the San Luis Reservoir SRA RMP/GP would be subject to California building codes that require protection against seismic ground shaking. **Construction, operation, and maintenance of all action alternatives, with mitigation under Alternative 2, Alternative 4, and Alternative 5, in combination with other projects would not result in a short or long-term significant cumulative impact on geology, seismicity, and soils.**

There is the potential to encounter previously undetected but potentially significant paleontological resources during construction of Alternative 2, Alternative 4, and Alternative 5; however, Mitigation Measure PR-1 would reduce impacts to less than significant. The cumulative projects, with the exception of the B.F. Sisk Dam SOD Modification Project, would note generate ground disturbing actions within the same footprint as the alternatives. The combined effect of Alternative 4 and the B.F. Sisk Dam SOD Modification Project as a connected action on paleontological resources is presented in Chapter 4.While there would be no other cumulative projects with ground disturbing actions within the same footprint as the alternatives, these cumulative projects could also affect similar paleontological resources to Alternative 2, Alternative 4, and Alternative 5. **Therefore, cumulative impacts on paleontological resources would be significant, Alternatives 2, 4, and 5's incremental impacts would be cumulatively considerable pre-mitigation, but not cumulatively considerable post-mitigation.**

5.2.6 Air Quality

Air pollution, by definition, is a cumulative impact because no single project determines the California Ambient Air Quality Standards (CAAQS) or NAAQS attainment status of a region. Air pollution is largely a cumulative impact because the attainment status of the region is a result of past and present development. While a single project would not determine the region's attainment status, it would continue to add to any existing air quality issues and would have a significant cumulative effect. Because the Chapter 4 significance thresholds for criteria pollutants are intended to both attain and maintain the CAAQS and NAAQS, they are sufficient to determine if a project's individual air quality impacts would also be cumulatively considerable. This approach is consistent with the CEQA guidance documents developed by both the BAAQMD (2017) and the SJVAPCD (2015). Pre-mitigation exceedances of SJVAPCD mass emission thresholds for O_3 precursors would, in general, lead to the increased health risks described in Chapter 3 within the affected air basin. For relatively small projects such as the action alternatives, attempts to model regional O_3 concentration impacts and resulting health impacts pre- and post-mitigation would not be practical or produce meaningful information and are not included in the cumulative analysis. **For construction of Alternative 3, the incremental contribution to significant cumulative air quality impacts would not be cumulatively considerable. Alternative 2's (tunnel option and pipeline option) incremental short-term contribution to significant air quality impacts, although cumulatively considerable pre-mitigation, would not be cumulatively considerable post-mitigation. Because emissions would exceed the respective significance thresholds before and after mitigation, the**

temporary incremental contribution to significant cumulative air quality impacts for construction of Alternatives 4 and 5 would be cumulatively considerable pre-mitigation, and for NOx and CO remain cumulatively considerable post-mitigation.

5.2.7 Greenhouse Gas Emissions

No single project can noticeably change the global climate temperature; therefore, when considered in relationship to all past, present, and future development, implementation of the action alternatives would result in a significant cumulative impact. The significance criterion used to assess an alternative's individual significance is sufficient to determine if a project would conflict with an applicable plan, policy, or regulation adopted for reducing GHG emissions for which project-specific thresholds have been set. Therefore, if an alternative would produce GHG emission impacts that are individually significant, then the alternative would also be cumulatively considerable. **Therefore, the incremental contribution to the significant cumulative GHG effect for construction of Alternative 3 would not be cumulatively considerable because emissions are less than the significance criteria. The incremental contribution to the significant cumulative GHG effect for construction of Alternative 2, Alternative 4, and Alternative 5 would be cumulatively considerable because the criteria are exceeded, but with mitigation would not be cumulatively considerable.**

5.2.8 Visual Resources

If construction of the San Luis Transmission Project and the San Luis Solar Project were completed concurrently with either Alternative 2 or Alternative 4, construction of the B.F. Sisk Dam SOD Modification Project was completed concurrently with Alternative 2 or Alternative 5, and if construction of the California High Speed Rail Project was completed concurrently with Alternative 5, there could be a cumulative short-term impact on visual resources given the introduction of construction equipment, construction traffic and construction lighting. However, implementation of Mitigation Measures VIS-1, VIS-2, VIS-3, and VIS-4 would reduce effects of Alternative 2, Alternative 4, and Alternative 5 to a less than significant level. None of the cumulative projects would occur in close proximity to the Santa Teresa WTP under Alternative 3. **Therefore, although these alternatives may combine with other projects to create a cumulatively considerable contribution to significant cumulative visual impacts pre-mitigation, impacts would not be cumulatively considerable post-mitigation.**

5.2.9 Noise and Vibration

Cumulative projects and population growth in the area of analysis could result in cumulative impacts to noise. Construction is projected to occur in Merced and Santa Clara counties as a result of projected population growth; however, construction is not expected to be in the vicinity of San Luis Reservoir, Santa Teresa WTP, or Pacheco Reservoir. Construction of the California High Speed Rail Project or the B.F. Sisk Dam SOD Modification Project could occur at the same time as Alternative 5 and the San Luis Transmission Project and the San Luis Solar Project could occur at the same time as Alternative 2 or Alternative 4. These cumulative projects, along with the alternatives, would involve a substantial amount of construction equipment and vehicle traffic that would cause an increase in ambient noise levels in the project vicinity. Therefore, the contribution of Alternative 2, Alternative 4, and Alternative 5 to temporary significant cumulative noise impacts during construction **would be cumulatively considerable and remain cumulatively considerable post mitigation.** Construction noise under Alternative 3 would have a significant impact to noise and vibration that would be **cumulatively considerable pre-**

mitigation, although the impact would be reduced through Mitigation Measure NOISE-1 and **therefore would not be cumulatively considerable post-mitigation.**

Operation of the Alternative 2, 3, and 4 would have less than significant impacts and **would not contribute to any cumulative noise impacts.** Long-term operation of the pump station under Alternative 5 would have a significant impact to noise and vibration that would be **cumulatively considerable pre-mitigation,** although the impact would be reduced through Mitigation Measure NOISE-3 and **therefore would not be cumulatively considerable post-mitigation.**

5.2.10 Traffic and Transportation

Construction of projects considered for cumulative impacts in Merced County including the California High Speed Rail Project, the San Luis Reservoir SRA RMP/GP, the B.F. Sisk Dam SOD Modification Project and development projects related to projected growth in the county could create additional construction traffic in the area of analysis during the same time period. The San Luis Reservoir SRA RMP/GP notes that as specific projects at the SRA are developed, site-specific environmental analyses would be conducted, and mitigation measures would be implemented to reduce impacts to visitor access or circulation on local roads. In addition, construction of the California High Speed Rail Project and the B.F. Sisk Dam SOD Modification Project would include mitigation, such as adding signals to intersections to improve LOS/operations, to reduce transportation impact. For Alternatives 2, 3, 4, and 5, construction-related traffic increases would be temporary and would not degrade the LOS values of roads in the area of analysis below the LOS standard. Operations of Alternatives 2, 3, 4, and 5 would not result in long-term increases in traffic, there would be no public transit impacts, and there would be no cumulative effects on public transit. **Therefore, cumulative operational impacts on traffic flow would not be significant.** Construction of Alternatives 2, 3, 4, and 5 could generate a short-term significant cumulative impact on traffic safety that would be **cumulatively considerable pre-mitigation,** although the impact would be reduced through Mitigation Measure TR-1 and **therefore would not be cumulatively considerable post-mitigation.**

5.2.11 Hazards and Hazardous Materials

The cumulative projects (new trails and facilities at San Luis Reservoir proposed in the San Luis Reservoir SRA RMP/GP, construction of the B.F. Sisk Dam SOD Modification Project, construction and operation of the San Luis Transmission Project, San Luis Solar Project and California High Speed Rail Project Pacheco Pass segment) could generate significant impacts to hazards and hazardous waste. The construction and operation of Alternatives 2, 4 and 5 in combination with these cumulative actions could result in significant cumulative impacts on hazards and hazardous materials, including increasing wildfire risk and conflicting with emergency response, and each of these alternative's temporary contribution to these **impacts would be cumulatively considerable.** The implementation of mitigation measures would reduce the severity of these alternatives' significant impacts to a less than significant level. **Therefore, with implementation of Mitigation Measures HAZ-1 through HAZ-6 and Mitigation Measure TR-1, as applicable to Alternatives 2, 4, and 5, these alternatives' incremental contribution to significant cumulative effects on hazards and hazardous materials, although cumulatively considerable pre-mitigation, would not be cumulatively considerable post-mitigation. Alternative 3's hazards and hazardous materials impacts would be less than significant, and Alternative 3's incremental contributions to cumulative hazards and hazardous materials impacts would not be cumulatively considerable.**

5.2.12 Aquatic Resources

The San Luis Reservoir SRA RMP/GP, Upper Guadalupe River Flood Control Project, State Water Project Supply Allocation Settlement Agreement, the B.F. Sisk Dam SOD Modification Project, Los Vaqueros Reservoir Expansion Project, San Joaquin River Restoration Program, The Pacheco Reservoir Reoperation Project, California Delta Conveyance Project, 2018 Addendum to the Coordinated Operation Agreement, and 2018 Bay-Delta Plan Update for the Lower San Joaquin River and Southern Delta could result in short-term and long-term effects to aquatic resources. For Alternatives 2, 3, and 4 effects on aquatic habitat conditions would be largely localized to areas where special-status fish species do not occur, so there would be no contribution to significant cumulative effects. For Alternative 5 construction and operation of the expanded Pacheco Reservoir could cause short and long-term direct or indirect impacts to South-Central California Coast Steelhead and their habitat further contributing to their threatened status given adverse significant cumulative conditions on Pacheco Creek caused by low water flow and habitat loss. **This impact would be cumulatively considerable**, but implementation of Mitigation Measure BIO-1 and Mitigation Measure BIO-2 would reduce the impact from construction and operation and render the alternative’s contribution to the significant adverse cumulative impact **less than cumulatively considerable post-mitigation**. Following construction, with the implementation of Mitigation Measure BIO-2, Alternative 5 would improve conditions on Pacheco Creek with increased creek flows beneficial to aquatic resources downstream of the expanded reservoir. **For all of the alternatives, any new diversions or other water operation changes with the potential to affect aquatic habitats in the Delta would be required to operate consistently with regulatory requirements, which are designed to avoid significant impacts to fisheries, leading to no cumulatively considerable contribution to significant cumulative effects in the Delta.**

5.2.13 Terrestrial Resources

Construction activities or operational impacts under Alternatives 2, 4, or 5 would result in significant impacts on terrestrial biological resources in the San Luis and Pacheco Reservoirs region. Alternatives described in the San Luis Reservoir SRA RMP/GP, the California High Speed Rail Project, the B.F. Sisk SOD Modification Project, the San Luis Transmission Project, and the San Luis Solar Project would also have impacts on terrestrial biological resources in the San Luis and Pacheco Reservoirs region. Together, these projects and implementation of Alternatives 2, 4, or 5 could result in significant cumulative effects associated with impacts on terrestrial biological resources, including loss of a large amount of habitat for wildlife and plants. **Incremental contributions of Alternatives 2, 4, and 5 to terrestrial biological impacts would be cumulatively considerable. With implementation of Mitigation Measures BIO-1 and BIO-2 and Mitigation Measures TERR-1 through 18, the incremental contribution of Alternative 2, 4 or 5 to significant cumulative effects on terrestrial biological resources, although cumulatively considerable pre-mitigation, would not be cumulatively considerable post-mitigation.**

Construction of Alternative 3 would not impact the terrestrial resources that Alternatives 2, 4 and 5 would impact, but could have significant impacts on migratory birds, including raptors, if active nests are disturbed during construction. The implementation of Mitigation Measure TERR-6 would minimize the potential for adverse effects on birds. No other cumulative activities or projects have been identified that would take place at the same time as construction of Alternative 3 that would impact migratory birds in the vicinity of the Santa Teresa WTP. **Therefore, there would be no significant cumulative effects at this location.**

5.2.14 Regional Economics

Delta Conveyance Project and the Los Vaqueros Reservoir Expansion Project would increase water exports to South-of-Delta contractors. This would increase water supply reliability for SCVWD and reduce economic effects associated with potential water shortages. The CVP M&I WSP would increase CVP water supplies to SCVWD during drought to avoid adverse public health and safety impacts. This also would avoid economic losses from water shortages. The SLLPIP alternatives would increase SCVWD water supply reliability during low point years and allow SCVWD to avoid economic effects of water shortages. Similar to the SLLPIP alternatives, construction expenditures for the California High Speed Rail Project and the B.F. Sisk Dam SOD Modification Project would result in economic output, labor income, and employment in Santa Clara and Merced counties. **Cumulatively, the projects would have a beneficial long-term economic effect.**

Alternative 2, Alternative 4, the San Luis Transmission Project, and the San Luis Solar Project would all result in closures of recreational facilities during construction. This would reduce the number of visitors to the San Luis Reservoir and reduce spending in Merced County, which would be an adverse short-term cumulative effect to the regional economy of Merced County. **The SLLPIP alternatives would contribute substantially to cumulative economic impacts related to reduced recreational spending in Merced County.**

Increases in population and jobs would increase economic activity as more housing would be developed and commercial development would likely increase. Industries with the largest projected job growth, in number of jobs, include health, educational, and recreational services; financial and professional services; manufacturing; wholesale; and transportation. There would be a long-term cumulative effect associated with job and population growth and the water supply provided by the SLLPIP alternatives**. This would be a positive, long-term cumulative effect.**

5.2.15 Land Use and Agricultural Resources

Delta Conveyance Project, the California High Speed Rail Project, CVP M&I WSP, San Joaquin River Restoration Program, the B.F. Sisk Dam SOD Modification Project, San Luis Solar Project, San Luis Transmission Project, and recreation area improvements in the San Luis Reservoir SRA RMP/GP could result in short-term and long-term changes in land use and agricultural resources. Projected growth in the area of analysis could result in cumulative impacts to land use and agricultural resources. Under Alternative 2 and 3 there would be no impacts to important farmland, no conflicts with zoning or land use plans, policies, or regulations, and no physical divisions of an existing community. Operation of Alternative 4 would increase the inundation area of San Luis Reservoir, but would not result in changes to land use nor the loss of Important Farmland or conflict with Williamson Act contracts. The cumulative projects and projected growth would occur outside of these areas of inundation. **Therefore, Alternatives 2, 3, and 4 in combination with other cumulative projects would not result in a significant cumulative impact related to land use and agricultural resources, and the impacts from the alternatives would not be cumulatively considerable.**

Operation of Alternative 5 would inundate grazing lands currently covered by Williamson Act contracts. The permanent inundation of this land would conflict with these Williamson Act contracts and would be **cumulatively considerable pre-mitigation,** although the impact would be reduced through Mitigation Measure LU-1 and **therefore would not be cumulatively considerable post-mitigation.**

5.2.16 Recreation

The San Luis Reservoir SRA RMP/GP, the B.F. Sisk Dam SOD Modification Project, and San Luis Transmission Project could result in short- and long-term changes in recreational facilities. The San Luis Reservoir SRA RMP/GP outlines future park improvements and expansion, while the San Luis Transmission Project could result in temporary closures of the Medeiros Use Area. Together, Alternative 2 and the B.F. Sisk Dam SOD Modification Project, and both Alterative 2 and Alternative 4, alongside the proposed improvements at San Luis Reservoir SRA, and the development of the San Luis Transmission Project could result in significant cumulative effects associated with recreation resources. **This temporary cumulative impact would be significant, and Alternative 2 and 4's short-term incremental contribution would be cumulatively considerable**, but implementation of Mitigation Measures REC-1 and REC-2 would reduce the impact of this construction and render the alternative's contribution to the significant adverse cumulative impact **less than cumulatively considerable. Alternatives 3 and 5 would have no or less than significant impacts on recreational facilities, and there would be no cumulatively considerable contribution to significant cumulative recreation impacts.**

5.2.17 Environmental Justice

The California High Speed Rail Project, the B.F. Sisk Dam SOD Modification Project, Young Ranch Residential Project, Blanchard Road Warehouse/Distribution Center for the San Luis Solar Project, San Luis Transmission Project, and recreation area improvements in the San Luis Reservoir SRA RMP/GP have been identified as cumulative projects with the potential to contribute to construction-related effects to minority and/or low-income populations within the area of analysis. Multiple, simultaneous construction projects at San Luis Reservoir could increase the likelihood of minority and/or low-income populations being adversely, disproportionately affected by air quality related construction effects. If construction of Alternatives 2 and 4 and implementation of other construction projects at San Luis Reservoir occurred at the same time, Alternatives 2 and 4 could contribute to an adverse cumulative effect on minority and/or low-income populations. However, the alternatives' effects would not be disproportionate given the similar demographic characteristics of all of the communities in the study area and the similar effects each community would experience. If Alternatives 3 and 5 are developed during the construction period of any of the identified cumulative projects or plans, Alternatives 3 and 5 could increase construction-related impacts on minority populations in addition to those already anticipated from the other cumulative construction projects. However, any potential effects from construction would be temporary and would be reduced by mitigation measures for air quality, noise and vibration, and traffic and transportation, as described in Chapter 4. **The impacts from the action alternatives would not be cumulatively considerable.**

5.2.18 Public Utilities, Services, and Power

Construction of projects considered for cumulative impact include the California High Speed Rail Project, the B.F. Sisk Dam SOD Modification Project, San Luis Transmission Project and San Luis Solar Project and the development projects related to projected growth in the counties. Construction associated with the cumulative projects would be subject to a SWPPP that would require the implementation of BMPs to control stormwater runoff during construction and comply with NPDES permit requirements. Over time, construction debris from other construction projects, and from future growth and development, could cause the landfill to reach capacity. However, the action alternatives' contributions to the regional landfills' remaining capacity would be minimal. Energy demand associated with construction of the cumulative projects, including the action alternatives, could be met by regional supplies, especially with construction efforts of the alternatives using generators.

Changes in operation of the action alternatives would not result in the need for additional energy supplies and would not result in significant energy impacts or the substantial depletion of local or regional energy supplies. Also, the action alternatives would not cause significant impacts on the provision of public services. **Therefore, the action alternatives in combination with other cumulative projects would not result in a cumulative significant short or long-term impact related to public utilities, services and power, and the impacts from the action alternatives would not be cumulatively considerable.**

5.2.19 Cultural Resources

The California High Speed Rail Project, the San Luis Transmission Line Project, the San Luis Solar Project, the B.F. Sisk Dam SOD Modification Project, and implementation of the San Luis Reservoir SRA RMP/GP have all been identified as cumulative actions that could result in significant short-term construction generated impacts to cultural resources, which include historical resources, unique archaeological resources, tribal cultural resources, and human remains. Archival and records search information, geoarchaeological sensitivity studies, and pedestrian inventory surveys were used to assess potential impacts to cultural resources within the SLLPIP area of analysis in Merced and Santa Clara counties. Alternative 3 would have no impact on cultural resources, so there would be no contribution to cumulative effects. For Alternatives 2, 4, and 5, the cumulative projects noted above could have a cumulatively significant effect on cultural resources, and **the incremental contributions of Alternatives 2, 4, and 5 to this impact would be cumulatively considerable.** Because Alternative 2 may involve impacts to cultural resources that cannot be identified, avoided, evaluated, or mitigated, **the incremental contribution to cumulative effects from this alternative would remain cumulatively considerable post mitigation.** Impacts under Alternatives 4 and 5 would be reduced through implementation of Mitigation Measures CR-1, CR-2 and CR-3, though given the alternatives' potential to increase mechanical and biochemical impacts generated by inundation and/or increased wave activity on known and unknown cultural resources that may be eligible for listing in the NRHP and/or the CRHR, the incremental contribution to **cumulative effects from these alternatives would remain cumulatively considerable post-mitigation.**

5.2.20 Population and Housing

The cities and counties expected to accommodate non-local workers for the duration of construction and operation for each alternative are expected to have projected growth through 2030 and have planned for this growth through their general plans by encouraging new development, including new housing (Merced County 2012, Stanislaus County 2016). Population increases in Merced and Santa Clara counties through 2040 are expected to be substantial in all nearby communities. This projected population increase, and the associated need for increased housing, is considered to be cumulatively significant. Alternatives 2, 3, 4, and 5 would have the potential to increase the population of any one of these four communities by a maximum of 119 non-local workers. These impacts would be temporary and would end after construction as the non-local workers would return to their places of origin. The number of new people attributable to the alternative is less than 1 percent of the population of any of the individual nearby communities, and only a fraction of 1 percent of the population of all four communities combined. No new housing is expected to be constructed for accommodation of the temporary workers, as sufficient available housing stock is expected to be available. **Therefore, the temporary incremental contribution to the significant cumulative effect associated with population and housing growth for Alternatives 2, 3, 4, and 5 would not be cumulatively considerable.**

5.2.21 Summary of Cumulative Effects

A summary of the cumulative effects identified for each alternative are presented in Table 5-7.

Table 5-7. Cumulative Effects Summary

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Water Quality			
Cause a violation of existing water quality standards or waste discharge requirements.	2-5	Not cumulatively considerable contribution to significant cumulative impact	None
Substantially degrade existing water quality conditions.	2-5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	WQ-1
In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation.	2-5	Not cumulatively considerable contribution to significant cumulative impact	None
Conflict with or obstruct implementation of a water quality control plan.		Not cumulatively considerable contribution to significant cumulative impact after mitigation	WQ-1
Result in effects on water quality related beneficial uses.	2-5	Beneficial	None
Water Supply			
Substantially reduce the annual supply of water available to the CVP, SWP, or other water users.	2 -5	SCVWD - Beneficial	None
	2-5	South of Delta CVP Ag. and SWP (Operations) – Not cumulatively considerable contribution to significant cumulative impact	None
	4	South of Delta CVP Ag. and SWP (Construction) – Cumulatively considerable contribution to significant cumulative impact	None
Groundwater Resources			
Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin	2-5	Cumulatively considerable contribution to significant cumulative impact	None

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Cause a degradation in groundwater quality such that it would exceed regulatory standards or would substantially impair reasonably anticipated beneficial uses of groundwater	2-5	Not cumulatively considerable contribution to significant cumulative impact	None
Cause an increase in groundwater use that generates a net reduction in groundwater levels that would generate permanent/ inelastic land subsidence caused by water level declines	2-5	No cumulative impact	None
Conflict with or obstruct implementation of a sustainable groundwater management plan	2, 3, 5	No cumulative impact	None
	4	Beneficial	None
Flood Control			
Substantial alteration of the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would: (a) substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site, (b) impede or redirect flood flows.	2-3, 5	Not cumulatively considerable contribution to significant cumulative impact	None
	4	Not cumulatively considerable contribution to significant cumulative impact (Short-term) No cumulative impact (Long-term)	None
Geology and Soils			
Directly or indirectly cause potential substantial adverse effects, including risk of loss, injury, or death, through rupture of a known earthquake fault; strong seismic ground shaking; seismic-related ground failure; and landslides	2-5	Less than significant cumulative impact	None
Located on a geologic unit or soil that is unstable or would become unstable as a result of the project, and potentially would result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse	2-5	Less than significant cumulative impact	None
Complete construction on expansive soils creating a substantial risk to life or property	2-5	Less than significant cumulative impact	None
Result in substantial soil erosion or the loss of topsoil	2-5	Less than significant cumulative impact	None
Result in the loss of availability of a known mineral resource of regional or local importance	2-5	No cumulative impact	None
Result in long term impacts to geology, soils, or mineral resources	2-5	Less than significant cumulative impact	None
Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature	2, 4-5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	PR-1
	3	No cumulative impact	None

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Air Quality			
Conflict with or obstruct implementation of the applicable air quality plan	2	Tunnel Option Constr. - Not cumulatively considerable contribution to significant cumulative impact after mitigation Pipeline Option Constr. –Not cumulatively considerable contribution to significant cumulative impact after mitigation Operation – Not cumulatively considerable contribution to significant cumulative impact	Tunnel - AQ-1, AQ-2, AQ-3 Pipeline - AQ-1, AQ-2, AQ-3, AQ-4, AQ-5
	3	Constr. – Less than significant cumulative impact Operation - Less than significant cumulative impact	None
	4	Constr. – Cumulatively considerable contribution to significant cumulative impact after mitigation Operation - Less than significant cumulative impact	AQ-1, AQ-2, AQ-6
	5	Constr. – Cumulatively considerable contribution to significant cumulative impact after mitigation Operation - Less than significant cumulative impact	AQ-1, AQ-2
Expose sensitive receptors to substantial pollutant concentrations	2-5	Less than significant cumulative impact	None
Cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the general conformity de minimis thresholds.	2-3	No Adverse Impact	None
	4-5	General Conformity Determination Required	None
Create objectionable odors affecting a substantial number of people.	2-5	No cumulative impact	None
Greenhouse Gas Emissions			
Generate greenhouse gas emissions, either directly or indirectly, that could have a significant impact on the environment.	2, 4, 5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	GHG- 1 Carbon Offsets
	3	Not cumulatively considerable contribution to significant cumulative impact	None
Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases.	2, 4, 5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	GHG- 1 Carbon Offsets
	3	Not cumulatively considerable contribution to significant cumulative impact	None
Visual Resources			
Have a substantial adverse effect on a scenic vista (areas with Scenic Attractiveness Class A or Class B classifications are considered scenic vistas)	2	Not cumulatively considerable contribution to significant cumulative impact after mitigation	VIS-1, VIS-3
	3-5	No cumulative impact	None
Substantially damage scenic resources within a State scenic highway corridor.	2, 4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	VIS-4
	3, 5	No cumulative impact	None

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Substantially degrade the existing visual character or quality of the site and its surroundings.	2	Not cumulatively considerable contribution to significant cumulative impact after mitigation	VIS-2
	3-5	No cumulative impact	None
Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area.	2, 3, 5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	VIS-1
	3	No cumulative impact	None
Noise and Vibration			
Expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance.	2-3	Less than significant cumulative impact	None
	4	Cumulatively considerable contribution to significant cumulative impact after mitigation	NOISE-1, NOISE-2, HAZ-5
	5	Cumulatively considerable contribution to significant cumulative impact after mitigation	NOISE-1, NOISE-2, NOISE-3, HAZ-5
Expose sensitive receptors to excessive groundborne vibration or groundborne noise.	2-5	Less than significant cumulative impact	None
Cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	2, 3, 5	Cumulatively considerable contribution to significant cumulative impact after mitigation	NOISE-1
	4	Cumulatively considerable contribution to significant cumulative impact after mitigation	NOISE-1, NOISE-2, NOISE-3
Operational sources located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport could expose people residing or working in the project area to excessive noise levels.	2-5	No cumulative impact	None
Traffic and Transportation			
Cause a substantial increase in traffic in relation to the existing traffic load and capacity of the street system	2-5	Less than significant cumulative impact	None
Substantially increase traffic hazards due to a geometric design feature or incompatible use.	2-5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TR-1
Conflict with a program plan, ordinance or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities	2-5	No cumulative impact	None
Result in inadequate emergency access.	2-5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TR-1
Hazards and Hazardous Materials			
Increase the risk of exposure from hazardous materials to the public and construction workers during alternative construction onsite, during the transport, use or disposal of hazardous materials offsite, and during long-term operations and maintenance activities.	2, 3	Less than significant cumulative impact	None
	4, 5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	HAZ-5
Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment	2-5	Less than significant cumulative impact	None

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Increase the potential for exposure to hazardous materials to local school children and staff with construction located within one-quarter mile of an existing or proposed school	2, 4,5	No cumulative impact	None
	3	Less than significant cumulative impact	None
Interfere with an active remediation site which could create a hazard to the public or the environment if contaminated soil and/or groundwater is encountered and released to the environment.	2	Not cumulatively considerable contribution to significant cumulative impact after mitigation	HAZ-1
	3	Less than significant cumulative impact	None
	4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	HAZ-5
	5	No cumulative impact	None
Conflict with activities and operations at airports near or within the project area during construction, resulting in safety hazards for pilots or people working and residing in the area.	2, 4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	HAZ-3, HAZ-4
	3, 5	No cumulative impact	None
Temporarily interfere with an emergency response plan or emergency evacuation plan for the project vicinity as a result of construction traffic and traffic controls impacting local roads.	2, 4, 5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TR-1
	3	Less than significant cumulative impact	None
Increase the risk of wildfire within the vicinity of the project area through the use of mechanical equipment during construction	2, 4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	HAZ-2
	3, 5	No cumulative impact	None
Aquatic Resources			
Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW, USFWS, or NMFS	2, 3, 4	San Luis Reservoir – No cumulative impact Delta - Not cumulatively considerable contribution to significant cumulative impact	None
	5	Pacheco Creek Construction - Not cumulatively considerable contribution to significant cumulative impact after mitigation Pacheco Creek Operation - Not cumulatively considerable contribution to significant cumulative impact Delta - Not cumulatively considerable contribution to significant cumulative impact	BIO-1, BIO-2
Interfere substantially with the movement of any native resident or migratory fish or aquatic-dependent species or with established native resident or migratory corridors, or impede the use of native nursery sites	2, 3, 4	No cumulative impact	None
	5	Pacheco Creek Construction - Not cumulatively considerable contribution to significant cumulative impact after mitigation Pacheco Creek Operation - No cumulative impact	BIO-1
Conflict with any local policies or ordinances protecting fisheries resources	2-5	No cumulative impact	None
Conflict with the provisions of an adopted HCP, Natural Community Conservation Plan, or other approved local, regional, or State HCP	2-5	No cumulative impact	None

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Terrestrial Resources			
Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as an endangered, threatened, candidate, sensitive, or special-status species, riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by the CDFW, NMFS, or USFWS	2	Not cumulatively considerable contribution to significant cumulative impact after mitigation	BIO-1, TERR-1 through 17
	3	Not cumulatively considerable contribution to significant cumulative impact after mitigation	BIO-1 TERR-6
	4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	BIO-1, TERR-1 through 15
	5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	BIO-1, BIO-2 TERR-1 through 15, TERR-18
Have a substantial adverse effect on Federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coast, etc.) through direct removal, filling, hydrological interruption, or other means	2, 4, 5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TERR-14, TERR-16
	3	No cumulative impact	None
Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites	2	Less than significant cumulative impact	None
	3	No cumulative impact	
	4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TERR-12, TERR-13, TERR-15
	5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TERR-12, TERR-15
Conflict with any local policies or ordinances protecting biological resources, or adopted Habitat Conservation Plan (HCP), Natural Community Conservation Plan (NCCP), or other approved local, regional, or State conservation plan	2	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TERR-1 through TERR-17
	3	Not cumulatively considerable contribution to significant cumulative impact after mitigation	BIO-1, TERR-18
	4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TERR-1, through, TERR-14, TERR-17
	5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	TERR-1, TERR-18
Regional Economics			
Changes in water supply to SCVWD due to low point interruptions could affect the regional economy.	2-5	Beneficial cumulative effect	None
Changes in water supply to CVP M&I users in the Bay Area could affect the regional economy.	2, 3	No cumulative effect	None
	4, 5	Beneficial cumulative effect	None
Changes in water supply to SWP M&I users in Bay Area and Southern California could affect the regional economy.	2, 3	No cumulative effect	None
	4, 5	Beneficial cumulative effect	None
Changes in water supply to agricultural users in the San Joaquin Valley could affect the regional economy.	2, 3	No cumulative effect	None
	4, 5	Beneficial cumulative effect	None

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Construction expenditures could increase employment, income, and output in the regional economy.	2-5	Beneficial cumulative effect	None
Operation and maintenance activities could increase employment, income, and output in the regional economy.	2-5	Beneficial cumulative effect	None
Changes in recreation opportunities could affect economic activity in Merced County related to San Luis Reservoir.	2, 4	Substantial contribution to adverse cumulative effect	None
	3, 5	No cumulative effect	None
Land Use and Agricultural Resources			
Cause an existing community to be physically divided	2, 3	No cumulative impact	None
	4,5	Not cumulatively considerable	None
Result in the conversion of Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to nonagricultural use	2, 3	No cumulative impact	None
	4,5	Not cumulatively considerable	None
Conflict with existing zoning for agricultural use or a Williamson Act contract	2-4	No cumulative impact	None
	5	Not cumulatively considerable contribution to significant cumulative impact after mitigation	LU-1
Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project adopted for the purpose of avoiding or mitigating an environment effect	2, 3	No cumulative impact	None
	4,5	Not cumulatively considerable	None
Recreation			
Substantially reduce recreational use on trails as a result of project construction	2-5	No cumulative impact	None
Substantially reduce access to or close recreation areas as a result of project construction	2, 4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	REC-1
	3, 5	No cumulative impact	None
Substantially contribute to overcrowding or exceed the facility capacity at other recreation sites by displacing users from San Luis Reservoir	2, 4	Not cumulatively considerable contribution to significant cumulative impact after mitigation	REC-1
	3, 5	No cumulative impact	None
Reduce access to recreation uses through long-term operational changes to water levels in recreational water bodies	2	No cumulative impact (non-low point years), Not cumulatively considerable (low point years)	None
	3, 5	No cumulative impact	None
	4	No cumulative impact (trail closures) after mitigation, Beneficial (water-based rec.)	REC-2
Environmental Justice			
Expose a minority and/or low-income population to adverse or disproportionately high effects or hazards from project construction.	2, 4	Adverse cumulative effect, would not disproportionately impact minority and low-income populations in the study area	None
	3, 5	Adverse cumulative effect, would not disproportionately impact minority populations in the study area	None
Public Utilities, Services, and Power			
Construction activities could affect the provision of governmental services or facilities including fire and police protection, and schools.	2-5	Less than significant cumulative impact	None

Significance Criteria	Alt.	Contribution to Cumulative Condition	Mitigation
Construction activities could result in the need for new water, wastewater, or stormwater facilities.	2-5	Less than significant cumulative impact	None
Construction activities would generate solid waste, the disposal of which could exceed the capacity of landfills designated to accommodate the project's solid waste disposal needs.	2-5	Less than significant cumulative impact	None
Construction activities could result in adverse impacts associated with the use and/or depletion of local or regional energy supplies.	2-5	Less than significant cumulative impact	None
Operations could result in increases in stormwater runoff and the need for new stormwater drainage facilities.	2-5	Less than significant cumulative impact	None
Changes in the operation of Pacheco Pumping Plant under the Lower San Felipe Intake Alternative could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies.	2, 4	Less than significant cumulative impact	None
Long-term operations of the hypolimnetic aeration system could result in the need for additional capacity of energy supplies or the depletion of local or regional energy supplies.	2	Less than significant cumulative impact	None
Long-term operations could result in wasteful, inefficient, or unnecessary consumption of energy	2-5	Less than significant cumulative impact	None
Cultural Resources			
Result in adverse effects to historic properties listed or eligible for listing in the NRHP, and/or substantial adverse changes to historical resources or unique archaeological resources listed or eligible for listing in the CRHR	2	Cumulatively considerable contribution to significant cumulative impact after mitigation	CR-1
	3	No cumulative impact	None
	4, 5	Cumulatively considerable contribution to significant cumulative impact after mitigation	CR-1
Population and Housing			
Temporarily induce population growth in the area of analysis, and potentially require new housing to accommodate this growth	2-5	Not cumulatively considerable contribution to significant cumulative impact	None
Construction could displace people or houses, and potentially require construction of replacement housing.	2-5	No cumulative impact	None
Induce substantial population growth or housing in the area of analysis	2-5	No cumulative impact	None
Operations could displace a number of people or houses, and potentially require construction of replacement housing.	2-5	No cumulative impact	None

Key: Ag = agricultural; Alt = alternative; CVP = Central Valley Project; SCVWD = Santa Clara Valley Water District; SWP = State Water Project

Chapter 6 Disclosures, Coordination, and Supplemental Material

NEPA and CEQA require consideration of irreversible and irretrievable commitments of resources and significant and unavoidable impacts. These considerations are described in this chapter. In addition, this chapter summarizes activities undertaken by Reclamation and SCVWD for public and agency involvement required for SLLPIP. For a complete list of regulatory requirements necessary for implementation of the SLLPIP alternatives, see Appendix C. This chapter also provides supplemental information, including a list of preparers, acronyms, references, glossary, and index.

6.1 Irreversible and Irretrievable Commitment of Resources

Construction of all the action alternatives evaluated in this EIS/EIR would involve the consumption of non-renewable natural resources. These non-renewable natural resources would consist of petroleum for fuels necessary to operate equipment used during construction activities. This would include generation of waste from earth-moving activities during the tunneling action, dredging of soils during installation of the pipeline under Alternative 2, site preparation for the placement of new treatment infrastructure on new pads at the treatment plant under Alternative 3, preparation of the embankment for the placement of new materials and the demolition of sections of the Gianelli Intake Structure and an existing berm at the Pacheco Pumping Plant under Alternative 4, and demolition of an existing dam, and preparation of the site for a new dam under Alternative 5. Soils would be placed on site near the areas where they were excavated or potentially reused under some of the alternatives to support the development of new infrastructure. Construction waste from the disposal of non-soil materials removed during the construction of these alternatives would be hauled to regional landfills. Petroleum fuels would be used to haul these materials to the disposal sites. In addition to fuels used in transportation, the use of the disposal sites would constitute an irreversible and irretrievable commitment of resources. Operation of Alternatives 4 and 5 would also result in newly inundated lands. The commitment of this land would result in an irretrievable loss of this resource.

6.2 Significant and Unavoidable Impacts

Significant and unavoidable adverse effects refer to the environmental consequences of an action that cannot be avoided by redesigning the Project, changing the nature of the Project, or implementing mitigation measures. NEPA requires a discussion of any adverse impacts that cannot be avoided (40 CFR 1502.16). The CEQA Guidelines require a discussion on significant environmental effects that cannot be avoided and those that can be mitigated but not reduced to an insignificant level (Sections 15126.2[a] and 15126.2[b]). This section discusses the significant and unavoidable impacts of the action alternatives presented in Chapter 2.

Table 6-1 presents the impacts which, even after mitigation measures are implemented, may remain significant and unavoidable for the action alternatives.

Table 6-1. Summary of Significant and Unavoidable Impacts

Impact	Alternative	Mitigation Measures	Evaluation of Significant and Unavoidable Impacts
WS: Construction activities could cause temporary reduction in the annual supply of water available to the CVP, SWP, or other water users.	4	None	Section 4.2.6
AQ: Construction activities could cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the significance thresholds.	4, 5	AQ-1: Reduction of construction-related emissions, AQ-2: On-road engine model year 2015 or newer, AQ-6: Pave all unpaved roads	Section 4.7.6 and Section 4.7.7
NOI: Construction activities could expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance	4, 5	NOISE-1: Noise Control Plan, NOISE-2: Pre-Construction Surveys, Monitoring and Retrofit, HAZ-5: Blasting Plan - (Alts. 4 and 5) NOISE-3: Pump Station Enclosure - (Alt. 5)	Section 4.10.6 and Section 4.10.7
CUL: Project construction may result in direct impacts to or the inundation of known and unknown cultural resources eligible for listing in the NRHP and/or the CRHR may lie within the intake area APE that cannot be observed, recorded, evaluated, or mitigated.	2, 4, 5	NEPA-only mitigation: Avoidance, minimization of impacts, and/or mitigation measures, determined through completion of the Section 106 process, will be required prior to implementation of this alternative. CEQA and NEPA mitigation: CR-1: Complete Survey and Evaluation, CR-2: Avoidance and Minimization, CR-3: Inadvertent Discovery Plan	Section 4.20.4

Impacts with the potential to result in a cumulatively considerable contribution to a significant cumulative impact are shown in Table 6-2.

Table 6-2. Impacts of Action Alternatives with the Potential to Result in a Cumulatively Considerable Incremental Contribution to a Significant Cumulative Impact

Resource Area	Impact
Groundwater Resources	The alternatives could cause changes in water deliveries to South-of-Delta CVP and SWP contractors and changes in storage in San Luis Reservoir resulting in increased groundwater use.
Air Quality	The San Luis Reservoir Expansion Alternative could cause temporary and short-term construction-related emissions of criteria pollutants or precursors that would exceed the significance thresholds.
Noise and Vibration	Construction activities could cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above existing levels, even without the Project. Additionally, construction activities associated with the San Luis Reservoir Expansion Alternative could expose sensitive receptors to noise levels in excess of standards established in the local general plan or noise ordinance and could expose sensitive receptors to excessive groundborne vibration or groundborne noise.
Regional Economics	The reduced visitor spending that would occur for the 8 to 12 year construction period and would be a substantial cumulative effect to the regional economy in Merced County.
Environmental Justice	Exposure of a minority and/or low-income population to adverse or disproportionately high effects or hazards from project construction in combination with other cumulative projects.
Cultural Resources	Construction of the proposed intake tunnel or pipeline, road improvements, and use or modification of staging areas may alter or destroy known or unknown cultural resources.

6.3 Areas of Controversy and Issues to be Resolved

CEQA requires disclosure of areas of controversy raised by agencies and the public and issues to be resolved. Table 6-3 presents a summary of the project issues identified during the scoping period. The scoping reports (SCVWD 2002, United States Department of Interior [DOI] and Reclamation 2008) provide further information on issues identified by agencies and the public during the public scoping process. Issues to be resolved include the final selection of the proposed action/project, and final selection of mitigation measures to reduce significant impacts.

Table 6-3. Areas of Controversy and Issues Raised by Agencies and the Public

Areas of Controversy/Issue	Summary of Issue	Document/Section Addressing Issue
Impacts to Land Use and Agriculture	Impacts of the action alternatives on residential property, agriculture, and grazing lands in the project area if the action alternatives are implemented.	Section 4.16 Land Use and Agricultural Resources
Impacts to Wildlife	Impacts of the action alternatives on wildlife habitat for sensitive and/or special status species	Section 4.13 Aquatic Resources and Section 4.14 Terrestrial Resources
Alternatives Analyzed in the EIS/EIR	Safety issues related to flooding and earthquake hazards if new dams were constructed. The range of alternatives considered in the EIS/EIR.	Chapter 2 Project Description

Areas of Controversy/Issue	Summary of Issue	Document/Section Addressing Issue
Impacts to Recreation, Power and Visual Resources	Impacts of the action alternatives on fishing, recreation, power generation and visual quality if the action alternatives are implemented	Section 4.9 Visual Resources, Section 4.17 Recreation, and Section 4.19 Public Utilities, Services and Power
Impacts to Water Quality	Impacts of the action alternatives on water quality if the action alternatives are implemented	Section 4.1 Water Quality
Federal Interest in the SLLPIP	Clarification of the Federal interest in the SLLPIP	Chapter 1 Introduction

Key: SLLPIP = San Luis Low Point Improvement Project

6.4 Agency Coordination

The development of the SLLPIP EIS/EIR, and implementation of the proposed action/project, has and will require coordination with a variety of Federal, State, and local agencies. The following sections describe these agencies and their roles in the process.

6.4.1 United States Fish and Wildlife Service

Reclamation initiated informal consultation with USFWS in July 2007 to ensure compliance with Endangered Species Act and the Fish and Wildlife Coordination Act. The USFWS provided Reclamation with a list of all the endangered species in each alternative's area of analysis that was utilized to support the analysis in Chapter 4. The USFWS will receive a copy of the Draft EIS/EIR for review. Depending on the preferred alternative's potential to affect ESA-listed species, Reclamation will either submit a letter documenting no effect or a Biological Assessment for compliance with ESA.

6.4.2 National Marine Fisheries Service

Construction activity could temporarily cause direct or indirect impacts to South-Central California Coast Steelhead and their habitat. If Alternative 5 is the preferred Alternative, consultation with NMFS would be initiated under Section 7 of ESA for construction related impacts on South-Central California Coast Steelhead.

6.4.3 U.S. Army Corps of Engineers

The SLLPIP has the potential to impact wetlands. Therefore, Reclamation and/or SCVWD will coordinate with the Corps Regulatory Division regarding any need for a CWA Section 404 permit.

6.4.4 California Department of Parks and Recreation

The CDPR manages the lands surrounding San Luis Reservoir. The NOI/NOP was sent to CDPR and CDPR will also receive a copy of this Draft EIS/EIR for their review. Reclamation and/or

SCVWD will coordinate with CDPR to discuss potential impacts to recreation from SLLPIP, and mitigation measures to reduce these impacts.

6.4.5 State Historic Preservation Officer

Implementation of the preferred alternative for the SLLPIP will require compliance with 54 United States Code (U.S.C.) § 306108, commonly known as Section 106 of the National Historic Preservation Act. To complete the Section 106 process, as outlined at 36 CFR Part 800, Reclamation is required to consult with SHPO, and afford the ACHP an opportunity to comment, regarding the effects of the proposed undertaking on historic properties. Historic properties are cultural resources that are listed, or eligible for listing, on the NRHP. Reclamation must complete the Section 106 process prior to the approval of the expenditure of Federal funds for the SLLPIP.

6.4.6 San Francisco Regional Water Quality Control Board and Central Valley Regional Water Quality Control Board

The preferred alternative for the SLLPIP could require several permits from the San Francisco RWQCB and Central Valley RWQCB including a dewatering permit, coverage under a NPDES permit for General Construction, and water discharge requirements for discharges to waters of the State. Reclamation and/or SCVWD will be consulting with the San Francisco RWQCB and Central Valley RWQCB to determine the correct permits and their requirements. Reclamation and the construction contractor will obtain these permits prior to construction. The San Francisco RWQCB and Central Valley RWQCB will receive a copy of the Draft EIS/EIR for review.

6.4.7 State Water Resources Control Board

SCVWD will be coordinating with SWRCB on the CWA Section 401 Water Quality Certification process that will be conducted concurrent with the CWA Section 404 permitting process. The SWRCB will receive a copy of the Draft EIS/EIR for review. SCVWD will also coordinate with SWRCB on the need for any new water rights required for an expanded Pacheco Reservoir.

6.4.8 San Joaquin Air Pollution Control District and Bay Area Air Quality Management District

The SLLPIP has the potential to impact air quality in Merced County and Santa Clara County. Reclamation and/or SCVWD will coordinate with the SJVAPCD regarding air quality impacts in Merced County and with BAAQMD regarding air quality impacts in Santa Clara County. SJVAPCD and BAAQMD will receive a copy of the Draft EIS/EIR for review.

6.4.9 California Department of Fish and Wildlife

The SLLPIP has the potential to affect species covered under the California Endangered Species Act. SCVWD will consult with the CDFW regarding the need for a Section 2081 incidental take permit under the California Endangered Species Act. A Lake or Streambed Alteration

Agreement from the CDFW will be required before project construction activities commence. SCVWD will be signing a contract with CDFW to provide ecosystem enhancement benefits for WSIP funding (refuge water supply and Pacheco Creek fisheries). The CDFW will receive a copy of the Draft EIS/EIR for review.

6.4.10 California Department of Water Resources

The SLLPIP alternatives would all change to varying degrees operations at San Luis Reservoir. San Luis Reservoir is jointly managed by Reclamation and DWR. DWR will receive a copy of the Draft EIS/EIR for review and, depending on the SLLPIP alternative selected for implementation, Reclamation and/or SCVWD will coordinate with DWR on potential changes to San Luis Reservoir operations.

DWR has administered grant funding to SCVWD for their participation in the SLLPIP and will file with the SWRCB for the water rights change necessary to expand the SWP place of use to include the south-of-Delta CVP service area. SCVWD will be signing a contract with DWR to provide emergency response benefits for WSIP funding.

The Division of Safety of Dams (DSOD) will evaluate and approve dam designs for Alternative 5. SCVWD will obtain a DSOD Dam Construction Permit before geotechnical borings are conducted at the Project site. An Operational License will be issued after the new dam, expanded Pacheco Reservoir, and appurtenant facilities are constructed.

6.4.11 California High Speed Rail Authority

The SLLPIP has the potential overlap with the construction of the California High Speed Rail Project, which could have a cumulative impact on roadway and highway traffic, air quality, staging locations and land uses, borrow acquisition, and waste disposal in the study area. Reclamation and SCVWD will coordinate with the HSRA on potential mitigation for any SLLPIP and high-speed rail cumulative impacts. HSRA will receive a copy of the Draft EIS/EIR for review.

6.4.12 Local Governments

The SLLPIP has the potential to impact facilities, land uses, and resources within Santa Clara and Merced Counties, the cities of Gustine and Los Banos in Merced County, and the cities of San Jose, Saratoga, Los Gatos, Milpitas, and Campbell, Gilroy and the Town of Los Gatos in Santa Clara County. The Santa Clara County Department of Planning and Development may require Encroachment and Building permits before construction activities commence. In addition, the SCVWD will need to obtain an Excavation Permit from the County for use in the proposed project’s borrow sites. These local governments will receive a copy of the Draft EIS/EIR for review. Reclamation and/or SCVWD will coordinate with these local governments potentially impacted by the SLLPIP.

6.5 Distribution List

Copies of the Draft EIS/EIR were sent to the following agencies and organizations:

6.5.1 Federal Agencies

- National Marine Fisheries Service
- NOAA Fisheries
- United States House of Representatives
- United States Senate
- U.S. Army Corps of Engineers
- U.S. Bureau of Indian Affairs
- U.S. Bureau of Land Management
- U.S. Bureau of Reclamation
- U.S. Department of the Interior, Office of the Solicitor
- U.S. Department of Justice
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service

6.5.2 State Agencies

- California Bay-Delta Authority
- California Department of Fish and Wildlife
- California Department of Parks and Recreation
- California Department of Transportation
- California Department of Water Resources
- California Environmental Protection Agency
- California High Speed Rail Authority
- California Office of Historic Preservation
- California Regional Water Quality Control Board (Region 5)
- California State Assembly
- California State Senate
- California State Water Resources Control Board

6.5.3 Regional and Local Parties

- Alameda County
- Bay Area Air Quality Management District
- City of Gilroy
- City of Gustine
- City of Los Banos
- City of San Jose
- Contra Costa County
- East Bay Municipal Utility District
- Fresno County
- Kern County
- Kings County
- Los Angeles County
- Madera County
- Merced County
- Orange County
- Pacific Gas & Electric
- San Benito County
- San Bernardino County
- San Diego County
- San Joaquin County
- San Joaquin Valley Air Pollution Control District
- San Luis Obispo County
- Santa Barbara County
- Santa Clara County
- Santa Clara Valley Water District
- Stanislaus County
- Tulare County
- Ventura County

6.6 List of Preparers

This EIS/EIR was prepared by Reclamation and SCVWD. A list of persons who prepared various sections of the EIS/EIR, significant background materials, or participated to a significant degree in preparing this EIS/EIR is presented below in Tables 6-4 through 6-6.

Table 6-4. Federal Agencies

Preparers	Agency	Role In Preparation
Michelle Denning	Bureau of Reclamation	Project objective identification, alternative formulation, EIS/EIR development and review
Lauren Frye	Bureau of Reclamation	EIS/EIR development and review
Nicole Johnson	Bureau of Reclamation	EIS/EIR development and review
Sharon McHale	Bureau of Reclamation	Project objective identification, alternative formulation, EIS/EIR development and review
Arlan Nickel	Bureau of Reclamation	EIS/EIR development and review
Michael Tansey, PhD.	Bureau of Reclamation	EIS/EIR development and review
Bill Taylor	Bureau of Reclamation	Alternative Screening

Table 6-5. Regional Agencies

Preparers	Agency	Role In Preparation
Behzad Ahmadi	SCVWD	Groundwater modeling
Tom Boardman	SLDMWA	Project objective identification, alternative formulation
Tracy Hemmeter	SCVWD	EIS/EIR development and review
Kellye Kennedy	SCVWD	Project objective identification, alternative formulation, EIS/EIR development and review
Yaping Liu	SCVWD	Groundwater modeling
Michael Martin	SCVWD	EIS/EIR development and review
Frances Mizuno	SLDMWA	Project objective identification, alternative formulation
Judy Nam	SCVWD	Groundwater modeling
Terri Neudorf	SCVWD	EIS/EIR development and review
Melih Ozbilgin	SCVWD	EIS/EIR development and review

Key: SCVWD = Santa Clara Valley Water District; SLDMWA = San Luis Delta-Mendota Water Agency;
WEAP = Water Evaluation and Planning

Table 6-6. Consultants

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role In Preparation
CDM Smith			
Carrie Buckman, P.E.	B.S. Environmental Engineering and Urban Planning M. Environmental Engineering 20 years experience	Water Resources Engineer	Program Director
Yonnel Gardes	B.S. Civil Engineering M.S. Transportation Engineering 17 years experience	Transportation Planner	Traffic and Transportation
Donielle Grimsley	B.S. Biology 10 years experience	Environmental Scientist	Water Quality

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role In Preparation
Brian Heywood, P.E.	M.S. Civil Engineering 18 years experience	Senior Water Resource Engineer	Groundwater
Anusha Kashyap	M.S. Environmental Engineering 8 years experience	Environmental Engineer	Groundwater, Water Supply and Socioeconomics
Laura Lawson	B.S. Environmental Studies 2 years experience	Environmental Planner	Geology and Soils, Visual Resources, Noise, and Environmental Justice
Terichael Office	B.S. Environmental Engineering 3 years experience	Environmental Engineer	Land Use, and Agricultural Resources
Christopher Park, AICP	M.S. City and Regional Planning 13 years experience	Water Resources Planner	Project Manager, Introduction, Project Description, Water Supply, Cumulative Impacts
Gwen Pelletier	M.S. Environmental Studies 13 years experience	Environmental Scientist	Air Quality and Greenhouse Gases
Gina Veronese	M.S. Agricultural and Resource Economics 16 years experience	Resource Economist	Socioeconomics
Suzanne Wilkins, AICP	B.S. Business Administration 25 years experience	Water Resources Planner	Hazardous Waste, Public Utilities, Flood Control, and Growth Inducing Impacts
Abbie Woodruff, AICP	M.S. Urban and Environmental Planning B.S. Geography B.S. Environmental Studies 4 years experience	Water Resources Planner	Document Review and Revision, Introduction, Project Description, Water Quality, Water Supply, Consultation and Coordination
Tyler Yniguez	B.S. Civil Engineering 4 years experience	Environmental Engineer	Public Utilities and Power, Population and Housing, Recreation
Pacific Legacy			
Katelyn Fittinghoff	B.A., 2 years experience	Technician - Prehistoric Archaeology	Cultural Resources
Marc Greenberg	M.A., 20 years experience	Supervisor - Prehistoric/Historic Archaeology	Cultural Resources
Rose Guthrie	B.A., 2 years experience	Technician - Prehistoric Archaeology	Cultural Resources
Lisa Holm	Ph.D., 20 years experience	Supervisor - Prehistoric/Historic Archaeology	Cultural Resources
John Holson	M.A., 35 years experience	Principal - Regulatory Compliance; Prehistoric/Historic Archaeology	Cultural Resources
Sandra Ledebuhr	B.A., 4 years experience	Technician - Prehistoric Archaeology	Cultural Resources

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role In Preparation
Mary O'Neil	B.A., 15 years experience	Supervisor - Prehistoric/Historic Archaeology	Cultural Resources
Chris Peske	B.A., 5 years experience	Technician - Prehistoric Archaeology	Cultural Resources
Ellie Reese	M.A., 20 years experience	Supervisor - Historic Archaeology	Cultural Resources
Josh Varkel	B.A., 2 years experience	Technician - Prehistoric Archaeology	Cultural Resources
Environmental Science Associates			
Brian Pittman, CWB	M.S. Environmental Studies 19 years experience	Terrestrial Biologist	Terrestrial Resources
Julie Remp	B.S. Wildlife, Fish, and Conservation Biology 10 years experience	Terrestrial Biologist	Terrestrial Resources
Gerrit Platenkamp, Ph.D.	Ph.D. Ecology 24 years experience	Terrestrial Biologist	Terrestrial Resources
Christopher Fitzer	M. Environmental Planning 19 years experience	Fisheries Biologist	Fisheries Resources
Paul Bergman	M.S. Fisheries B.S. Fisheries and Biology 13 years experience	Fisheries Biologist	Fisheries Resources
MBK Engineers			
Lee Bergfeld	M.S. Civil Engineering, 18 years experience	Hydrological Modeling	Appendix B, CalSim modeling, SCVWD Model result integration
Walter Bourez	M.S. Civil Engineering, 24 years experience	Hydrological Modeling	Appendix B, CalSim modeling, SCVWD Model result integration
Ian Uecker	M.S. Civil Engineering, 2 years experience	Hydrological Modeling	Appendix B, CalSim modeling
Wesley Walker	M.S. Civil Engineering, 2 years experience	Hydrological Modeling	Appendix B, CalSim modeling

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Glossary

100-year flood: A flood having a 1% chance of being equaled or exceeded in magnitude in any given year.

acre-foot: The quantity of water required to cover 1 acre to a depth of 1 foot. Equal to 1,233.5 cubic meters (43,560 cubic feet).

affect/effect: To affect (a verb) is to bring about a change. An effect (usually a noun) is the result of an action.

affected environment: Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as a result of a proposed human action.

air quality: Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

alternatives: Courses of action that may meet the objectives of a proposed action at varying levels, including the most likely future without the project or action. An environmental assessment or an environmental impact statement identifies and objectively evaluates and analyzes all reasonable alternatives, including a no action alternative.

Ambient Air Quality Standards (AAQS): The U.S. Environmental Protection Agency sets National Ambient Air Quality Standards (NAAQS), as required by the Clean Air Act, and the California Air Resources Board sets California Ambient Air Quality Standards (CAAQS), as required by the California Clean Air Act, for pollutants considered harmful to public health or the environment. AAQS are in place for six pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.

ambient noise: Also called background noise, ambient noise is the background sound pressure level at a given location, normally specified as a reference level to study a new intrusive sound source.

aqueduct: Man-made canal or pipeline used to transport water.

aquifer: An underground geologic formation of permeable rock that stores, transmits, and yields significant quantities of groundwater to wells and springs.

archaeology: The study of human activity through the recovery and analysis of material culture. The archaeological record consists of artifacts, architecture, biofacts or ecofacts, and cultural landscapes.

assimilative capacity: The ability of a body of water to cleanse itself; to receive waste waters or toxic substances without deleterious effects and without damage to aquatic life or humans who consume the water.

bedrock: The solid rock at the surface or underlying other surface materials.

beneficial use: As defined in Water Code §13050, beneficial uses of the waters of the state include domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

berm: A horizontal strip or shelf built into an embankment or cut to break the continuity of the slope, usually for the purpose of reducing erosion or to increase the thickness of the embankment at a point of change in a slope or defined water surface elevation. A horizontal step in the sloping profile of an embankment dam.

best management practice (BMP): A policy, program, practice, rule, regulation, or ordinance for the use of devices, equipment, or facilities that is an established and generally accepted practice resulting in more efficient use or conservation of water, or a practice that has been given to indicate that significant conservation benefits can be achieved.

borrow area: The area from which natural materials, such as rock, gravel or soil, used for construction purposes is excavated.

California Environmental Quality Act (CEQA): California legislation that requires State, regional, and local agencies to prepare environmental impact assessments of proposed projects with potentially significant environmental effects and to circulate these documents to other agencies and the public for comment before making decisions. CEQA requires the lead agency to make findings for all significant impacts identified in an Environmental Impact Report. The lead agency must adopt all mitigation to reduce environmental impacts to a less-than significant level, unless the mitigation is infeasible or unavailable and there are overriding considerations that require the project to be approved. See Public Res. Code 21001.1, 21002, 21080; Guidelines 15002(c).

CalSim model: CalSim is a planning tool and model designed to simulate the operations of the CVP and SWP reservoir and water delivery system under current and future conditions. CalSim predicts how reservoir storage and river flows would be affected based on changes in system operations. CalSim output is typically used to help assess impacts on water supply, water quality, aquatic resources, and recreation.

Central Valley Project (CVP): As defined by Section 3403(d) of the Central Valley Project Improvement Act, "all Federal reclamation projects located within or diverting water from or to the watershed of the Sacramento and San Joaquin rivers and their tributaries as authorized by the Act of August 26, 1937 (50 Stat. 850) and all Acts amendatory or supplemental thereto, ..."

Central Valley Project water service contractor: Water users who have contracted with Reclamation for water developed by and conveyed through CVP facilities.

crest: The top surface of a weir or dam.

critical habitat: A description of the specific areas with physical or biological features essential to the conservation of a listed species and that may require special management considerations or protection. These areas have been legally designated via Federal Register notices.

cubic feet per second (cfs): A measure of the volume rate of water movement. As a rate of stream flow, a cubic foot of water passing a reference section in 1 second of time. One cubic foot per second equals 0.0283 meters per second (7.48 gallons per minute). One cubic foot per second flowing for 24 hours produces approximately 2 acre-feet.

cultural resources: Prehistoric and historic archaeological sites, architectural/built-environment resources (e.g., levees, weirs, buildings), and places important to Native Americans and other ethnic groups, generally 50 years old or older regardless of their significance.

dam: An artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water.

dam failure: Catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water or the likelihood of such an uncontrolled release.

delta: A low, nearly flat alluvial tract of land formed by deposits at or near the mouth of a river.

Dissolved Oxygen (DO): A commonly employed measure of water quality. The concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation. DO levels are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life.

earthquake: A sudden motion or trembling in the earth caused by the abrupt release of accumulated stress along a fault.

electrical conductivity: A measure of the total concentration of dissolved salts in water. A measure of a water’s ability to conduct electricity.

embankment: An earth structure, the top of which is higher than the adjoining surface.

Endangered Species Act (ESA) of 1973, as Amended: Federal legislation that is intended to provide a means to conserve the ecosystems upon which endangered and threatened species depend, and to provide programs for the conservation of those species, thus preventing extinction of plants and animals. The law is administered by the U.S. Department of the Interior’s Fish and Wildlife Service and Department of Commerce’s National Marine Fisheries Service, depending on the species.

erosion: The gradual wearing away of land by water, wind, and general weather conditions; the diminishing of property by the elements.

expansive soils: Soils that shrink and swell as a result of moisture changes.

exports: Water diverted from the Delta and conveyed to users outside the Delta.

fault: A fracture or fracture zone in the earth along which there has been displacement of the two sides relative to one another and which is parallel to the fracture.

filter: A material or constructed zone of earthfill that is designed to permit the passage of flowing water through it, but prevents the passage of significant amounts of suspended solids through it by the flowing water.

flood: A temporary rise in water levels resulting in inundation of areas not normally covered by water.

floodplain: Any land area susceptible to inundation by floodwaters from any source.

flow: The volume of water passing a given point per unit of time.

freeboard: Vertical distance between the reservoir surface elevation and the top of the dam.

groundwater: Any water naturally stored underground in aquifers, or that flows through and saturates soil and rock, supplying springs and wells.

groundwater basin: An alluvial aquifer or a stacked series of alluvial aquifers with reasonably well defined boundaries in a lateral direction and having a definable bottom.

groundwater level: Refers to the water level in a well, and is defined as a measure of the hydraulic head in the aquifer system.

Groundwater Management Plan: A comprehensive written document developed for the purpose of groundwater management and adopted by an agency having appropriate legal or regulatory authority.

groundwater overdraft: A condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years.

groundwater pumping: Quantity of water extracted from groundwater storage.

groundwater recharge: The natural and intentional infiltration of surface water into the zones of saturation.

groundwater subbasin: A subdivision of the groundwater basin created by dividing the basin using geologic and hydrologic conditions or institutional boundaries.

habitat: The place or environment where a plant or animal naturally lives and grows.

habitat conservation plan: A plan that outlines ways of maintaining, enhancing, and protecting a given habitat type needed to protect species; usually includes measures to minimize impacts, and may include provisions for permanently protecting land, restoring habitat, and relocating plants or animals to another area.

hazard: A situation that creates the potential for adverse consequences such as loss of life, property damage, or other adverse impacts.

hydroseeding: a planting process which utilizes a slurry of seed and mulch.

Indian Trust Assets (ITAs): Indian trust assets are legal interests in property held in trust by the federal government for federally recognized Indian tribes or individual Indians. "Assets" are anything owned that has monetary value.

inflow: Water that flows into a body of water.

intake: Any structure through which water can be drawn into a waterway. Any structure in a reservoir, dam, or river through which water can be discharged.

landslide: The unplanned descent (movement) of a mass of earth or rock down a slope.

lead agency: The government agency that has the principal responsibility for carrying out or approving a project and therefore the principal responsibility for preparing CEQA/NEPA documents. For the B.F. Sisk Dam Corrective Action Study EIS/EIR, U.S. Department of the Interior, Bureau of Reclamation is the Federal lead agency under NEPA and the California Department of Water Resources is the State lead agency under CEQA.

levee: A natural or artificial barrier that helps keep rivers from overflowing their banks.

liquefaction: The process in which soil loses cohesion when subject to seismic activity (i.e., shaking).

mitigation: To moderate, reduce, or alleviate the impacts of a proposed activity; includes, in order, (1) avoiding the impact by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (5) compensating for the impact by replacing or providing substitute resources or environments.

National Environmental Policy Act (NEPA): Federal legislation establishing the national policy that environmental impacts will be evaluated as an integral part of any major Federal action. Requires the preparation of an Environmental Impact Statement for all major Federal actions significantly affecting the quality of the human environment.

Natural Community: A distinct and reoccurring assemblage of plants and animals associated with specific physical environmental conditions and ecological processes.

Notice of Determination (NOD): A brief notice to be filed by a public agency after it approves or determines to carry out a project subject to the requirements of CEQA.

outflow: The amount of water passing a given point downstream of a structure, expressed in acre-feet per day or cubic feet per second. Water flowing out of a body of water.

overtopping: Flow of water over the top of a dam or embankment.

paleontology: The study of the forms of life existing in prehistoric or geologic times, as represented by the fossils of plants, animals, and other organisms.

public involvement: Process of obtaining citizen input into each stage of the development of planning documents. Required as a major input into any Environmental Impact Statement or Environmental Impact Report.

qualitative: Having to do with quality or qualities. Descriptive of kind, type or direction, as opposed to size, magnitude or degree.

quantitative: Having to do with quantity, capable of being measured. Descriptive of size, magnitude or degree.

Reasonable and Prudent Alternative (RPA): Alternative action identified during formal consultation (under Section 7 of the ESA) that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) U.S. Fish and Wildlife Service or National Marine Fisheries Service believes would avoid the likelihood of jeopardizing the continued existence of listed species or result in the destruction or adverse modification of critical habitat (50 CFR 402.02).

Record of Decision (ROD): Concise, public, legal document required under the National Environmental Policy Act that identifies and publicly and officially discloses the responsible official's decision on an alternative selected for implementation. It is prepared following completion of an Environmental Impact Statement.

reservoir: A body of water impounded by a dam and in which water can be stored.

riprap: A layer of large uncoursed stone, precast blocks, bags of cement, or other suitable material, generally placed on the slope of an embankment or along a watercourse as protection against erosion.

salinity: The amount of dissolved salts in a given volume of water.

San Luis Low Point Improvement Project: Prepared jointly by the U.S. Department of the Interior, Bureau of Reclamation and the Santa Clara Valley Water District to address water supply reliability and schedule certainty issues for Santa Clara Valley Water District associated with low water levels in San Luis Reservoir.

Safety of Dams Corrective Action Study: Prepared jointly by the United States Department of the Interior, Bureau of Reclamation and the California Department of Water Resources to address dam stability and safety concerns associated with several sections of the B.F. Sisk Dam.

scenic vista: A viewpoint that provides expansive views of a highly valued landscape for the benefit of the general public. Areas with Scenic Attractiveness Class A or Class B classifications are considered scenic vistas.

sediment: Any finely divided organic and/or mineral matter deposited by air or water in nonturbulent areas.

seismicity: The frequency, intensity, and distribution of earthquake activity in a given area.

shear key: A device to transfer shear across a joint, usually a moveable immersion joint.

south-of-Delta: Water storage supplied with water exported south from the Delta.

State Water Project (SWP): California's State-owned and -operated water project consisting of 22 dams and reservoirs, which delivers water 600 miles from the Sacramento Valley to Los Angeles.

State Water Project water service contractor: Water users who have contracted with the California Department of Water Resources for water developed by and conveyed through SWP facilities.

stormwater: Untreated surface runoff into a body of water during periods of precipitation.

subsidence: A local mass movement that involves principally the gradual downward settling or sinking of the earth's surface with little or no horizontal motion.

Sustainable Groundwater Management Act (SGMA): Requires that all groundwater basins categorized as medium- and high-priority form a Groundwater Sustainability Agency and be managed under a Groundwater Sustainability Plan by January 31, 2020.

total maximum daily load (TMDL): Estimates of the amount of specific pollutants that a body of water can safely take without threatening beneficial uses.

Toxic Air Contaminants: According to Section 39655 of the California Health and Safety Code, a toxic air contaminant is "an air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose present or potential hazard to human health." Section 39655 also incorporates all federal hazardous air pollutants as toxic air contaminants by reference.

turbidity: A measure of the cloudiness of water caused by the presence of suspended matter. Turbidity in natural waters may be composed of organic and/or inorganic constituents, and has direct implications to drinking water treatment.

visual resources: The natural and artificial features of a landscape that characterize its form, line, texture, and color.

water year: A continuous 12-month period for which hydrological records are compiled and summarized. In California, a water year begins October 1 and ends September 30 of the following year.

water year hydrologic classification: Characterization of the hydrologic record for streams into wet, normal, and dry periods. Based on the Sacramento Valley Index, water year classifications are determined using the following equation:

$$\text{INDEX} = 0.4 * X + 0.3 * Y + 0.3 * Z$$

Where: X = Current year's April – July Sacramento Valley unimpaired runoff

Y = Current October – March Sacramento Valley unimpaired runoff

Z = Previous year's index

Classification	Millions of Acre-Feet
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8 and less than 9.2
Below Normal	Equal to or less than 7.8 and greater than 6.5
Dry	Equal to or less than 6.5 and greater than 5.4
Critical	Equal to or less than 5.4

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EXHIBIT 5

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY **GAVIN NEWSOM,** *Governor*

DEPARTMENT OF WATER RESOURCES
P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

December 20, 2021

Mr. Steve Lindsay, President
Pacheco Pass Water District
Post Office Box 1382
Hollister, California 95023

North Fork Dam, No. 77
Santa Clara County

Dear Mr. Lindsay:

This is to inform the Pacheco Pass Water District (District) that the Division of Safety of Dams (DSOD) has completed an independent assessment of the spillway at North Fork Dam consisting of a file review and visual inspection. DSOD conducted this review given the risk posed by the unmitigated failure of a section of the left spillway wall and the urgent need to evaluate the remainder of the structure for additional deficiencies. The left wall section failed in January 2017 and has not been mitigated despite DSOD's April 5, 2017 and April 6, 2018 letters ordering its repair.

Based on DSOD's review and inspection, the spillway is vulnerable to failure during future storms or landslide events due to its lack of maintenance, design deficiencies, and history of failures. Therefore, we conclude that the spillway must be replaced with one meeting modern design standards. This new spillway must be completed by December 31, 2032, which will allow for the District to budget and secure the necessary funding for the design and construction.

DSOD is aware that the District is working to secure external funding to construct a partial-height wall, which we approved in a May 7, 2020 letter as an interim repair to the failed left wall section. We also understand the District expects to receive the external funding and are on track to complete the interim repairs by July 2023. Please keep DSOD apprised on construction schedules. The completion of the interim repairs does not change the District's obligation to construct a new spillway by December 31, 2032.

No earthwork activities shall proceed along and upslope of the left spillway walls without DSOD review and approval. Such work poses a risk of reactivating historic landslides in the left hillslope that could block the spillway [redacted]

Due to the poor condition of the spillway at North Fork Dam, the District must continue to comply with the reservoir restriction imposed in our April 6, 2018 letter, which requires the upstream and downstream outlet controls to remain in the fully open position to maximize releases and maintain the lowest possible water surface elevation. In addition, the District must perform daily inspections if the spillway is in use due to a storm event, and any change in conditions must be reported to DSOD immediately.

In the interest of dam safety, DSOD is committed to working closely with the District toward addressing the spillway deficiency at North Fork Dam. If you have any questions or need additional information, you may contact Area Engineer Austin Roundtree at (916) 565-7822 or Regional Engineer Melissa Collord at (916) 565-7820.

Sincerely,

Shawn Jones for

Sharon K. Tapia, P.E.
Division Manager
Division of Safety of Dams

cc: Mr. Casey Meredith, Chief
Dam Safety Planning Division
California Governor's Office of Emergency Services
3650 Schriever Avenue
Mather, California 95655

Mr. Jeff Cattaneo, District Manager
San Benito County Water District
Post Office Box 889
Hollister, California 95024

Mr. Christopher Hakes, Deputy Operating Officer
Dam Safety and Capital Delivery
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, California 95118-3686

<u>EXHIBIT 6</u>

Article

A 10 per cent increase in global land evapotranspiration from 2003 to 2019

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Check for updates

Madeleine Pascolini-Campbell[1]✉, John T. Reager[1], Hrishikesh A. Chandanpurkar[1] & Matthew Rodell[2]

Accurate quantification of global land evapotranspiration is necessary for understanding variability in the global water cycle, which is expected to intensify under climate change[1–3]. Current global evapotranspiration products are derived from a variety of sources, including models[4,5], remote sensing[6,7] and in situ observations[8–10]. However, existing approaches contain extensive uncertainties; for example, relating to model structure or the upscaling of observations to a global level[11]. As a result, variability and trends in global evapotranspiration remain unclear[12]. Here we show that global land evapotranspiration increased by 10 ± 2 per cent between 2003 and 2019, and that land precipitation is increasingly partitioned into evapotranspiration rather than runoff. Our results are based on an independent water-balance ensemble time series of global land evapotranspiration and the corresponding uncertainty distribution, using data from the Gravity Recovery and Climate Experiment (GRACE) and GRACE-Follow On (GRACE-FO) satellites[13]. Variability in global land evapotranspiration is positively correlated with El Niño–Southern Oscillation. The main driver of the trend, however, is increasing land temperature. Our findings provide an observational constraint on global land evapotranspiration, and are consistent with the hypothesis that global evapotranspiration should increase in a warming climate.

Evapotranspiration (ET)—the outgoing flux of water vapour from the surface and via transpiration of plants—is the second-largest component of the global water cycle over the land masses following precipitation (Pr)[7,14]. Owing to observational and measurement challenges, ET at continental and global scales is typically approximated using models[4,5], remote sensing by proxy[7,15] and upscaling of point measurements[8–10]. Each of these approaches is sensitive to the choice of input data used and the algorithm or model applied in an indirect estimation of ET. As errors in ET calculation often manifest as biases rather than random errors (for example, an algorithmic parameter error or a model structural error), global ET estimates can suffer from the amplification of these small biases into critical miscalculations through upscaling. Furthermore, the common thermal imaging-based approaches for mapping ET[16] rely on calibration via a limited number of ground validation sites, which themselves may suffer from systematic biases. As a major element of the global water cycle, ET is an important metric for quantifying and understanding the nature of changes in the water cycle. It has been hypothesized that in a warming climate, the water cycle will 'intensify'[1–3], and as a consequence, global land ET should increase[17]. Vegetation changes may also influence ET variability through complex land–atmosphere interactions[18]. The importance of ET to the global water cycle in the context of a changing climate further points to the need for a better-constrained estimate of global land ET.

Previous studies have shown that the estimation of continental to global ET is quite challenging, and it is likely that this flux still represents the most uncertain term in the global water budget. The lack of an observational constraint on global land ET makes it difficult to evaluate the trends and drivers of global ET calculated from different methodologies (Extended Data Table 1). Using eddy covariance observations and machine learning, a study found that global ET increased between 1982 and 1998, but then decreased from 1998 to 2008 due to limited water supply[19]. Other studies have also found evidence of increasing ET in recent decades: a study using the Global Land Evaporation: the Amsterdam Methodology (GLEAM) model constrained by satellite observations detected a positive trend over 1980 to 2011, and found that decadal ET was dominated by natural variability associated with El Niño–Southern Oscillation (ENSO)[20], whereas a different study also found a positive trend, but detected varying relationships among models and remote-sensing products with tropical Pacific variability[21]. Other modelling studies also have found an increase in ET due to enhanced photosynthesis associated with increased atmospheric carbon dioxide[22], and anthropogenic greenhouse gas and aerosol emissions[23]. These studies represent a variety of methodologies and conclusions that illustrate the need for a consistent constraint on global land ET.

Here we present a direct mass-balance (that is, top down) estimate of monthly global land ET based on Gravity Recovery and Climate Experiment (GRACE) and GRACE-Follow On (GRACE-FO) satellite observations[13]. At basin scales, the mass conservation equation requires discharge (Q) at the mouth, total Pr over the basin and basin water storage change to calculate ET as a residual. With GRACE

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providing the water storage changes, water budget estimates of ET have proven effective in providing independent constraints regionally[24–29] and globally[30,31]. In previous work, we applied this method to evaluate ET products for major basins in the continental United States, and found that even aggregating at the basin scale produced biases in remote-sensing and model-based methods compared with water-balance closure[25].

At global scales, accurate knowledge of Q remains challenging given the sparsity of coastal stations[32]. However, this can be addressed by calculating global discharge with an ocean mass-balance approach[33,34], and this study uses novel estimates of global Q that do not rely on gauges or models. The water-balance variables are entirely independent: the precipitation data are averaged over land areas, whereas the discharge estimates close the ocean mass balance using data exclusively from ocean areas. We use four Pr datasets (from gauges, remote sensing and reanalysis) and five different Q datasets (modelled and mass-balance based) to constrain dataset uncertainty and create a sufficiently wide ensemble of possible ET values. The novelty of this study is the application of the water-balance method over the global land surface to provide a global mean estimate of ET without reliance on upscaling of local measurements. Although limited by the accuracy of the input data, the water-balance ET estimate conserves mass, and therefore the true value of ET lies within this ensemble, and can be used as a constraint on other modelled and remote-sensing ET products at the global scale.

Below we present our results, and throughout, we assess trend significance with a Mann–Kendall significance test at the $\alpha = 0.05$ level.

Seasonal cycle of ET

We calculate an ensemble of 20 estimates of global land ET and its uncertainty using the water balance for 2003 to 2019 (Methods, Extended Data Figs. 1, 2). Global long-term mean ET for 2003 to 2019 is 423 mm yr^{-1} (temporal standard deviation of 98 mm yr^{-1}), and this is generally comparable to estimates in the literature from water-balance studies (450–470 mm yr^{-1})[7,14], a model-based estimate (415–586 mm yr^{-1})[5] and upscaled flux estimates (325–510 mm yr^{-1})[9,10] (Extended Data Table 1), although there is a variety in the magnitude of ET and time period assessed. The seasonal cycle of water storage change (S) over time (t) (dS/dt; maximum negative value of −185 mm yr^{-1}) and ET leads Pr (peaking in July with a mean of 811 mm yr^{-1}), and global Q (also peaking in July with a mean of 366 mm yr^{-1}) (Fig. 1).

The seasonal cycle characteristics of ET and its ensemble are plotted with confidence intervals and compared against commonly used ET products—Moderate Resolution Imaging Spectroradiometer (MODIS)/Terra Net Evapotranspiration Gap-Filled (MOD16A2GF) version 6, Priestly–Taylor Jet Propulsion Laboratory algorithm (PT-JPL), FLUXCOM and Global Land Data Assimilation System version 2.2 (GLDAS2.2) (Fig. 2a, Extended Data Table 2). The mean seasonality of ET agrees with FLUXCOM, which also peaks in June, but is found to lead the other products by one month. However, we note that MOD16A2GF, PT-JPL, FLUXCOM and GLDAS2.2 do not include ET estimates from Antarctica, unlike our ET ensemble. Including Antarctica in our ET calculation effectively acts to lower the global mean value of ET, and our estimate of ET calculated without Antarctica has closer agreement in both timing and magnitude with other products (Extended Data Fig. 8b, e). Antarctica contributes less than 5% of global land ET and 3% of precipitation, and the freshwater flux from Antarctica is approximately 1% of the global Q flux.

The long-term mean seasonal cycle is removed from each ET product by subtracting the climatological mean for each month, and the data are smoothed using a 15-month moving-average filter (Fig. 2b). The mean interannual variability of ET is notably greater than that of the model and remote-sensing-based estimates, consistent with previous studies[24,25,31].

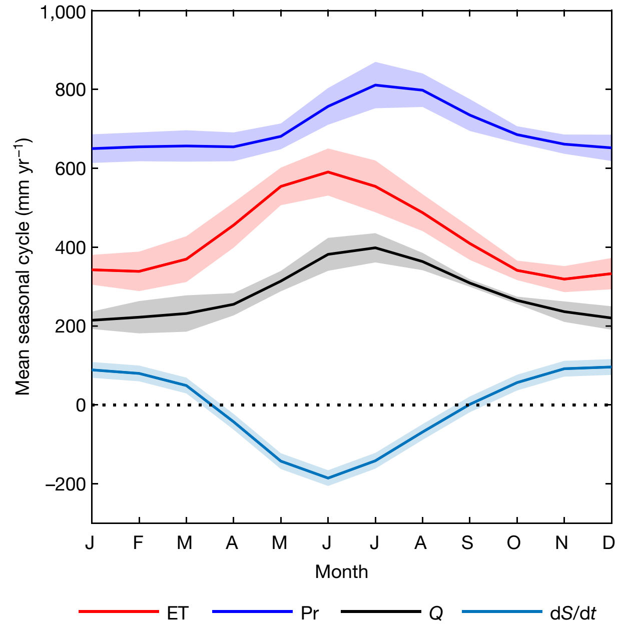

Fig. 1 | Water-balance seasonal cycles. Long-term mean seasonal cycle of ET (red solid line), Pr (blue line), Q (black line) and dS/dt (teal line) over 2003 to 2019. In each case, the seasonal cycles have been bias corrected. The shading is the standard deviation among the bias-corrected seasonal cycle of the ET ensemble (red shading), and input datasets used for Pr (four datasets, blue shading), Q (five datasets, black shading) and dS/dt (three methods from JPL RL06 GRACE TWS, teal shading).

Trends in the water cycle

The trends in the ET time series are investigated for the period of availability of each dataset as well as the common period (Fig. 2c, Extended Data Table 2). Over the common period (2003 to 2013), the trends are positive (except for FLUXCOM) and GLDAS2.2 has the largest trend (7.05 mm yr^{-1}), followed by our ET ensemble (2.81 mm yr^{-1}).

Turning to the ET ensemble, we find a statistically significant positive trend of 2.30 mm yr^{-1} (2003–2019) (Fig. 3a). The trend corresponds to an approximately 10% increase above the long-term mean of ET during the time period. In comparison, Pr increased by 3% and Q decreased by 6% relative to their long-term mean.

The uncertainty of the ET trend involves three elements: (1) uncertainty in the fit of the linear regression, (2) uncertainty due to the bootstrapping used for gap-filling the missing GRACE data, and (3) trend uncertainty due to error propagation of the input variables (see ‘Uncertainty in trends’ in Methods). We assess the uncertainty in the linear regression and find a standard error of 0.18 (linear fit $R^2 = 0.44$, s.e. = 0.18 mm yr^{-1}). We also plot the 95% confidence intervals on the trend due to gap filling with the bootstrapped data (Fig. 3a, dotted red lines), and find the overall trend is positive and significant.

Propagated uncertainty in the trend is greatest for Pr (±0.41 mm yr^{-1}), followed by Q (±0.32 mm yr^{-1}), and smallest for dS/dt (±0.05 mm yr^{-1}). This leads to a bounded ET trend estimate of 2.30 ± 0.52 mm yr^{-1} (determined by summing the square of the error in the trend of each component). The fractional uncertainty from Pr is 61%, 38% from Q and 1% from dS/dt. From this analysis it follows that the ET trend is positive and significant in light of the propagated error, and ranges from 1.78 mm yr^{-1} to 2.82 mm yr^{-1}.

The trends in the water-balance variables over 2003 to 2019 are illustrated in Fig. 3b–d. During this time period, Pr has a positive trend of 1.00 mm yr^{-1}, Q has a negative trend of −1.01 mm yr^{-1} and dS/dt also has a negative trend of −0.75 mm yr^{-1}, and all these trends are significant. We also create time series of the following ratios: ET/Q, ET/ Pr and

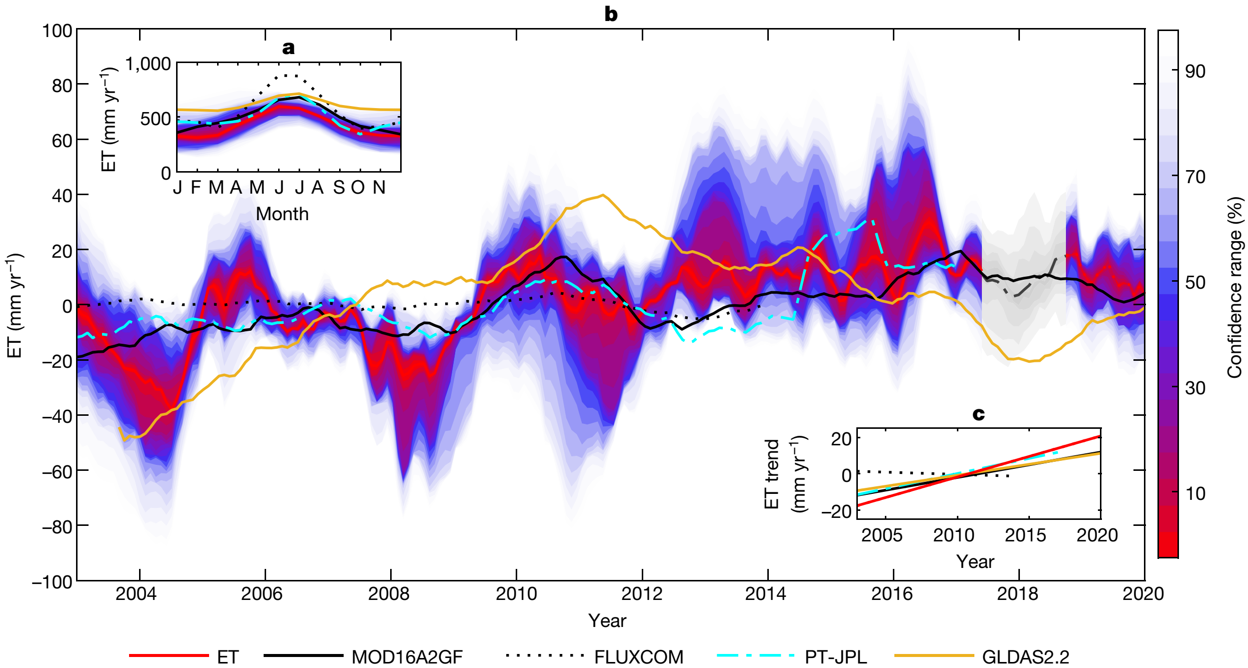

Fig. 2 | Comparison of ET with other products. a, Long-term mean (2003–2019) seasonal cycle of ET compared with other ET products. **b**, Time series of ET with seasonal cycle removed and a moving average of 15 months applied for ET (red line), FLUXCOM (dotted black), GLDAS2.2 (orange), MOD16A2GF (black) and PT-JPL (dashed cyan). **c**, The trend in ET for each of the smoothed time series calculated for the available period of the time series in **b**. The shading (**a**, **b**) represents the confidence intervals for the ensemble of ET. The mean of the bootstrapped data used for gap-filling ET is plotted in **b** (dashed black line) as well as the corresponding confidence intervals (grey shading).

Q/ Pr (Extended Data Fig. 3). ET/*Q* and ET/Pr increase between 2003 and 2019, and the positive trends are significant. The increase in ET/*Q* indicates a change in the partitioning of these water-cycle components.

Influence of climate variability

Natural climate variability is investigated as a possible driver for these significant trends. We correlate the interannual anomaly time-series of ET, Pr, *Q* and d*S*/d*t* with global sea surface temperature (SST; Extended Data Fig. 4, left panels), and the Multivariate ENSO Index (MEI) (Extended Data Fig. 4, right panels). For consistency, the long-term mean seasonal cycle is removed from the SST dataset at each grid point by subtracting the climatological monthly mean for each month based on 2003 to 2019, then both SST and MEI are smoothed with a 15-month moving average filter. ET is positively correlated with tropical Pacific SST (Extended Data Fig. 4a) and the MEI ($r = 0.41$, $P < 0.05$) (Extended Data Fig. 4b). We also note that there is probably a lag between ENSO events and impacts on global hydrology, making the reported correlation values conservative.

In contrast, Pr and *Q* are negatively correlated with central tropical Pacific SST in an ENSO-like pattern[35,36] (Extended Data Fig. 4c, d), and the MEI (Pr, $r = -0.43$, $P < 0.05$; *Q*, $r = -0.62$, $P < 0.05$). d*S*/d*t* is weakly negatively correlated to tropical Pacific SST and the MEI index ($r = -0.25$, $P < 0.05$). The sign of the Pr anomaly agrees with previous studies that have shown that total land Pr declines (increases) during El Niño (La Niña) events[20].

We regress the smoothed MEI index onto ET, Pr, *Q* and d*S*/d*t* (Extended Data Fig. 5) and we find that the MEI explains 17% of the variance in ET ($R^2 = 0.17$), 18% of the variance in Pr ($R^2 = 0.18$), 38% of the variance in *Q* ($R^2 = 0.38$) and 6% of the variance in d*S*/d*t* ($R^2 = 0.06$). We also regress ET against global land surface temperature (Extended Data Fig. 5a), and find that land surface temperature explains 54% of the variance during 2003 to 2019.

To remove natural climate variability, we subtract the regression model of global ET with the MEI from the original ET series (this effectively removes the portion of the variance explained by natural variability associated with MEI) (Extended Data Fig. 6a). We find that there is still a significant positive linear trend in ET of 2.08 mm yr^{-1}. Removing the impact of temperature (by subtracting the linear regression of ET with land surface temperature from the original ET) (Extended Data Fig. 6b), the trend declines to a value of 0.14 mm yr^{-1}, and it is not significant.

The relationship of the other ET products to ENSO is also explored (Extended Data Fig. 7). GLDAS2.2 is significantly negatively correlated with tropical Pacific SST and MEI ($r = -0.24$, $P < 0.05$), PT-JPL is significantly positively correlated with MEI ($r = 0.36$, $P < 0.05$), and FLUXCOM and MOD16A2GF are not significantly correlated. This analysis demonstrates the varied response to natural climate variability (ENSO) among different ET products.

Implications for the water cycle

ET increased over 2003 to 2019 with a significant positive linear trend of 2.30 ± 0.52 mm yr^{-1}, corresponding to an increase of approximately 10 ± 2% above the global mean ET. The trend is significant even in light of the gap filling and error of the input data. The positive trend results from the interaction of all water-balance components: a positive trend in Pr, coupled with negative trends in *Q* and d*S*/d*t*. Pr is also increasingly partitioned into ET and not *Q*, which has implications for water availability. The observed increase in ET is consistent with previous studies[20,22,23].

A 10% increase in ET represents an increased loss of water from land with potential implications for water resources, climate and agriculture. Higher ET fluxes can also influence the land–atmosphere energy exchange and produce surface cooling from enhanced latent heat fluxes[37]. In the context of our results, which indicate that the positive ET trend is due to warming, this could create a negative feedback mechanism to counteract warming. We note that our global ET estimate is a bulk estimate, and therefore cannot highlight specific hotspots of

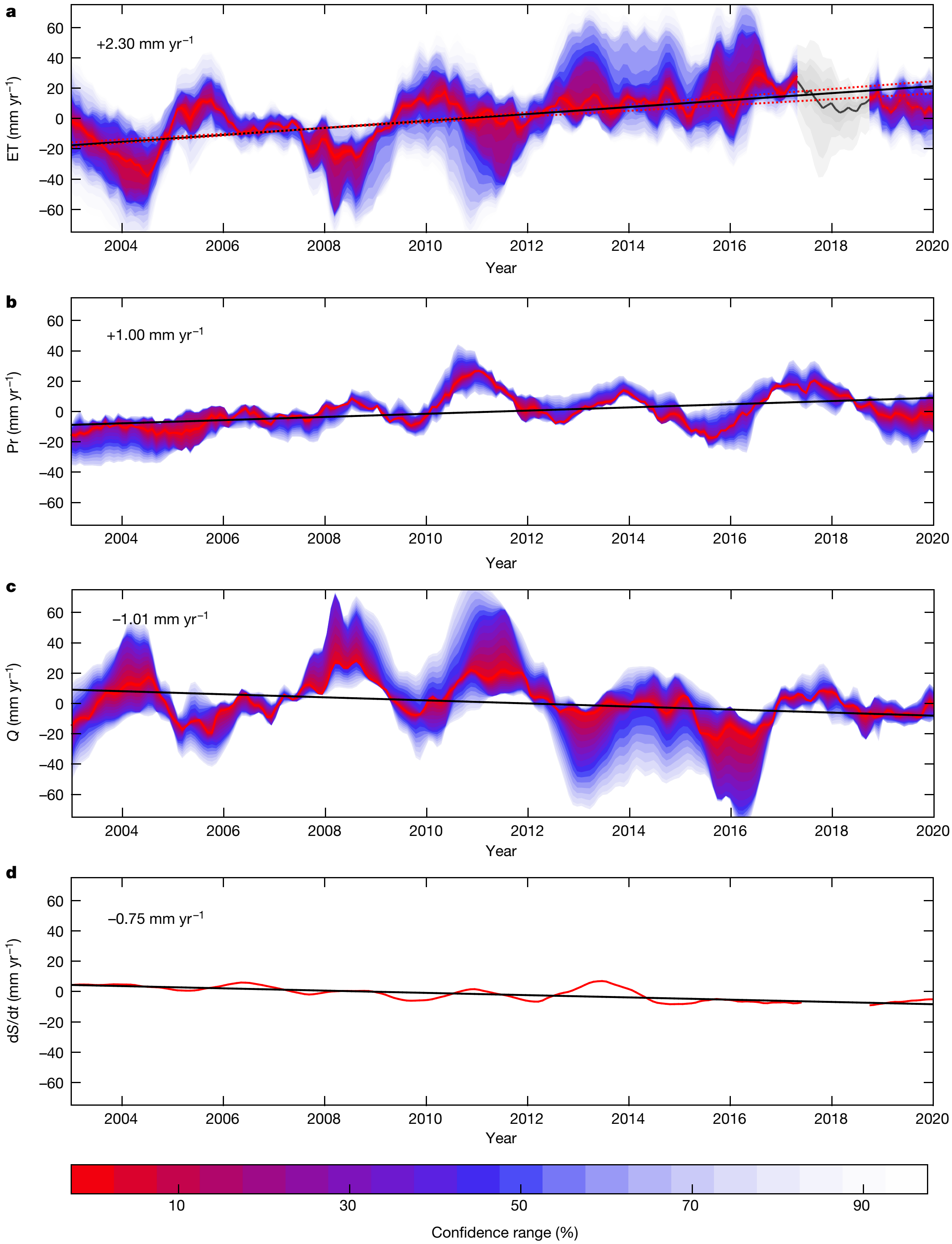

Fig. 3 | Trends in the water balance. a–**d**, Time series with seasonal cycle removed and a moving average filter of 15 months applied for ET (**a**), Pr (**b**), *Q* (**c**) and d*S*/d*t* (**d**). The trend for 2003 to 2019 of the mean of the ensemble is plotted as a black line, and the slope of the trend is indicated in top right corner. The 95% confidence interval for the trend of ET due to the bootstrap gap-filling is plotted as dotted red lines (**a**). The shading represents the confidence intervals for the ensembles of ET, Pr and *Q*. The mean of the bootstrapped data used for gap-filling ET is plotted (**a**; black line) as well as the corresponding confidence intervals (grey shading).

global change, and future regionally based work is needed to identify regional variations.

On the basis of the present findings, there is more of an apparent effect of temperature rather than ENSO variability on the trend in ET. This finding is consistent with the premise that the water cycle will intensify in a warming climate due to greater atmospheric demand[1]. Global land surface temperature variability explains most of the variability in ET (54%), whereas natural climate variability associated with

ENSO explains only 17%. Furthermore, when we remove the variability associated with land surface temperature from the original ET series, the trend in ET is no longer significant, suggesting that increasing land surface temperature, and not natural climate variability, accounts for the positive trend. However, a longer record is needed to determine the sensitivity of ET to warming, extending over multiple ENSO events. We also note that we focus exclusively on climate variability associated with ENSO, and that other climate modes may also contribute to ET variability. Our results also indicate a varied relationship between the ET products and natural climate variability, highlighting the need for additional evaluation and refinement of these products using observational datasets such as those used in this study.

Remote-sensing and land surface model (LSM) products underestimate interannual variability, reaffirming findings from previous studies at basin scales[24,25,31]. The main control on interannual variations in ET are the water and energy balances, including water storage change. By using water storage change from GRACE and GRACE-FO, we are able to accurately capture subsurface processes (including soil moisture), and natural and human-driven changes in water storage. We note that GLDAS2.2, which assimilates observations from GRACE, has the closest agreement with interannual variability from water-balance ET, indicating potential improvements with water storage information.

Conclusion

We present a mass-constrained estimate of global ET using all available GRACE and GRACE-FO data for 2003 to 2019. Constraining our knowledge of global land ET is of critical importance given that the water cycle is expected to change in the future[1–3]. Our findings provide a mass-constrained estimate of global land ET, and indicate that ET has increased since 2003, and this positive trend is significant even when the uncertainty of the input datasets is taken into account. The increase in ET is mostly explained by warming temperatures, and this is consistent with thermodynamic theory that posits ET will increase in a warming climate. According to our results, the moisture for increased ET comes partly from increased Pr and partly from decreased Q. This indicates that increased Pr will not automatically lead to increased Q, suggesting that runoff generation into Q also depends on the saturation of the surface and how much water can be stored. Our findings have implications for the understanding of global hydroclimate change and water resources management.

Online content

Any methods, additional references, Nature Research reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at https://doi.org/10.1038/s41586-021-03503-5.

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Methods

All correlation testing is based on Pearson's correlations with $\alpha = 0.05$, and all linear trend significance testing is based on a Mann–Kendall significance test with $\alpha = 0.05$.

Water-balance ET

ET is calculated for 2003 to 2019 as:

$$\mathrm{ET} = \mathrm{Pr} - Q - \mathrm{d}S/\mathrm{d}t \quad (1)$$

where Pr is global terrestrial precipitation, Q is global continental discharge and $\mathrm{d}S/\mathrm{d}t$ is the change in global terrestrial total water storage anomaly (TWSA), which is calculated from GRACE total water storage[13]. To be precise, equation (1) would require that $\mathrm{d}S/\mathrm{d}t$ be calculated using instantaneous observations of TWS at the beginning and end of observation periods of the three fluxes, whereas GRACE can only provide monthly mean observations of TWS[28]. However, the resulting uncertainty becomes negligible when the equation is applied for a multiyear analysis. Greenland and Antarctica are included in our calculation of global land for consistency with the input Q datasets, which include runoff from these land masses.

We use the most recent GRACE mascon solution Level-2 Release 06 (RL06) (available online at https://podaac.jpl.nasa.gov/dataset/TELLUS_GRAC-GRFO_MASCON_CRI_GRID_RL06_V2). This dataset includes GRACE and GRACE-FO data from 2002 to 2020. We note that unlike other remote-sensing approaches (for example, electromagnetic), which need to be calibrated, and for which biases may appear due to errors in calibration across missions, this does not impact data from time-variable gravity missions[38], and therefore there is no mission bias between GRACE and GRACE-FO. Trends in TWSA from commonly used models diverge from the observed GRACE TWSA owing in part to a lack of groundwater storage terms, as well as human activity in many LSMs[39]. We therefore only use TWSA from GRACE data to construct our ET ensemble and do not include LSM TWS.

We choose to use only the JPL RL06 mascon solution for TWSA as this is the latest mascon solution, and an improvement on previous generations. It has also been shown that solution uncertainty is a function of spatial scale, and is therefore smallest at global scales[40]. Given that our study domain is global land, this gives us more confidence in our choice to use one solution. For 2003 to 2016, we use linear interpolation to fill in the missing months. For the period of missing data between 2017 and 2018, including the period between the end of GRACE and GRACE-FO, we use bootstrapping methods to resample the data and fill in the missing 15 months of data as well as construct confidence intervals (discussed below).

To obtain $\mathrm{d}S/\mathrm{d}t$, we use three different methods: (1) a backward-difference method in which the change in TWS is the difference between TWS in one month and the previous month, (2) the backward-difference method as in method 1 but with a three-month running average applied, and (3) a centred finite-difference method in which $\mathrm{d}S/\mathrm{d}t$ is calculated as the difference between a given month with the month before the previous (for example, $\mathrm{d}S/\mathrm{d}t$ for February is calculated as the difference between March and January TWS and then divided by $2\Delta T$ (where ΔT is one month)). The approaches used in methods 2 and 3 are to remove noisy artefacts in $\mathrm{d}S/\mathrm{d}t$ that arise during the differencing process, and this has also been used and described in other studies[24,25,41,42].

We compare the three methods to calculate $\mathrm{d}S/\mathrm{d}t$ (Extended Data Fig. 1) and find that the three are highly similar, and the sensitivity of $\mathrm{d}S/\mathrm{d}t$ on the calculation of ET is also small, with mean ET differing by less than 1 mm yr^{-1} among the different calculations. As the differencing operations do not meaningfully enlarge the ensemble of ET, we therefore just use the backward-difference method to calculate ET.

For Pr we use the following four datasets: Global Precipitation Climatology Project (GPCP) version 2.3 (GPCPV2.3) merged Pr estimate at 2.5° resolution[43], National Oceanic and Atmospheric Administration (NOAA)–National Centers for Environmental Prediction (NCEP)–National Center for Atmospheric Research (NCAR) Climate Data Assimilation System (CDAS) Pr[44], Modern-Era Retrospective Analysis for Research and Applications (MERRA)-2 Reanalysis Pr at 0.5° by 0.625° (ref. [45]) and, finally, ERA-5 Reanalysis Pr from the European Center for Medium-Range Weather Forecasts at 0.5° resolution[46]. All Pr data are provided at a monthly time step. The Pr datasets were chosen based on their global coverage (including over the ice sheets) to be consistent with the Q estimate that includes runoff from the ice sheets.

For Q, we use the state-of-the-art Japanese 55-year Reanalysis (JRA-55) for Driving Ocean (JRA55-do), which is adjusted against observed river runoff and is available from 1958 to 2019[47]. We also use four global ocean mass-balance-based estimates of Q, which combine different measurements of ocean mass change (from altimetry and ocean heat content data), ocean precipitation (from GPCP version 2.2[48] and Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP)[49]) and vertically integrated moisture flux divergence that serves as a proxy for ocean Pr minus ocean ET estimates (from GPCP version 2.2[48], ERA-5[46], Objectively Analyzed Air–Sea Fluxes for the Global Oceans (OAFlux)[50] and MERRA-2 Reanalysis[45]). These estimates are available from 2003 to 2019 at a monthly time step. The Q estimates are calculated over the ocean, and hence do not conflict with our subsequent calculation of land ET using land water mass balance. We note that some Q values are negative (Extended Data Fig. 1) and this is an artefact of the mass-balance technique. Negative Q values are impossible in nature, but are possible as the mass-balance technique enforces conservation of mass via budget closure[33].

The four global discharge datasets from ocean mass balance are calculated as follows[33]:

$$Q = \frac{\mathrm{d}M_{\mathrm{ocn}}}{\mathrm{d}t} - \mathrm{Pr}_{\mathrm{ocn}} + E_{\mathrm{ocn}} \quad (2)$$

where Q is global discharge, $\mathrm{d}M_{\mathrm{ocn}}/\mathrm{d}t$ is the ocean mass balance, $\mathrm{Pr}_{\mathrm{ocn}}$ is precipitation over the ocean and E_{ocn} is evaporation over the ocean. $\mathrm{d}M_{\mathrm{ocn}}/\mathrm{d}t$ is obtained by solving the global mean sea level (GMSL) budget for ocean mass anomalies and then computing a monthly derivative:

$$\mathrm{GMSL} = \mathrm{GMSL}_{\mathrm{STERIC}} + \mathrm{GMSL}_{\mathrm{MASS}} \quad (3)$$

The data for GMSL are obtained from ocean altimetry data from Archiving, Validation, and Interpretation of Satellite Oceanographic Data (AVISO), processed with Segment Sol multi-mission d'ALTimetrie (SSALTO) multi-mission ground segment/Data Unification and Altimeter Combination System (DUACS) (AVISO SSALTO/DUACS) and EN4 from the UK Met Office Hadley Centre ocean temperature data to calculate the steric component ($\mathrm{GMSL}_{\mathrm{STERIC}}$)[51]. $\mathrm{GMSL}_{\mathrm{MASS}}$ is computed as the difference between GMSL and $\mathrm{GMSL}_{\mathrm{STERIC}}$ and the monthly derivative is then found. $\mathrm{Pr}_{\mathrm{ocn}}$ is obtained from GPCP version 2.2 and CMAP, and E_{ocn} obtained from OAFlux measurements for two of the global discharge measurements. In the other two measurements, $\mathrm{Pr} - E$ is solved by calculating the ocean atmospheric moisture budget with the ERA-5 and MERRA-2 reanalyses:

$$-(\mathrm{Pr} - E) = \frac{\mathrm{d}W}{\mathrm{d}t} + \nabla \cdot Q \quad (4)$$

where $\mathrm{d}W/\mathrm{d}t$ is the column-integrated water vapour, and $\nabla \cdot Q$ is the horizontal convergence of moisture flux.

To generate the global land ET ensemble, we calculate ET using equation (1) above with four different Pr datasets, five different Q datasets and backward-difference $\mathrm{d}S/\mathrm{d}t$ giving an ensemble of 20 members. We calculate ET for 2003 to 2019. The individual datasets used to generate the ET ensemble are shown in Extended Data Fig. 1.

To bias correct the water-balance components, as in Fig. 1, we remove the mean of each individual ensemble member. We then calculate the spread between ensemble members due to differences in their seasonality as the standard deviation. This represents the differences in seasonality, rather than the differences due to biases existing in Pr, Q and subsequently in ET.

LSMs and remote sensing-based ET products

We use ET from GLDAS2.2 for the Catchment Land Surface Model (CLSM) model, which includes Data Assimilation from GRACE (GRACE-DA), available from February 2003 to present at a daily temporal resolution, and 0.25° globally (available online at https://disc.gsfc.nasa.gov/)[52]. For remote-sensing-based products, we use MOD16A2GF version 6, which calculates ET globally using a Penman–Montieth-based algorithm[15]. MOD16A2GF is available from 2000 to present at an eight-day temporal resolution and spatial resolution of 500 m (available online at https://lpdaac.usgs.gov/products/mod16a2gfv006/). We download MOD16A2G using the AppEEARS tool for global land from 2003 to 2019 (online at https://lpdaacsvc.cr.usgs.gov/appeears/).

We use an ET product calculated with the PT-JPL retrieval algorithm at 36-km resolution[8]. The algorithm converts potential ET to actual ET using net radiation, normalized difference vegetation index, soil-adjusted vegetation index, maximum air temperature and water vapour pressure data from remote-sensing and observational datasets[8]. Finally, we use ET from the FLUXCOM dataset, which combines in situ observations from Fluxnet, meteorological measurements and remote sensing in a machine learning approach to create global gridded ET estimates[9]. This is available from 2001 to 2013 at a resolution of 0.5° (available online at https://www.fluxcom.org). In this study, we average the remote-sensing-based product (RS) and the RS and meteorologically derived product (RS + METEO) into one estimate.

Climate data

We use Extended Reconstructed Sea Surface Temperature (ERSST) version 4 SST, which is available at 2° spatial resolution from 1854 to present[53] (downloaded from https://iridl.ldeo.columbia.edu/SOURCES/.NOAA/.NCDC/.ERSST/.version4/). We use the MEI to represent natural climate variability associated with the tropical Pacific (downloaded from https://psl.noaa.gov/enso/mei.ext/table.ext.html). The MEI is a composite index comprising SST, sea-level pressure, zonal and meridional wind, and longwave outgoing radiation over the tropical Pacific. We also use the Goddard Institute for Space Studies (GISS) Surface Temperature Analysis v4 (GISTEMP v4) for the global land surface temperature anomaly, which is available from 1880 to present (downloaded from https://data.giss.nasa.gov/gistemp/)[54].

Uncertainty

The overall error in ET is due to the accumulated errors from precipitation, discharge and dS/dt. For dS/dt, we use the formal error product provided with the GRACE RL06 TWSA dataset. We do not have formal errors for precipitation and discharge, and therefore we apply an ensemble approach and define the uncertainty as the standard deviation across the input datasets.

We calculate the time-varying uncertainty associated with each of the input variables (Extended Data Fig. 2). For Pr and Q, the uncertainty is calculated as the standard deviation of the input datasets used. For dS/dt, we calculate global continental uncertainty using the formal error product for TWSA provided with the GRACE RL06 mascon solutions. We propagate the uncertainty from TWSA into the backward-difference derivative dS/dt[25].

The overall error in ET (σ_{ET}) is calculated as[28]:

$$\sigma_{\mathrm{ET}} = \left(\sigma_{\mathrm{Pr}}{}^2 + \sigma_Q{}^2 + \sigma_{\mathrm{d}S/\mathrm{d}t}{}^2\right)^{1/2} \tag{5}$$

The long-term mean σ_{ET} is 138 mm yr^{-1}. Uncertainty in Pr (σ_{Pr}) is the greatest term in the error budget (long-term mean of 107 mm yr^{-1}), followed by Q (σ_Q) (long-term mean of 84 mm yr^{-1}) and dS/dt ($\sigma_{\mathrm{d}S/\mathrm{d}t}$) (long-term mean of 13 mm yr^{-1}). This finding is consistent with the known large uncertainties existing across different Pr datasets[55].

Bootstrapping for missing GRACE months

To fill the gap in our time series of ET (July 2017 to September 2018) due to the missing TWSA data (which coincides with the ending of GRACE and start of GRACE-FO), we use a bootstrapping method to resample the ET data and construct confidence intervals[56]. We randomly sample from the ensemble of 20 ET time series with the seasonal cycle removed, to create a 1,000-member bootstrap ensemble preserving the mean and variance of the original data. From this bootstrap ensemble, we then randomly select 15 months of data to fill each of the missing ET series. We then process the ET ensembles to calculate the 15-month moving average series, and trends.

Uncertainty in trends

The uncertainty in the trend of ET includes: (1) the error in the linear regression fit to the data, (2) the uncertainty due to the gap filling with bootstrapping, and (3) propagated uncertainty from the error in Pr, Q and dS/dt.

To obtain 1, we report the standard error of the regression model as a measure of the error in the regression. To obtain 2, for each of the 1,000-member bootstrap series, we fill the missing ET months using 15 randomly selected months from the bootstrap series. In each case, we calculate the overall trend obtained with each gap-filled ET series, generating 1,000 trend estimates. We then create 95% confidence intervals on the ensemble of the 1,000 trends of the gap-filled ET data. This procedure determines how sensitive the trend is to the gap filling.

To obtain 3, we calculate the uncertainty in the trend of each ensemble (Pr, Q and dS/dt) by propagating the error in the trend for each of the ensembles after (1) removing the mean seasonal cycle and (2) smoothing at 15 months. To produce an estimate of monthly error, we use the long-term mean value of error for Pr ($\sigma_{\mathrm{Pr}} = 107$ mm yr^{-1}), Q ($\sigma_{\mathrm{Q}} = 84$ mm yr^{-1}) and dS/dt ($\sigma_{\mathrm{d}S/\mathrm{d}t} = 13$ mm yr^{-1}) (described above in Methods section 'Uncertainty'). To propagate the error due to removal of the mean seasonal cycle ($\sigma_{\mathrm{deseasonalized}}$), we sum in quadrature the mean monthly error (σ) with the error of mean seasonal cycle $\sigma/\sqrt{N}$, where N is the number of months going into the calculation of the mean ($N = 17$).

To obtain an estimate of the error after a 15-month moving average, we divide the monthly error of the deseasonalized series ($\sigma_{\mathrm{deseasonalized}}$) by $\sqrt{N_{\mathrm{movingmean}}}$, where $N_{\mathrm{movingmean}} = 15$. This value is taken to represent uncertainty in the y value of our linear regression model. The uncertainty in the x value is zero.

Next we propagate the uncertainty into the slope of the linear model for each variable (Pr, Q and dS/dt) using the following:

$$\sigma^2_{\mathrm{Trend}} = \frac{n\sigma^2}{\sum_{i=1}^{n} x_1^2 - \left(\sum_{i=1}^{n} x_1\right)^2} \tag{6}$$

where $\sigma^2_{\mathrm{Trend}}$ is the uncertainty in the value of the linear trend, n is the number of observations and x is the time of the observation. They are then combined to find total uncertainty in the trend of ET using equation (2) above ($\sigma^2_{\mathrm{trend,total}}$). Fractional uncertainty is determined for each variable by dividing the trend uncertainty ($\sigma^2_{\mathrm{Trend}}$) by $\sigma^2_{\mathrm{trend,total}}$.

Contribution of ice sheets to ET

We obtain a time-invariant mean monthly freshwater flux of 25 mm yr^{-1} (using the period 2003 to 2016) for Greenland[57]. This estimate is based on liquid runoff from the Greenland ice sheet and tundra.

For Antarctica, we obtain an estimate of monthly freshwater flux with a value of 2 mm yr^{-1} (ref. [58]). This also agrees with an estimate from

JRA55-do, which is based on a time-invariant estimate from satellite altimetry[59]. Both these estimates represent liquid water fluxes, excluding the solid-ice-calving component. Combined, these account for approximately 7% of the flux in mean Q, whereas the flux from just Antarctica is about 1% of the flux in Q.

We recalculate Pr and dS/dt over land areas excluding Greenland + Antarctica and just Antarctica. We subtract 27 mm yr^{-1} (Greenland + Antarctica) and 2 mm yr^{-1} (Antarctica) from our Q ensemble, and recalculate the ET ensemble (Extended Data Fig. 8). We estimate the percentage contribution by converting the fluxes to total accumulated water by multiplying by basin area. As a caveat to these results, we note that we use a time-invariant number to represent discharge. However, given the small overall contribution of ice-sheet discharge compared with global discharge, we also expect the uncertainty due to ice-sheet discharge to be small.

Data availability

The data that support the findings of this study have been added to the Zenodo repository and can be accessed at https://doi.org/10.5281/zenodo.4601596. Source data are provided with this paper.

Code availability

The code that produced the findings of this study is available from the corresponding author upon reasonable request.

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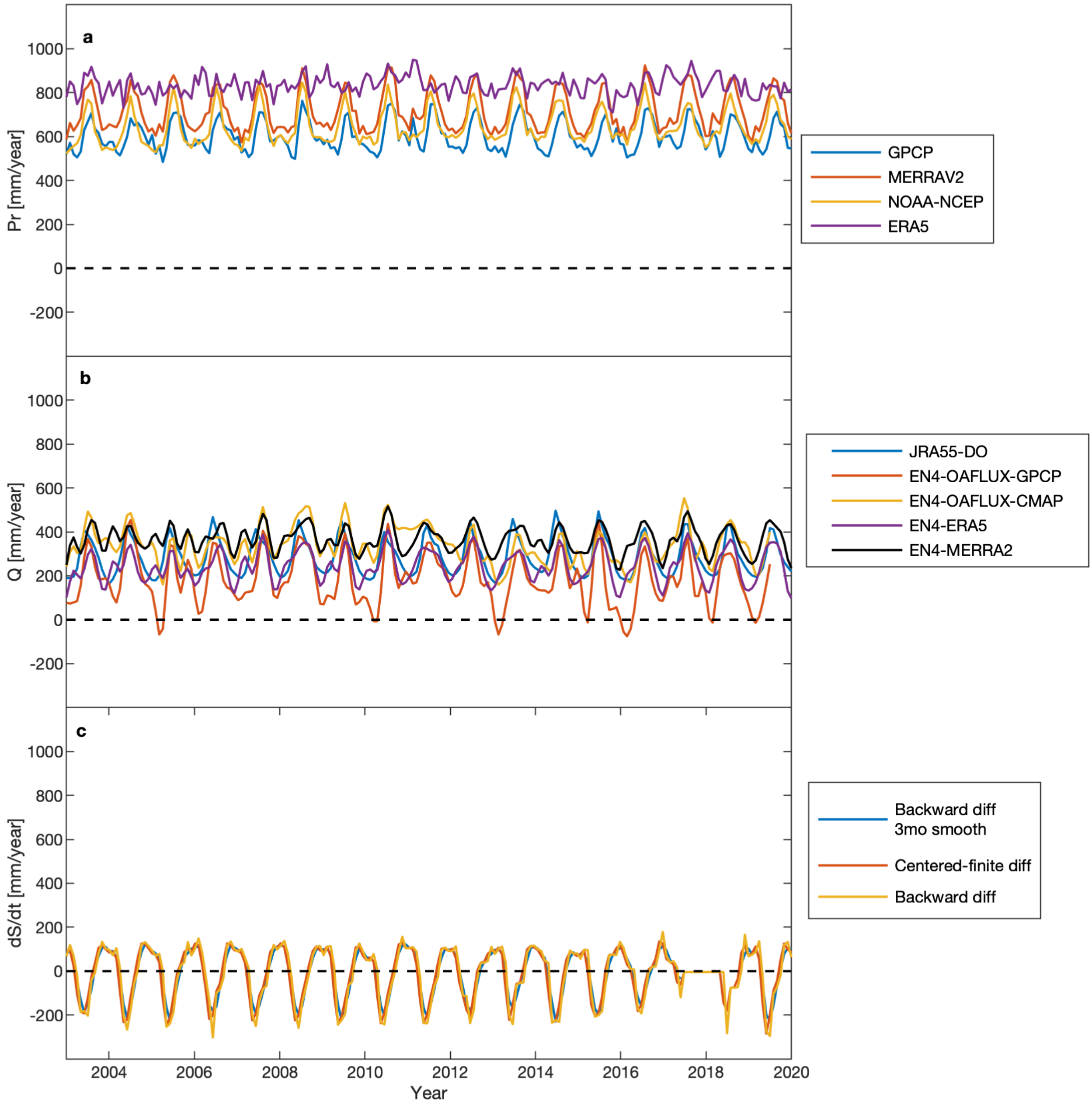
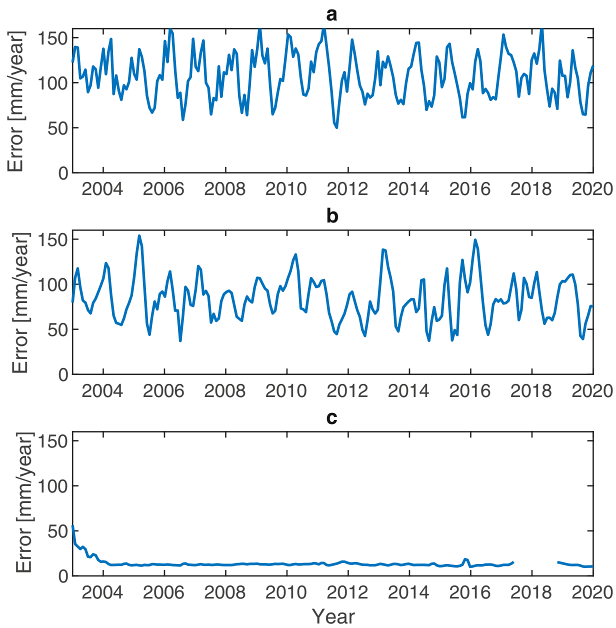
Author contributions M.P.-C. conceived, and carried out the research, led the data analysis and wrote the manuscript. J.T.R. conceived the research, designed the analysis and provided comments on the manuscript. H.A.C. produced the global discharge dataset and also provided input on the analysis. M.R. provided comments on the manuscript.

Competing interests The authors declare no competing interests.

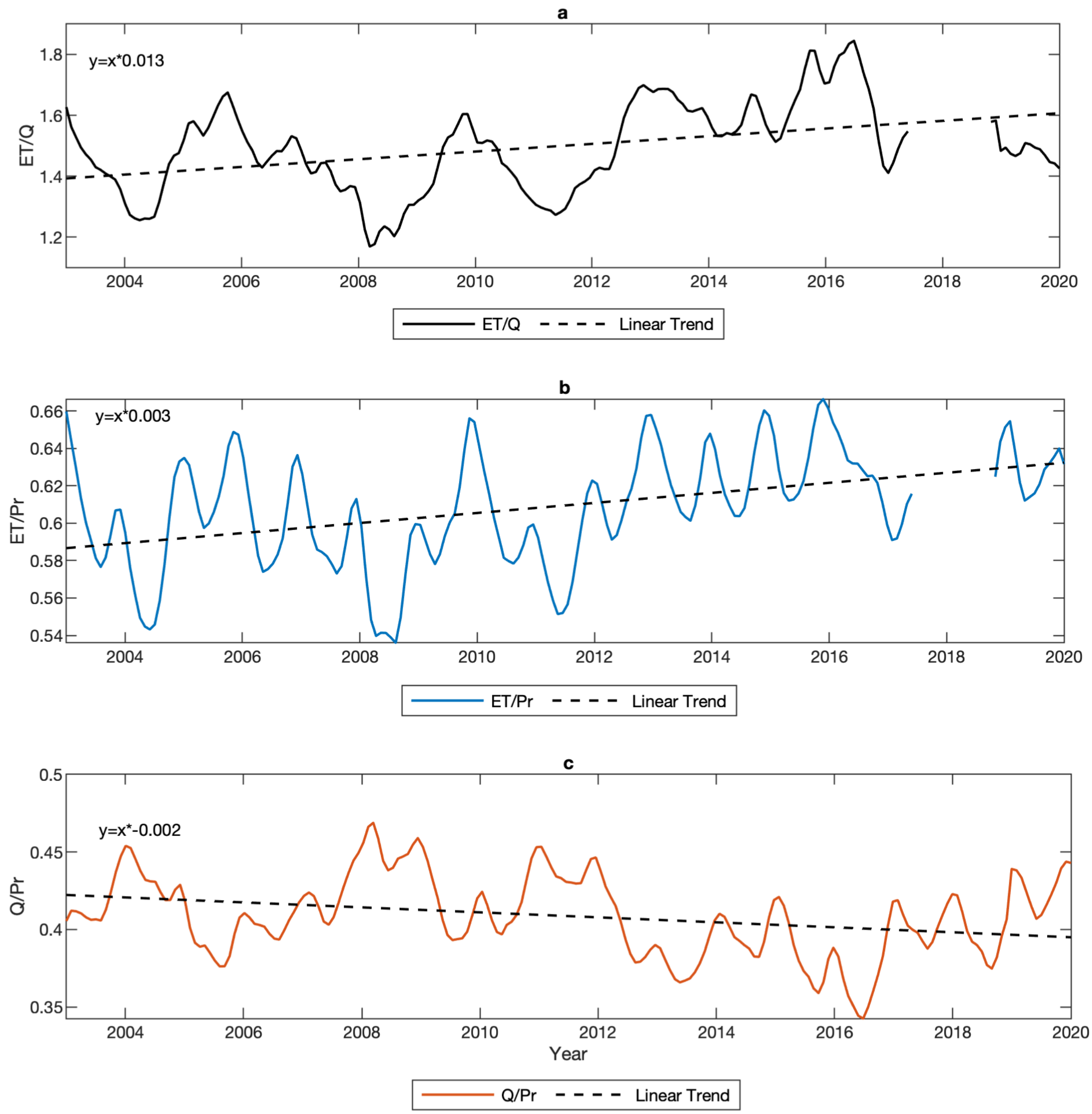
Additional information
Correspondence and requests for materials should be addressed to M.P.-C.
Peer review information *Nature* thanks Di Long, Bart Nijssen and the other, anonymous, reviewer(s) for their contribution to the peer review of this work.



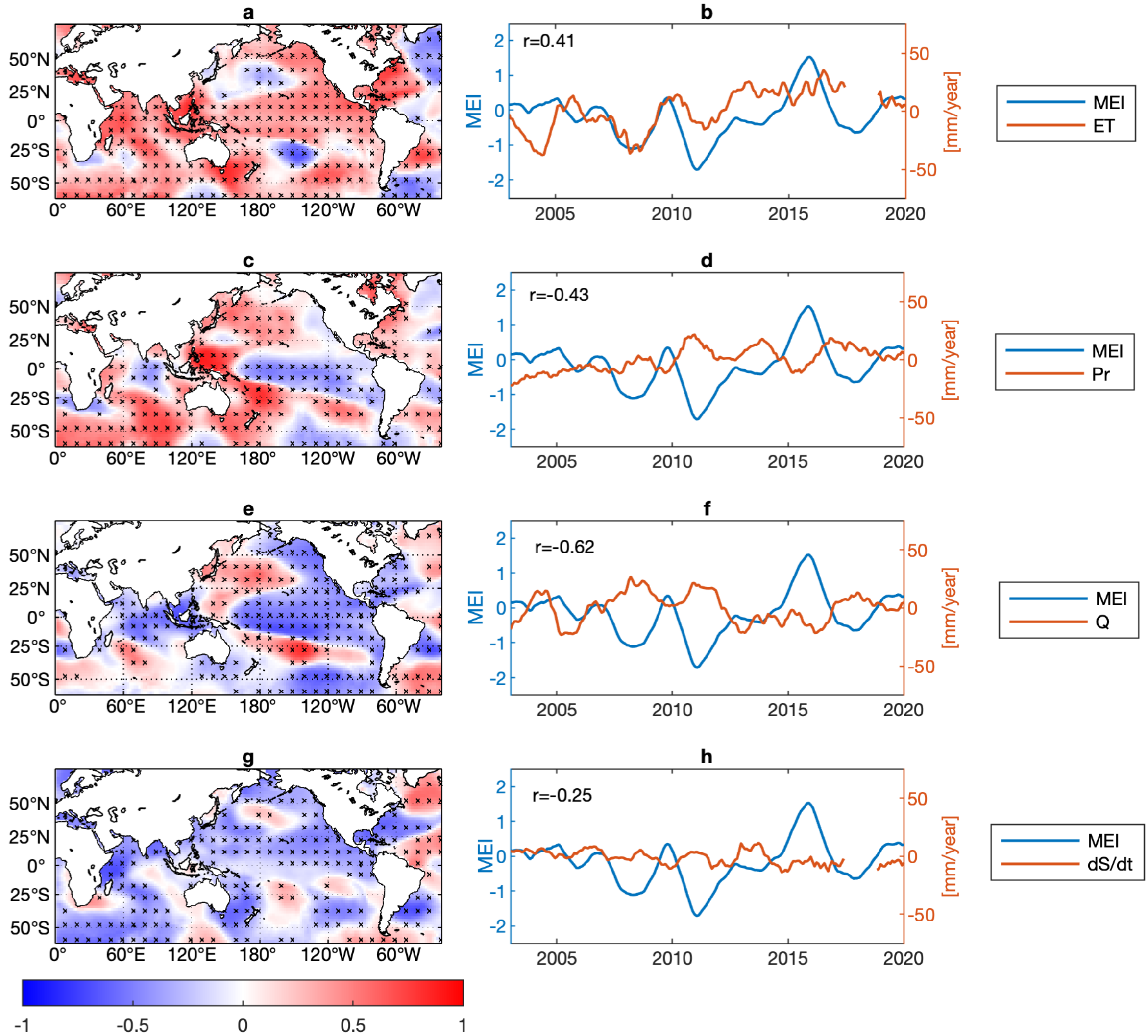
Extended Data Fig. 1 | Input water cycle timeseries. a–c, The raw time series for global land precipitation (GPCPV2.3, MERRA-2, NOAA–NCEP and ERA-5) (**a**), discharge (JRA-55, and ocean mass-balance estimates EN4–OAFlux–GPCP, EN4–OAFlux–CMAP, EN4–ERA5, EN4–MERRA2) (**b**) and change in total water storage (d*S*/d*t*) from GRACE/GRACE-FO using three different methods to compute the derivate (backward difference with three-month smoothing, centred finite difference and backward difference) (**c**).



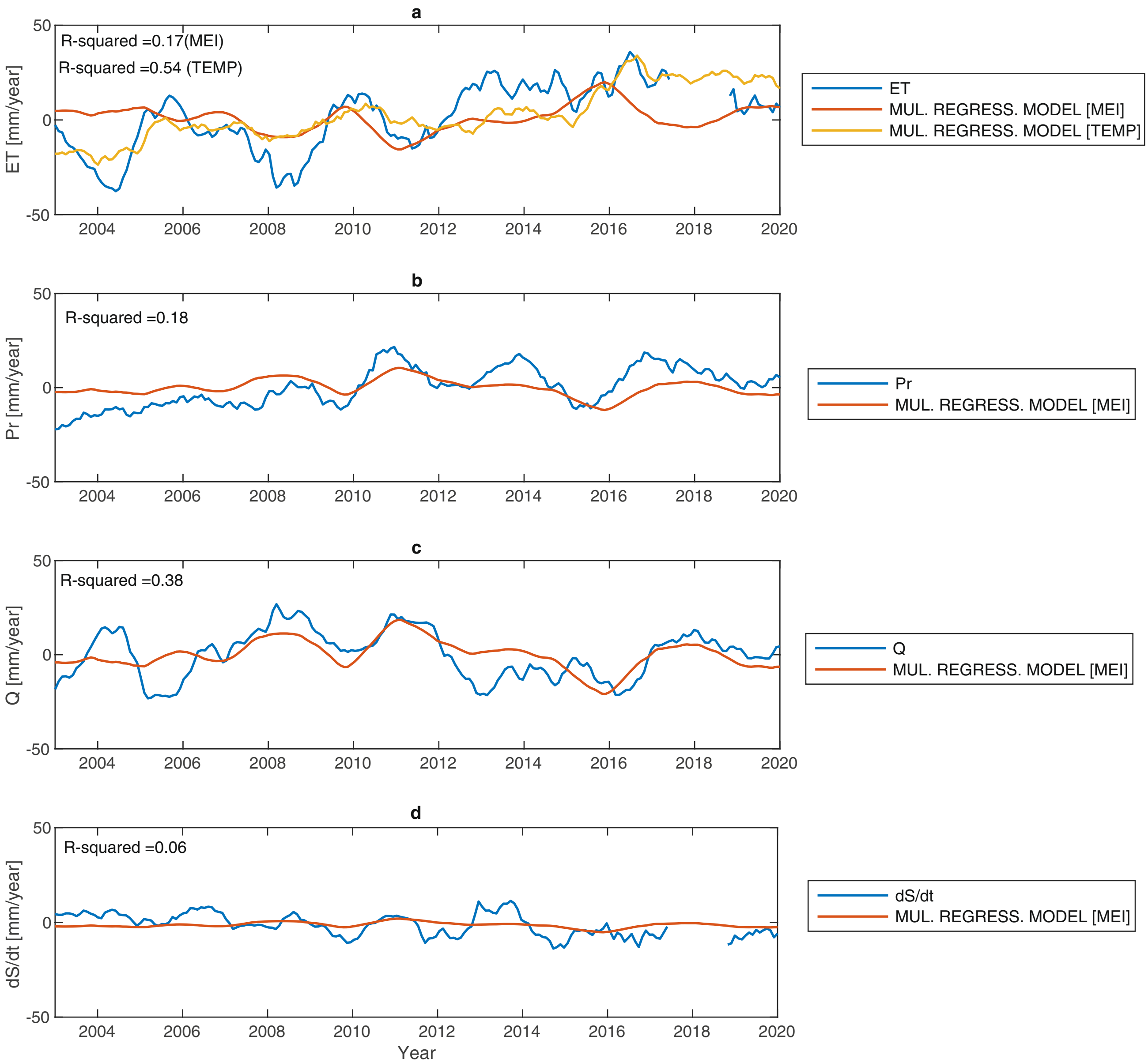
Extended Data Fig. 2 | Error budget of water-balance components. **a**, **b**, Monthly error time series for precipitation (**a**) and discharge (**b**) calculated as the standard deviation of input data sets. **c**, Error in dS/dt calculated from the formal GRACE JPL RL06 mascon error product, and propagated into derivative. Monthly time series of errors plotted for 2003 to 2019 in units of mm yr^{-1}.



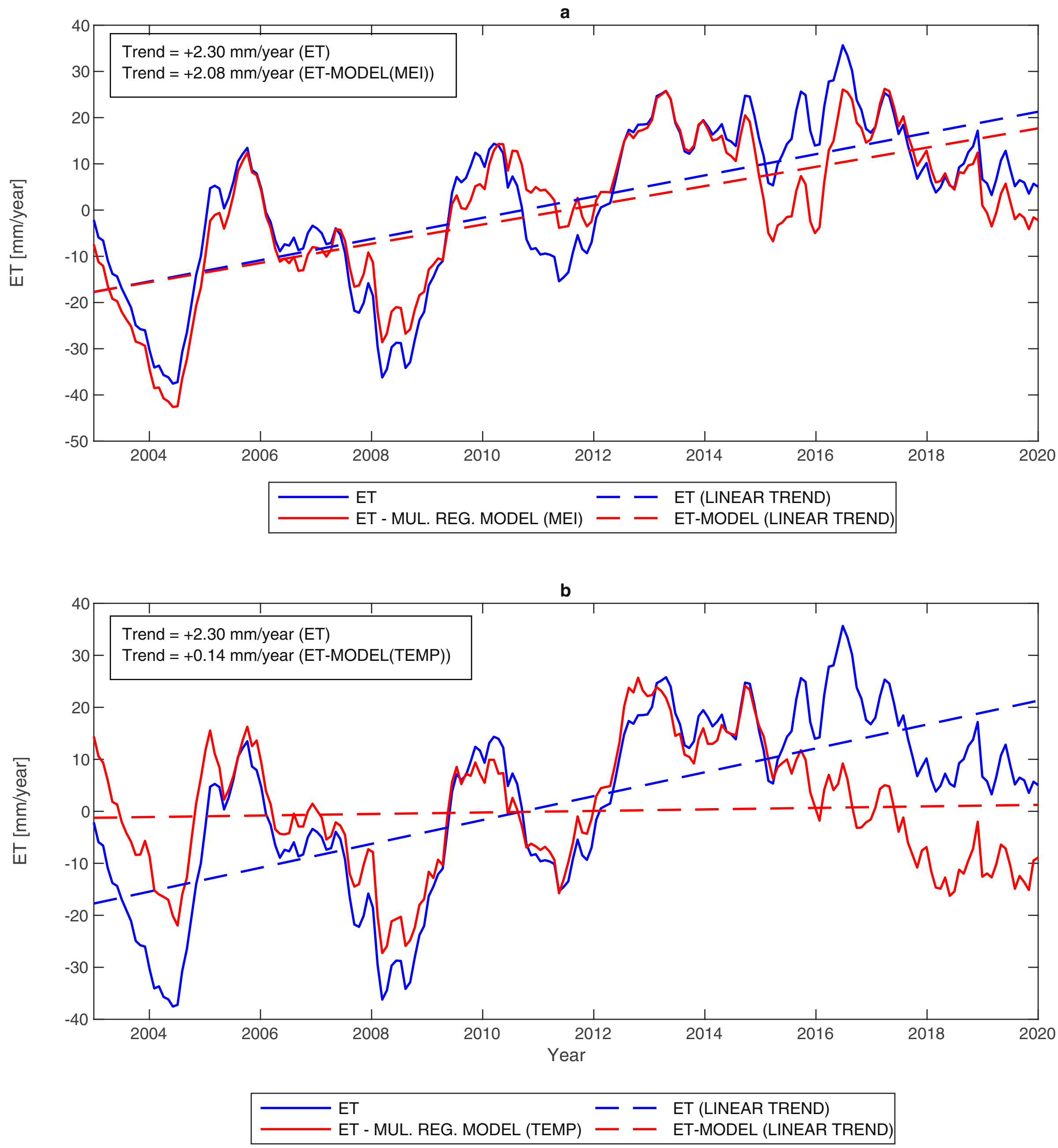
Extended Data Fig. 3 | Ratios of water-balance components. a–c, Ratios between components of the water balance for ET/Q (**a**), ET/Pr (**b**) and Q/Pr (**c**). In each case, the ratios are calculated using the time series with the seasonal cycle removed and 15-month smoothing applied. The ensemble mean for each variable (ET, Pr and Q) is used.



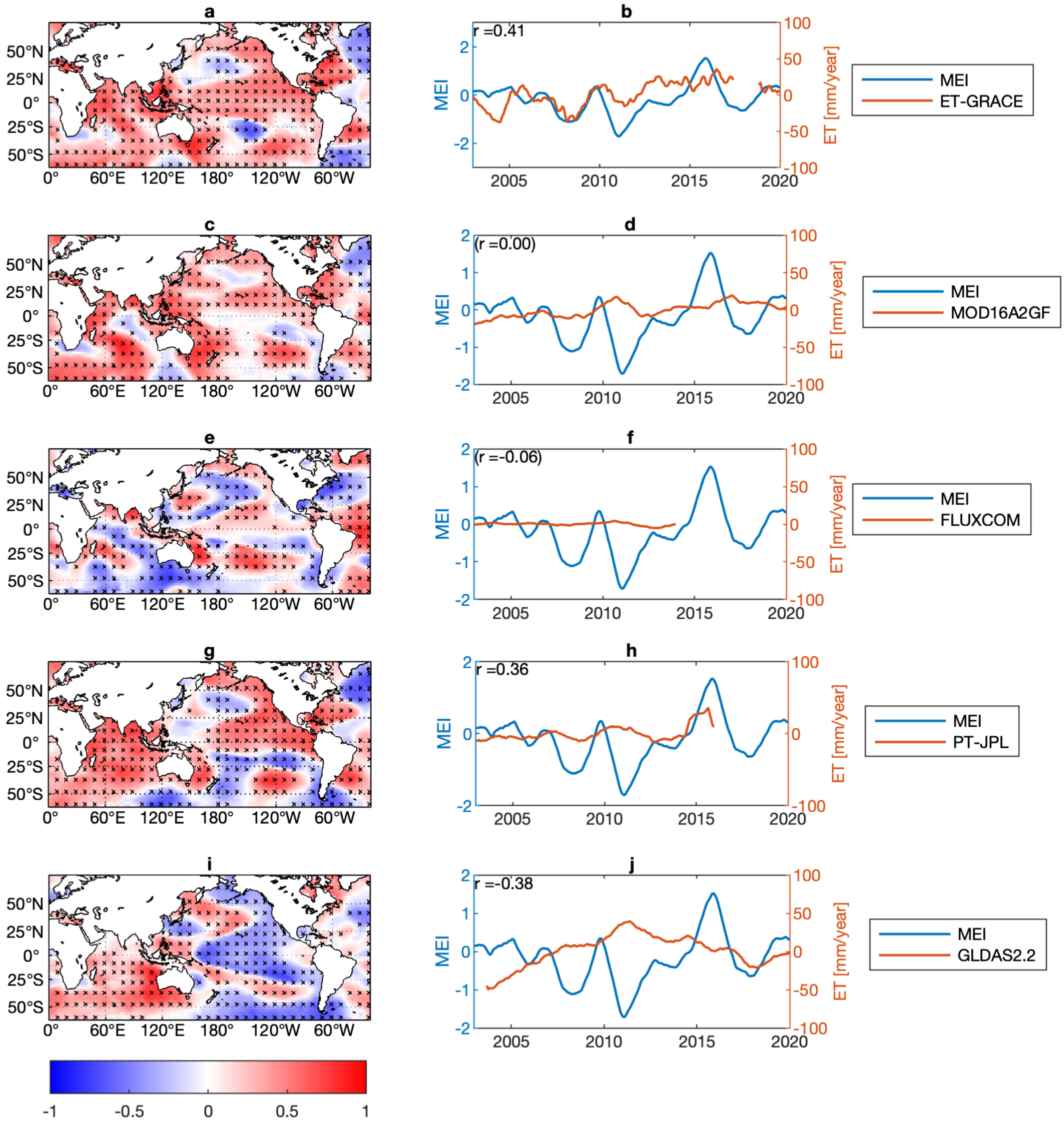
Extended Data Fig. 4 | Water-balance relationship with ENSO. Left: correlation with ERSST version 4 SST against ET (**a**), Pr (**c**), Q (**e**) and dS/dt (**g**). Right: time series of MEI index against ET (**b**), Pr (**d**), Q (**f**) and dS/dt (**h**). For each panel, the SST and water-balance variable have the seasonal cycle removed and a 15-month moving average filter applied. The r value of the correlation between the MEI and water-cycle variable are shown in top left corner (right panels). Stippling on the maps (left panels) indicates that the value of the Pearson correlation between the SST and the water-balance variable (ET, Pr, Q and dS/dt) at that grid point is significant ($\alpha = 0.05$ level). Maps created using MATLAB with the M_Map package (online at https://www.eoas.ubc.ca/-rich/map.html).



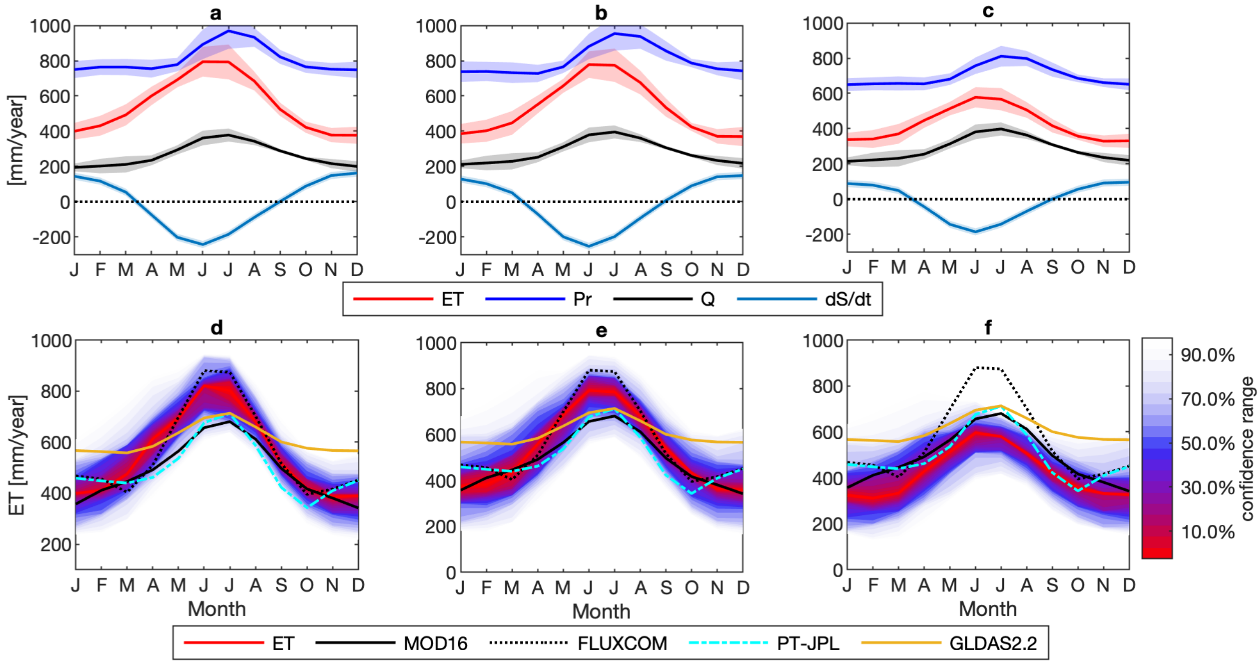
Extended Data Fig. 5 | Effect of ENSO and temperature. a, Multiple linear regression of global surface temperature (yellow line) and MEI (red line) onto ET (blue line). **b**–**d**, Multiple regression of MEI (red line) onto Pr (**b**), *Q* (**c**) and d*S*/d*t* (**d**). In each, the input times series data has been filtered using a 15-month moving average. The amount of variability explained is indicated by R^2 (top left corner of panels).



Extended Data Fig. 6 | Effect of removing natural climate variability and temperature on ET. a, ET anomaly time series (solid blue line) and linear trend (dashed blue line), and ET anomaly time series minus the multiple regression model of MEI onto ET (solid red lines) and trend (dashed red line). **b**, Same as **a**, but for multiple regression model of surface temperature. The value of the trends in mm yr^{-1} are indicated in the top left.



Extended Data Fig. 7 | Influence of ENSO on ET products. Left: correlation with ERSST version 4 SST against different ET products: ET (**a**), MOD16A2GF (**c**), FLUXCOM (**e**), PT-JPL (**g**) and GLDAS2.2 (**i**). Right: time series of MEI index against ET (**b**), MOD16A2GF (**d**), FLUXCOM (**f**), PT-JPL (**h**) and GLDAS2.2 (**j**). For each panel, the SST and water-balance variable have the seasonal cycle removed and a 15-month moving average filter applied. The *r* value of the correlation between MEI and ET shown in top left corner (right panels) (*r* values surrounded by () are not significant at the $\alpha = 0.05$ level). Stippling on the maps (left panels) indicates that the value of the correlation at that grid point is significant ($\alpha = 0.05$ level). Maps created using MATLAB with the M_Map package (online at https://www.eoas.ubc.ca/-rich/map.html).



Extended Data Fig. 8 | Contribution of ice sheets to ET. a–c, Seasonal cycle for ET, Pr, Q and dS/dt calculated without Greenland + Antarctica (**a**), without Antarctica (**b**) and with all global land (ET from this study) (**c**). The shading is the standard deviation among the bias-corrected seasonal cycle of the ET ensemble (red shading), and input datasets used for Pr (four datasets, blue shading), Q (five datasets, black shading) and dS/dt (three methods to calculate derivative from JPL RL06 GRACE TWS, teal shading). **d–f**, Ensemble of ET compared with other ET products for ET calculated without Greenland + Antarctica (**d**), without Antarctica (**e**) and with all global land (ET from this study) (**f**). The shading represents the confidence intervals for the ensemble of ET (range shown in the colour bar).

Extended Data Table 1 | ET long-term mean and trends

	Product	Dataset	Time period	Mean ET or Trend [mm/year]
Mean ET	ET (This study)	Observational water balance	2003 - 2019	423
	Haddeland et al. (2011)	Model-based	1985 - 1999	415-586
	Hobeichi et al. (2018)	Upscaled flux estimate	2000 - 2009	325
	Jung et al. (2019)	Upscaled flux estimate	2000 - 2013	508 - 510
	Rodell et al. (2015)	Satellite water balance	2000 - 2010	470
Trend	ET (This study)	Water balance with GRACE/GRACE-FO 4 precip, 5 Q datasets	2003 - 2019	3.30
	Jung et al. (2010)	Gridded ET from machine learning with eddy covariance and meteo obs.	1982 - 2008	0.45
	(Jung et al. (2010) above, different time period)		1998 - 2008	- 0.80
	Zhang et al. (2015)	Process-based Land Surface Evapotranspiration/ Heat Fluxes algorithm using MOD16A2GF	1982 - 2013	0.88
	Miralles et al. (2014)	GLEAM constrained with satellite obs.	1980 - 2011	0.32

Long-term mean global land ET and trends from this study, and reported in the literature (long-term mean ET fluxes and trends from the literature have all been converted to mm yr^{-1}).

Extended Data Table 2 | ET seasonal cycle and trends

Dataset	Time period	Seasonal Cycle Amplitude [mm/year]	Trend (Available period) [mm/year]	Trend (2003 - 2013) [mm/year]
ET	2003 - 2019	285	2.30	2.81
MOD16A2GF	2000 - 2019	338	1.40	1.52
FLUXCOM	2001 - 2013	485	-0.24	-0.24
PT-JPL	2002 - 2017	370	1.67	0.43
GLDAS2.2	2000 - 2019	155	1.21	7.05

Seasonal cycle amplitude and ET trends of datasets used in this study. Trends are shown for the common period (2003–2013) as well as the full period of availability for each dataset.

EXHIBIT 7

Review Article
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Harmful Freshwater Algal Blooms, With an Emphasis on Cyanobacteria

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Suspended algae, or phytoplankton, are the prime source of organic matter supporting food webs in freshwater ecosystems. Phytoplankton productivity is reliant on adequate nutrient supplies; however, increasing rates of nutrient supply, much of it manmade, fuels accelerating primary production or eutrophication. An obvious and problematic symptom of eutrophication is rapid growth and accumulations of phytoplankton, leading to discoloration of affected waters. These events are termed blooms. Blooms are a prime agent of water quality deterioration, including foul odors and tastes, deoxygenation of bottom waters (hypoxia and anoxia), toxicity, fish kills, and food web alterations. Toxins produced by blooms can adversely affect animal (including human) health in waters used for recreational and drinking purposes. Numerous freshwater genera within the diverse phyla comprising the phytoplankton are capable of forming blooms; however, the blue-green algae (or cyanobacteria) are the most notorious bloom formers. This is especially true for harmful toxic, surface-dwelling, scum-forming genera (e.g., *Anabaena, Aphanizomenon, Nodularia, Microcystis*) and some subsurface bloom-formers (*Cylindrospermopsis, Oscillatoria)* that are adept at exploiting nutrient-enriched conditions. They thrive in highly productive waters by being able to rapidly migrate between radiance-rich surface waters and nutrient-rich bottom waters. Furthermore, many harmful species are tolerant of extreme environmental conditions, including very high light levels, high temperatures, various degrees of desiccation, and periodic nutrient deprivation. Some of the most noxious cyanobacterial bloom genera (e.g., *Anabaena, Aphanizomenon, Cylindrospermopsis, Nodularia*) are capable of fixing atmospheric nitrogen (N_2), enabling them to periodically dominate under nitrogen-limited conditions. Cyanobacteria produce a range of organic compounds, including those that are toxic to higher-ranked consumers, from zooplankton to further up the food chain. Both N_2- and non-N_2-fixing genera participate in mutualistic and symbiotic associations with microorganisms, higher plants, and animals. These associations appear to be of great benefit to their survival and periodic dominance. In this review, we address the ecological impacts and environmental controls of harmful blooms, with an emphasis on the ecology, physiology, and management of cyanobacterial bloom taxa. Combinations of physical, chemical, and biotic features of natural waters function in a synergistic fashion to determine the sensitivity of water bodies. In waters susceptible to blooms, human activities in water- and airsheds have been linked to the extent and magnitudes of blooms. Control and management of cyanobacterial and other phytoplankton blooms invariably includes nutrient input constraints, most often focused on nitrogen (N) and/or phosphorus (P). The types and amount of nutrient input constraints depend on hydrologic, climatic, geographic, and geologic factors, which interact with anthropogenic and natural nutrient input regimes. While single nutrient input constraints may be effective in some water bodies, dual N and P input reductions are usually required for effective long-term control and management of harmful blooms. In some systems where hydrologic manipulations (i.e., plentiful water supplies) are possible, reducing the water residence time by enhanced flushing and artificial mixing (in conjunction with nutrient input constraints) can be particularly effective alternatives. Implications of various management strategies, based on combined ecophysiological and environmental considerations, are discussed.

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KEY WORDS: Algae, blooms, eutrophication, cyanobacteria, phytotoxins, water quality, trophodynamics, limnology, lakes, rivers, estuaries, nutrients, zooplankton, fish, microorganisms, nitrogen, nitrogen fixation, phosphorus, lake management.

DOMAINS: freshwater systems, ecosystems and communities, microbiology, plant sciences; environmental toxicology, plant processes, ecosystem management

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INTRODUCTION

Why do Blooms Occur?

Microscopic suspended algae, or phytoplankton, are of fundamental importance in supporting the productivity of aquatic ecosystems. Phytoplankton utilize light, carbon dioxide, and a range of inorganic and organic nutrients to photosynthetically produce biomass, which provides the energy and materials at the base of food webs. In most water bodies, there is a fine balance between adequate irradiance and nutrient supply that determines the rate of production of phytoplankton biomass, or primary productivity[1,2,3]. The regulation of phytoplankton production by light and nutrient availability is often referred to as "bottom-up" control. Newly produced phytoplankton biomass is consumed by planktonic herbivores, which by grazing or predation exert a "top-down" control on phytoplankton production. The balance between bottom-up and top-down control determines how much *net* production takes place. Physical factors such as vertical mixing and the rate of flushing (i.e., residence time) in a water body exert additional controls on how much phytoplankton production and consumption can take place over time and space[4,5,6]. The interaction between physical, chemical, and biotic factors determines environmental heterogeneity, a key factor determining the diversity and successional patterns of phytoplankton[2,7,8]. Under optimal growth conditions, high rates of primary productivity take place. If consumption cannot keep pace with production, excess phytoplankton accumulates. Phytoplankton accumulations that lead to visible discoloration (most often yellow, green, blue-green, red, or brown) of the water are commonly referred to as blooms[9,10,11]. Phytoplankton blooms can occur at the surface or at specific depths in the water column corresponding to optimal light and nutrient levels as well as thermal and density stratification. Blooms can accumulate passively through buoyancy compensation, or they may accumulate through active mechanisms, including high growth rates and swimming migration. From an ecosystem perspective, high rates of nutrient loading accompanied by water residence time long enough to support adequate growth and high reproductive rates, combined with relatively low grazing rates, represent optimal conditions for phytoplankton bloom development[2,4,9,12,13].

What Makes a Bloom Harmful?

Blooms accumulate, proliferate, and manifest themselves in myriad ways. Many blooms accumulate near the water's surface, where light is plentiful[9,10]. Rapid bloom development can result if growth and division rates are fast or, in the case of buoyant species, when stable water column conditions (i.e., lack of mixing) facilitate surface accumulations. Accumulations may lead to adverse tastes and odors as well as toxicity of affected waters[9,14]. At high cell densities, blooms may rapidly deplete nutrients, increase turbidity (and hence decrease transparency), exhaust inorganic carbon (CO_2) supplies and other essential resources, thus causing a sudden decline in biomass, referred to as a "crash"[9,11]. This usually involves decaying, odoriferous, unsightly scums. Scums can harbor a variety of microbial pathogens and rob the underlying waters of oxygen, causing significant chemical and biological changes, including hypoxia (dissolved oxygen concentrations less than 4 mg l^{-1}, stressful to most fauna), anoxia (no detectable oxygen, fatal to most finfish and shellfish), release of toxic hydrogen sulfide, and accelerated release of nutrients from sediments which further aggravates eutrophication and blooms[8,10,13]. Waters impacted in this matter are often off-limits to recreational use (bathing, fishing). In addition, some bloom-forming species produce compounds toxic to biota including invertebrates (e.g., zooplankton), finfish and shellfish, and vertebrate consumers of drinking water, including humans[14,15]. These conditions are undesirable and noxious from water use, recreational and health perspectives; hence the designation "harmful".

Who are the Players?

Most major freshwater algal phyla contain some harmful or otherwise nuisance bloom genera (Table 1, Figs. 1 and 2). These include the eukaryotic green algae or chlorophytes, dinoflagellates, cryptophytes, chrysophytes (including diatoms), and the prokaryotic blue-green algae or cyano-bacteria[2,16,17]. These groups include taste and odor producers, toxin producers, food web disrupters, and hypoxia-generating and aesthetically undesirable types (freshwater "red tides", scum-formers). Examples are discussed below. Cyano-bacteria, by far the most notorious and problematic freshwater group, is the detailed subject of this review.

Chlorophyta (Green Algae)

Members of the phylum Chlorophyta, or green algae, are inhabitants of geographically diverse lakes, reservoirs, streams, and rivers varying in trophic state. Chlorophytes include microscopic planktonic (solitary, colonial, or filamentous forms), attached filamentous, and macroalgal genera. While some macroalgal blooms can cause water quality problems in the littoral zones of lakes, rivers, and estuaries, chlorophytes are normally not thought of as nuisance algae. However, nutrient-enriched conditions favor members of this group, and high chlorophyte density is indicative of eutrophying conditions. In highly eutrophic waters, green algae often codominate with bloom-forming cyanobacteria (see below). However, in contrast to the cyanobacteria, there is no documentation of toxicity among chlorophytes.

Some chlorophyte genera form distinctive blooms that on rare occasions may proliferate and persist to cause water quality problems such as hypoxia, tastes, and odors[2]. Members of the genus *Botryococcus* can form highly buoyant surface-dwelling aggregates that can accumulate as scums[18]. While these surface blooms are aesthetically detractive, they are not necessarily indicative of excessive nutrient loading or water quality deterioration. For example, *Botryococcus* blooms regularly occur in the surface waters of Lake Taupo, New Zealand's largest lake, located in the middle of the North Island (Paerl, unpublished). This oligotrophic lake has excellent water quality and a world-class trout fishery. Other genera that can grow to high enough abundance to cause discoloration of inland waters include *Sphaerocystis, Dictyosphaerium*, *Scenedesmus,* and *Chlorococcus*.

Dinophyta (Dinoflagellates)

This phylum is composed of highly motile single-celled taxa, some of which are armored and others not. Dinoflagellates are almost exclusively planktonic, preferring well-illuminated near-surface waters[2,19]. Most dinoflagellates are pigmented (chlorophyll and carotenoids) and grow photosynthetically; however, there are nonpigmented genera that must support growth heterotrophically, either by directly utilizing dissolved organic matter or by ingesting small food particles, including bacteria and other algae[20]. Dinoflagellates are widely distributed in freshwater environments. They may be found over a broad range of trophic states, spanning oligotrophy to hypereutrophy.

Accelerated growth and dense accumulations of dinoflagellates in near-surface waters can cause blooms. As with other bloom-forming phytoplankton, nutrient-enriched conditions tend to enhance growth and bloom potential. However, there is substantial variability in the extent to which blooms are related to trophic state of affected waters. In some large lakes, blooms can occur even under low nutrient-loading conditions. A key to the success of bloom-forming dinoflagellates is their ability to rapidly migrate between nutrient-rich deeper waters and radiance-rich surface waters, thereby satisfying both nutrient and light requirements[6,19].

Dinoflagellate blooms can manifest themselves at high densities (>100,000 cells/ml) and in many colors, including pale green, yellow, red, and brown. The armored genera *Ceratium*, *Heterocapsa*, *Gymnodinium*, and *Peridinium* can, by

TABLE 1
Representative Freshwater Nuisance A

Kingdom/Phylum	Genus	Preferred Bloom Conditions
Prokaryota		
Cyanobacteria		
(N_2-fixing)	*Anabaena*	P-enriched, warm, stratified, long-residence
	Aphanizomenon	time, high irradiance, eutrophic
	Cylindrospermopsis	
	Gloeotrichia	
	Nodularia	
(Non-N_2-fixing)	*Microcystis*	N- and P-enriched, eutrophic conditions,
	Oscillatoria	warm, stratified, long residence time
	Gomphosphaeria	
Eukaryota		
Chlorophyta	*Botryococcus*	Moderate N- and P-enriched, stratified, high irradiance
	Chlorococcus	Eutrophic, N- and P-enriched
	Sphaerocystis	
Pyrrhophyta (Dinophyta)	*Ceratium*	N- and P-enriched, stratified, some
	Peridinium	oligohaline
	Heterocapsa	
	Prorocentrum	
Cryptophyta	*Cryptomonas*	N- and P-enriched, eutrophied,
	Rhodomonas	fresh to oligohaline, stratified
Chrysophyta	*Chromulina*	N- and P-enriched, toxic at high N
	Chrysochromulina	enrichment, stratified
	Dinobryon	
	Mallomonas	
	Prymnesium	

virtue of high densities and rich carotenoid content, form spectacular blooms often referred to as freshwater "red tides". These blooms can, at times, lead to massive accumulations of decaying biomass in surface waters, and when blown ashore or trapped in shallow embayments, can cause water quality problems including foul odors and tastes, hypoxia, and loss of aesthetic and recreational value of affected waters. While marine analog genera (including *Alexandrium, Gymnodinium*, *Heterosigma*, and *Noctiluca*) are well-known toxin producers negatively affecting a wide array of biota ranging from invertebrates to fish to large mammals and humans, freshwater dinoflagellates are generally nontoxic. Some toxic and hypoxia-generating nuisance dinoflagellate species flourish under brackish estuarine conditions (*Dinophysis*), where blooms can cause substantial ecological and economic (fisheries) losses. Included are periodic outbreaks of *Prorocentrum* in the Chesapeake Bay, and *Gymnodium, Gyrodinium,* and *Heterocapsa* in North Carolina estuaries. These blooms have, at times, been linked to excessive inputs of both nitrogen (N) and phosphorus (P).

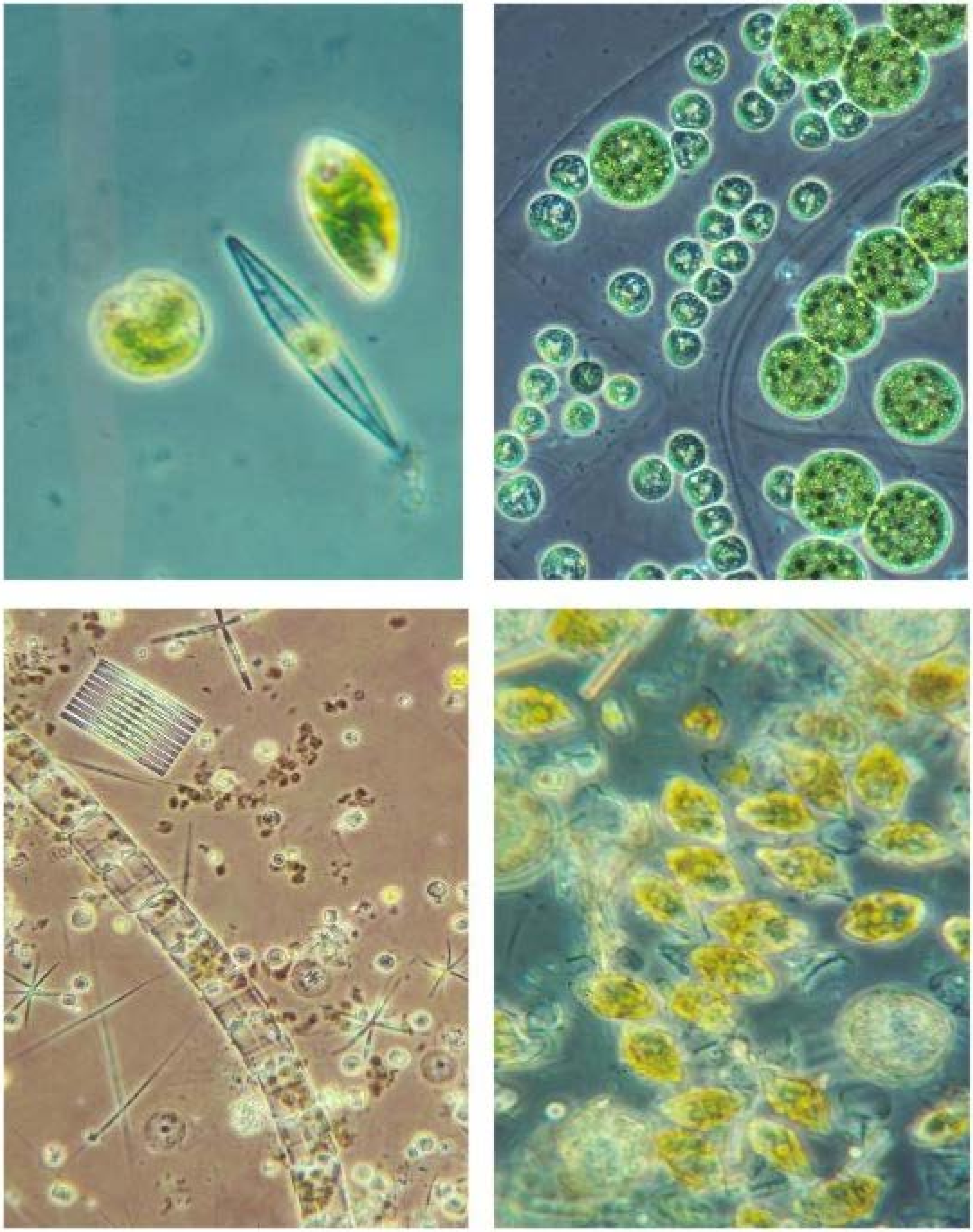
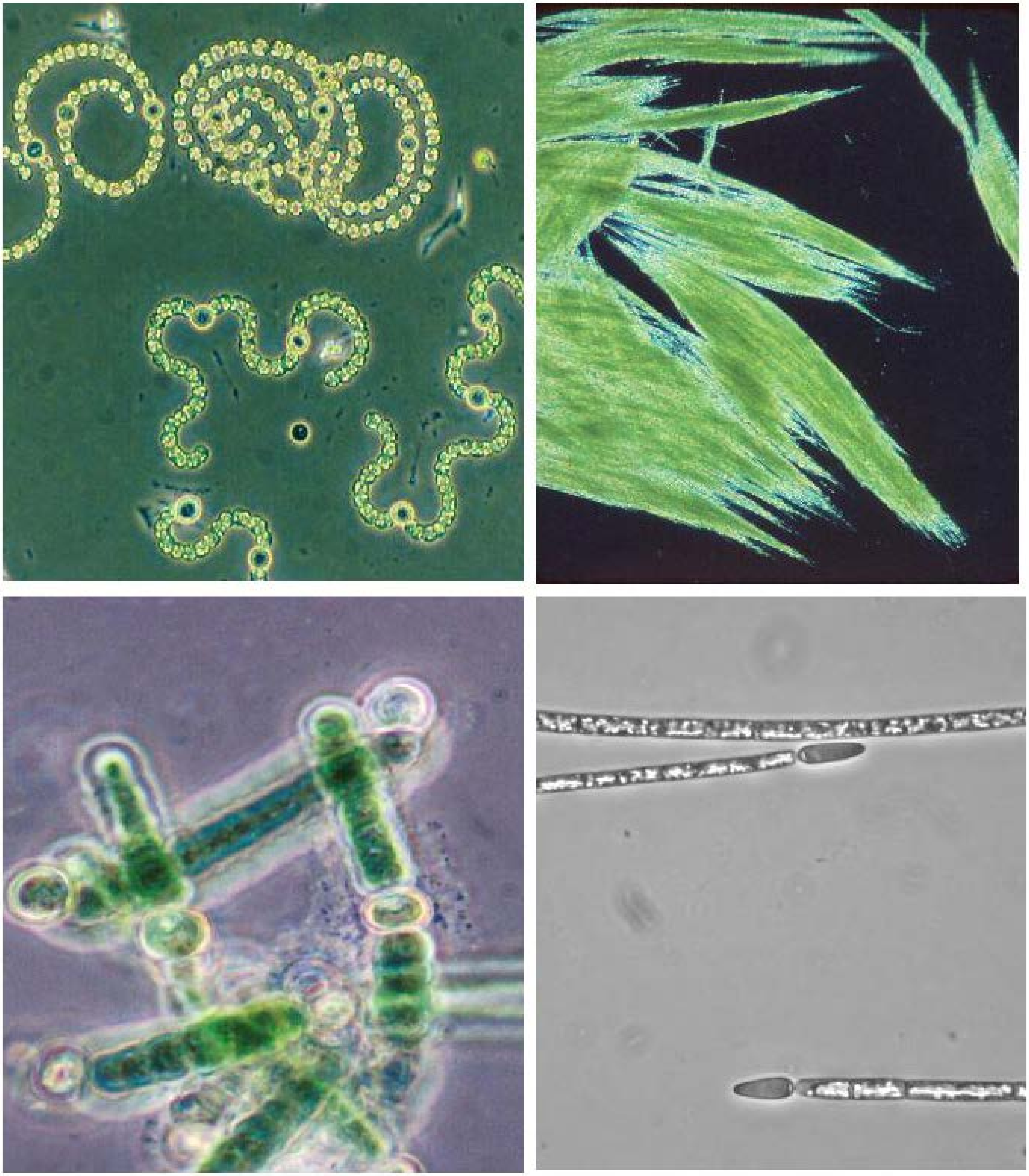


FIGURE 1. Representative photomicrographs of eukaryotic algal phyla containing bloom-forming species. These examples are from natural populations in the Neuse River Estuary, North Carolina. Upper left, cryptomonads and a diatom; upper right, chlorophytes or green algae; lower left, chain-forming diatoms; lower right, dinoflagellates.

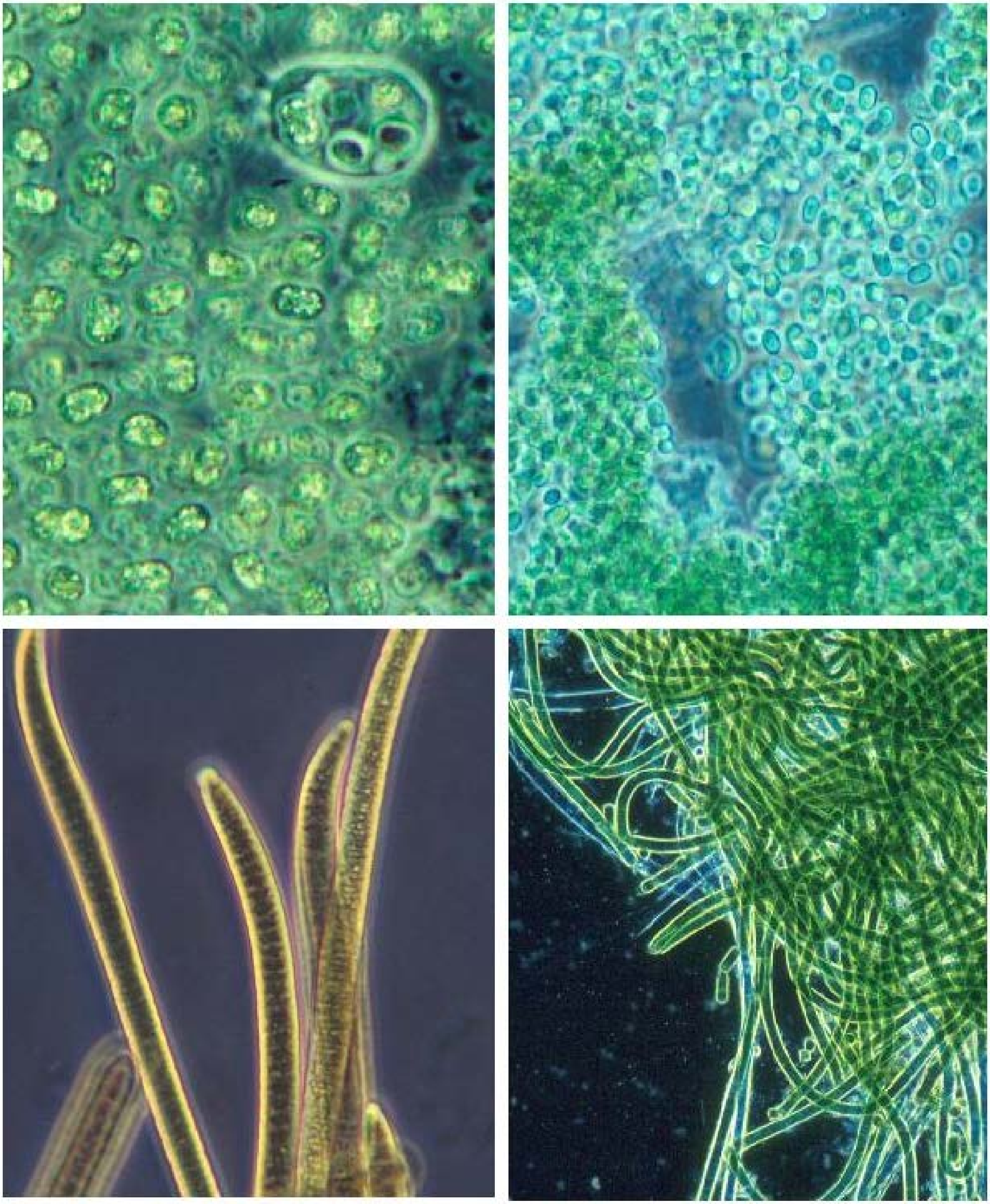
Cryptophyta

Cryptophytes are motile planktonic algae that grow phototrophically[2]. This group is broadly distributed in lakes, slow-moving rivers, and oligohaline regions of estuaries, but less so in fast-moving streams[21]. Cryptophytes generally prefer nutrient-enriched waters ranging from mesotrophic to hypereutrophic. High densities of the genera



(2A)

FIGURE 2. Major cyanobacterial bloom-forming genera. (A) Members of heterocystous, N_2-fixing genera. Upper left, *Anabaena flos-aquae* (top of frame) and *A. spiroides*; upper right, flake-like colonies of *Aphanizomenon flos-aquae*; lower left, *Nodularia* sp.; lower right, *Cylindrospermopsis raciborskii*. (B) Members of nonheterocystous genera. Upper left, *Microcystis aeruginosa* colony; upper right, unidentified colonial coccoid cyanobacteria; lower left, *Oscillatoria* sp. filaments; lower right, aggregated *Lyngbya* sp. filaments.



(FIGURE 2B)

Rhodomonas and *Cryptomonas* can occur following periods of nutrient enrichment. The discoloration resulting from *Rhodomonas* and *Cryptomonas* blooms can be traced to abundant cellular carotenoid pigments. In some systems, these blooms are indicative of enhanced nutrient loading. Typically, *Cryptomonas* blooms occur from late winter through spring, giving way to diatom, chlorophyte, dinoflagellate, and cyanobacterial dominance in summer and fall. When combined with dinoflagellates, cryptomonad blooms can be responsible for freshwater "red tides", localized hypoxia, and adverse aesthetics. As a group, cryptophytes are not known to be toxic to either resident biota or humans.

Chrysophyta

The chrysophytes consist of phototrophic, unicellular, colonial, filamentous, or siphonaceous genera, all of which contain abundant colored (usually golden to brown) carotenoid pigments. All genera are planktonic, many are motile, propelled by either flagella (classes: Chrysophyceae, Haptophyceae, and Craspedophyceaea) (*Chromulina*, *Chrysochromulina*, *Prymnesium*) or mucilage excretions ("jet propulsion"), as is the case among the diatoms (class Bacillariophyceae)[2]. Others are nonmotile, either solitary or colonial (*Dinobryon*, *Mallomonas*, *Synura*). Chrysophytes exhibit broad growth requirements and can be found in diverse freshwater habitats.

Few nuisance taxa exist; however, among these, water quality problems have been reported. Dense blooms of mucilage-producing diatoms can foul shorelines, and large accumulations of diatom biomass can exacerbate hypoxia. Such blooms can be indicative of enhanced nutrient loading, although they are not nearly as diagnostic as cyanobacterial and green algal blooms. In both fresh and brackish nutrient-enriched waters, *Prymnesium* can accumulate in large numbers. Members of this genus produce a potent toxin that affects gill-bearing animals, including fish and mollusks. This genus has posed serious water quality problems in aquaculture ponds, especially those in tropical locations where the combined effects of high temperature, stagnancy, and toxic *Prymnesium* can lead to severe fish kills. In the brackish waters of the western Baltic Sea, the Danish sounds, and Kattegat-Skagerrak (near the entrance to the North Sea) large and persistent blooms of *Chrysochromulina polylepis* have been reported in response to periods of elevated nutrient (especially nitrogen) loading[22]. These blooms have proven toxic to fish and shellfish; an unusually large bloom in 1988 was shown to be responsible for devastating the salmon net pen aquaculture industry in the Kattegat region between southwestern Sweden and southern Norway[22]. Toxicity in *C. polylepis* appears to be strongly stimulated by nitrogen enrichment relative to phosphorus, leading to increased phosphorus limitation. These problems can occur in brackish and full-salinity aquaculture ponds[23], but have not been reported in freshwater environments.

Cyanobacteria

The cyanobacteria (blue-green algae) are the most widespread and problematic freshwater nuisance algal taxa. Cyanobacteria are prokaryotic, i.e., they have no defined nucleus and organelles; their cellular structure is most similar to bacteria. In freshwater environments, cyanobacteria can be found in three basic morphological groups: 1) unicells, which may be solitary or aggregated in colonies; 2) undifferentiated, nonheterocystous filaments, which also may be solitary or aggregated; and 3) filamentous forms containing differentiated cells called heterocysts (Fig. 2). Each of these groups contains nuisance taxa (Table 2, Fig. 2) that will be discussed in detail below. Cyanobacteria are the oldest (~2.5 billion years) oxygenic phototrophic inhabitants on Earth. A long evolutionary history has endowed them with an array of physiological, morphological, and ecological adaptations in response to geochemical and climatic change[24,25,26]. Cyanobacteria are also uniquely adapted to nutrient deficiencies and alterations. For example, they are the only phytoplankton group capable of utilizing atmospheric dinitrogen gas (N_2) as a nitrogen source via biological N_2 fixation ($N_2 + 6H^+$® $2NH_3$) and as such can circumvent N-limited conditions. In addition, they are capable of taking up phosphorus (P) in excess of cellular growth requirements (luxury consumption), and storing it for subsequent use under P-limited conditions. These physiological traits allow cyanobacteria to exploit both nutrient-deficient and -enriched environments[9,10,13,27].

The most visible and troubling aspect of cyanobacterial opportunism is the development and proliferation of surface and subsurface nuisance blooms in nutrient-enriched freshwater and brackish ecosystems[9,13,28] (Fig. 3). Because they may be toxic, blooms can pose serious water quality, fisheries resource, aquaculture, and animal and human health problems[29,30,31]. Blooms have been linked to liver disease, human cancers, and deaths[31,32] (Table 3). In addition, blooms can cause hypoxia and anoxia of underlying waters, which may lead to fish and bottom fauna mortalities[27,33]. Recreational use and aesthetic values of affected waters may be seriously impaired. In addition, nutrient (C, N, P, iron, and trace elements) fluxes and biogeochemical cycling can be impacted by high rates of CO_2 and N_2 fixation and massive amounts of biomass generated and sedimented during blooms[34,35,36].

TABLE 2
Name and Producer Organism for the Cyanobacterial Toxins

Name	Produced by
Biotoxins	
Anatoxin-a	*Anabaena, Aphanizomenon, Oscillatoria (Planktothrix)*
Homo-Anatoxin-a	
Anatoxin-a(s)	*Anabaena, Oscillatoria (Planktothrix)*
Cylindrospermopsin	*Aphanizomenon, Cylindrospermopsis, Umezakia*
Microcystins	*Anabaena, Aphanocapsa, Hapalosiphon, Microcystis, Nostoc, Oscillatoria (Planktothrix)*
Nodularins	*Nodularia* (brackish water)
Paralytic Shellfish Poisons (Saxitoxins)	*Anabaena, Aphanizomenon, Cylindrospermopsis, Lyngbya*
Debromoaplysiatoxin,	
Lyngbyatoxin	*Lyngbya* (marine)
Aplysiatoxin	*Schizothrix* (marine)
Cytotoxins	Both fresh and marine cyanobacteria

HARMFUL CYANOBACTERIAL BLOOM DYNAMICS

A particularly troublesome aspect of harmful blooms are growing reports of blooms proliferating in previously bloom-free waters experiencing anthropogenic nutrient (most often N and P) enrichment. Historically, the most notorious (i.e., toxin-producing, hypoxia-generating) nuisance algae in freshwaters are cyanobacteria. They include the genera *Anabaena*, *Aphanizomenon*, *Lyngbya, Microcystis*, *Nodularia*, and *Oscillatoria* which are traditionally confined to heavily nutrient-enriched impoundments[9,10,13,27,29]. However, global expansion into more-recently eutrophying waters is underway. Examples include the appearance, persistence, and proliferation of toxic heterocystous, N_2-fixing genera (*Anabaena*, *Aphanizomenon*, *Cylindrospermopsis, Gloeotrichia, Nodularia*) and non-N_2-fixing genera (*Microcystis*, *Oscillatoria, Lyngbya)* in lakes, reservoirs, rivers, and brackish ecosystems throughout Europe, South Africa, Australia, New Zealand, Brazil, Colombia, and Canada. In the U.S., cyanobacterial bloom taxa appear to be expanding in large riverine, estuarine, and coastal ecosystems (e.g., Lake Pontchartrain, Louisiana; St. Johns River Estuary and Florida Bay, Florida; tributaries of the Albemarle-Pamlico Sound System, North Carolina; Potomac River-Chesapeake Bay, Maryland-Virginia). These systems are experiencing increasing agricultural runoff, groundwater, and atmospheric loading of nutrients, especially N and P[37]. Documented toxin and taste/odor-producing genera (*Microcystis*, *Anabaena, Aphanizomenon, Anabaenopsis, Cylindrospermopsis*) are becoming more prevalent and problematic in aquaculture operations, including fresh to brackish catfish, shrimp, striped bass, and euhaline salmon net-pen culture[31]. In the St. Johns River, a riverine-estuarine system draining a large network of eutrophic lakes in central and Northeast Florida, the filamentous heterocystous genus *Cylindrospermopsis*, first reported in the late 1980s[38], has proven to be an aggressive invader of freshwater components of the system. In addition, there are a growing number of reports of more incipient cyanobacterial invasions and outbreaks. Recently, MacGregor et al.[39] provided the first documentation of N_2-fixing *Nodularia* spp. in the open waters of Lake Michigan.

(3A)

FIGURE 3. Examples of freshwater cyanobacterial blooms. (A) Upper left, *Nodularia* spp. bloom in the Baltic Sea off the southern coast of Finland; mid-left, *Microcystis aeruginosa* and *Anabaena* spp. bloom in the lower St. Johns River, Florida (courtesy J. Burns); lower left, *Anabaena* spp. bloom in Lake Okaro, New Zealand (North Island); (B) lower right, *Microcystis aeruginosa* bloom in a canal in the Netherlands; mid-right, *Anabaena-Cylindrospermopsis* bloom in Australia (courtesy G. Jones); upper right, *Microcystis-Oscillatoria* bloom in the Neuse River, North Carolina.

What are the environmental factors mediating cyanobacterial bloom expansion? How are these factors related to human activities and hence potential controls and management of these activities? Relevant factors include:

- N and P
- Organic matter
- Iron and trace elements
- Conductivity and salinity
- Turbulence
- Water residence (flushing) times
- Water column vertical stratification and stability
- Interactions with microbes, competitors, and consumers
- Human introduction and displacement of species
- Climate change

Environmental factors implicated in the control of cyanobacterial growth and dominance are listed in Table 4 and conceptually presented in the context of ecosystem function in Fig. 4. Most of these factors are also applicable to other freshwater nuisance algal groups.

Nitrogen and Phosphorus

On cellular and ecosystem scales, N and P are usually in short supply relative to plant growth requirements[40,41,42,43]. It follows that enrichment of natural waters with one or both

(FIGURE 3B)

of these nutrients stimulates primary productivity. The resultant rate of increase of plant-produced organic matter is called eutrophication; in general, increasing N and P inputs accelerates eutrophication. From an ecosystem perspective, eutrophication can be viewed as a fertilization process. While fertility is essential and desirable from an ecosystem productivity perspective, it is also possible that "too much of a good thing" may result from overfertilization. For example, under conditions of accelerating N and P input, the rate of primary production can exceed the rate at which it is utilized by invertebrate and fish secondary consumers. The "unused" or excess organic matter may then accumulate, initially as planktonic algal blooms and/or massive growths of attached microalgae or macrophytes, then as oxygen-consuming masses of decaying organic matter (detritus). This is the precursor of previously mentioned water quality and health problems, including adverse tastes and odors, toxicity, hypoxia, and anoxia. These initial symptoms of eutrophication can magnify into more serious, long-term water quality and habitat-degradation problems. Hypoxia and anoxia are prime causative agents of shellfish and finfish mortality[44]. They also exert stress on oxygen-requiring higher animals, increasing susceptibility to disease and parasitism.

There is a rich literature pointing to excessive P loading as a chief causative agent of freshwater eutrophication[43,45]. P-driven eutrophication has been strongly implicated in the development of both N_2-fixing and non-N_2-fixing cyanobacteria. This linkage is particularly strong if affected waters have relatively long residence times (i.e., low rates of flushing), surface water temperatures periodically exceeding 20^{o}C, and vertical temperature stratification (i.e., poorly mixed)[9,10,13,46]. In addition, organic matter-enriched conditions may favor the development and persistence of cyanobacteria[47]. Whether or not N_2 fixers dominate the cyanobacterial community depends on N availability as well as the molar ratios of both total and soluble (biologically available) N to P. Waters having N:P <15 (molar) are most susceptible to cyanobacterial dominance[48,49,50]. Conversely, waters having molar N:P ratios in excess of 20 are more likely to be dominated by non-N_2-fixing eukaryotic algal taxa[49]. These crite-

TABLE 3
Examples of Recent Environmental and Health Problems Associated with Toxic Cyanobacteria

Organism/Toxin	Problem	Reference
Microcystin (organism unknown)	Net-pen liver disease of maricultured Atlantic Salmon: British Columbia, Canada, and Washington	Carmichael (unpubl.)
Microcystin (organism unknown)	Intestinal lesions of maricultured penaeid shrimp: Hawaii, Colombia SA	Carmichael (unpubl.)
Microcystin (organism unknown)	Acute lethal liver disease of aquacultured striped bass: California	Carmichael (unpubl.)
Microcystin (organism unknown)	Acute lethal liver disease of aquacultured catfish: North Carolina	Zimba et al. (in press)
Microcystins (*Microcystis aeruginosa*)	Acute nonlethal toxicity in natural populations of trout and carp: England and Australia	30, 31
Microcystins	At least 49 human fatalities from use of contaminated municipal water in a hemodialysis clinic: Pernambuco, Brazil	Carmichael et al. (in press)
Anatoxin-a, anatoxin-a(s), microcystins, nodularins, and saxitoxins	Continued widespread animal poisonings throughout the world	14, 31
Cylindrospermopsin (*Cylindrospermopsis raciborskii*)	Cattle poisoning: Queensland, Australia	142
Cylindrospermopsin (*Cylindrospermopsis raciborskii*)	148 humans hospitalized with hepatoenteritis in Palm Island, Queensland, Australia due to contaminated water supply	141

ria are most effective in periodically stratified, long residence (> 30 days) systems.

The “N:P rule” is less applicable to highly eutrophic (hypereutrophic) systems in which *both* N and P loadings are very large (i.e., where N and P inputs may exceed the assimilative capacity of the phytoplankton). These systems may periodically contain N:P ratios in excess of 20, but since both N and P are supplied at close to nonlimiting rates, factors other than nutrient limitation (e.g., light, vertical mixing, residence time, conductivity/salinity, trace element availability) may dictate algal community composition and activities. Here, N_2 fixation, or diazotrophy, confers little, if any, advantage; hence non-N_2-fixing cyanobacteria and other algal taxa will predominate. These conditions favor very high rates of primary production and near-surface bloom accumulation. This, in turn, will reduce clarity and restrict photosynthetically active radiation (PAR; 400 to 700 nm) to the upper few centimeters of the water column. Such conditions provide an ideal niche for the surface-dwelling, bloom-forming, non-N_2-fixing cyanobacterial genus *Microcystis*, which invariably dominates in highly eutrophied, stratified ponds, rivers,

TABLE 4
Environmental Factors Influencing Cyanobacterial Growth and Bloom Formation

Factor	Impacts and Cyanobacterial Responses
Physical	
Temperature	Temperatures >15°C favor cyanobacterial growth, many species have optima at >20°C.
Light	Many bloom genera prefer/tolerate high light, while others are shade-adapted.
Turbulence and mixing	Most bloom genera prefer low turbulence over a range of spatial scales, poorly mixed conditions are favorable.
Water residence time	Long residence times are preferred by all genera.
Chemical	
Major nutrients (N and P)	Both N and P enrichment favor non-N_2-fixing genera. Low N:P ratios (i.e., high P enrichment) favors N_2 fixers.
Micronutrients (Fe, metals)	Fe required for photosynthesis, NO^-_3 utilization, and N_2 fixation; evidence for periodic Fe limitation. Other metals (e.g., Cu, Mo, Mn, Zn, Co) required but not limiting.
Dissolved inorganic C (DIC)	DIC can limit phytoplankton growth, but cyanobacteria can circumvent this; DIC limitation and high pH may provide competitive advantages to cyanobacterial bloom taxa.
Dissolved organic C (DOC)	Many cyanobacterial bloom taxa are capable of utilizing DOC; blooms often flourish in DOC-enriched waters.
Salinity	Not restrictive to cyanobacteria *per se*, but some bloom-forming genera (*Anabaena*, *Microcystis*) do not thrive in saline waters. Other genera (*Nodularia*) are salt-tolerant.
Biological	
Grazing	Selective factor, favoring large inedible filamentous and colonial, as well as toxic (to zooplankton) genera
Microbial interactions	Consortial cyanobacterial-bacterial interactions may promote growth and bloom formation/persistence. Interactions may be chemically mediated (i.e., role for “toxins”?). Some cyanobacteral-protozoan interactions may also be mutually beneficial. Evidence for viral and bacterial antagonism (i.e., lysis) towards cyanobacteria. However, does not appear to be a common mechanism for bloom control. Cyanobacterial-microbial competition for nutrients exists and may be a competitive mechanism.
Symbioses with higher plants and animals	Cyanobacteria are epiphytic/epizoic and form endosymbioses with algae, ferns, and vascular plants. Many are obligate and involve N_2-fixing cyanobacterial genera.

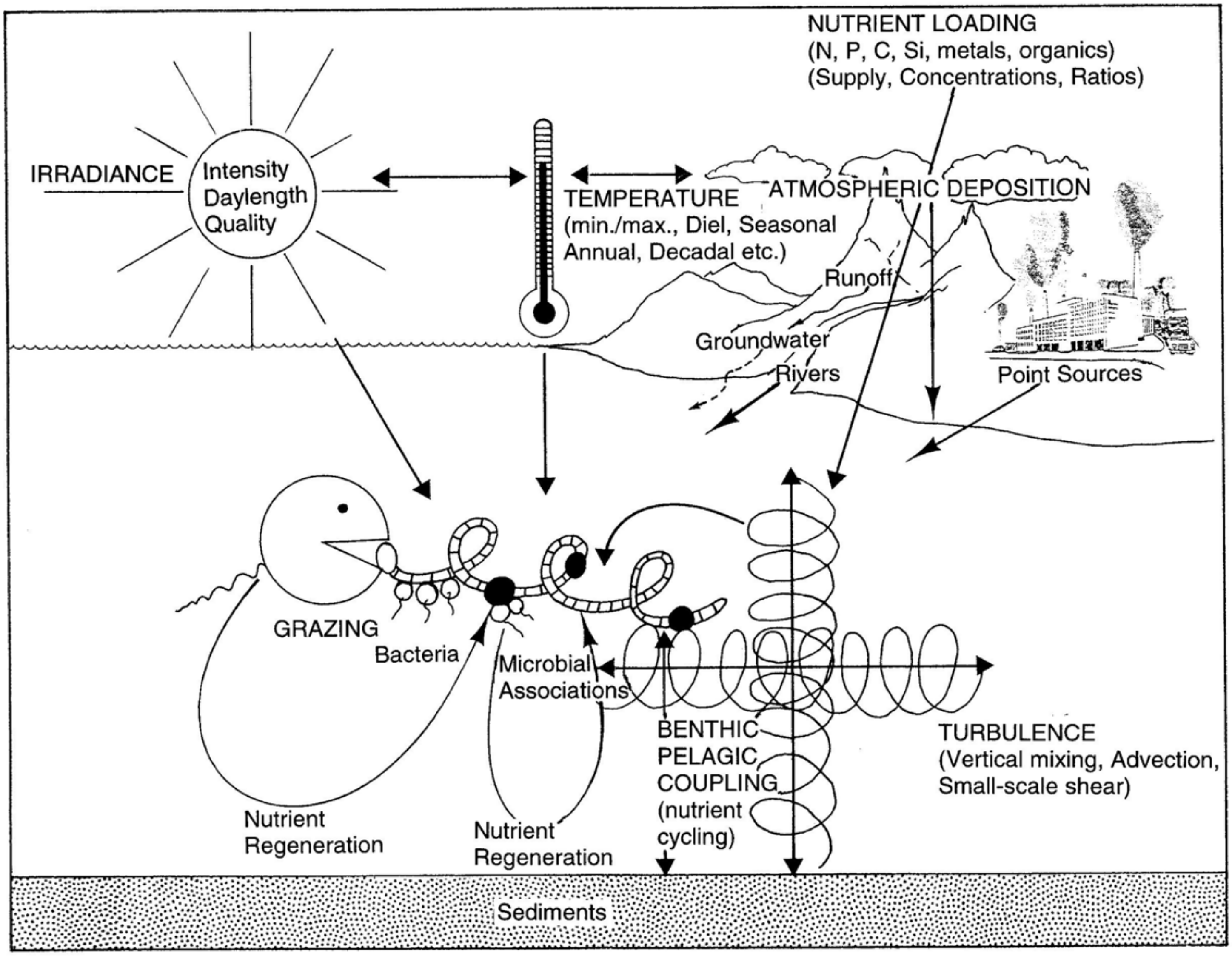


FIGURE 4. Conceptual diagram showing the interacting (in time and space) physical, chemical, and biotic environmental controls of cyanobacterial bloom dynamics.

lakes, and reservoirs receiving elevated N *and* P loadings. *Microcystis* blooms are often accompanied by other nondiazotrophic cyanobacterial genera, including *Gomphosphaeria, Oscillatoria*, and *Lyngbya*.

Moderately N- and P-enriched waters frequently support mixed assemblages of diazotrophic cyanobacteria and various nondiazotrophic algal assemblages. In temperate regions, these waters receive either co-occurring or sequential pulses of N and/or P. Typically, late winter and early spring are high precipitation periods, leading to elevated spring nutrient-laden (especially N) nonpoint source (NPS) surface runoff. This favors nondiazotrophic bloom species. In relatively dry summer months, runoff and NPS loading are reduced. During this period, point-source (PS) (e.g., wastewater treatment plants, municipal and industrial sources) and internally generated N and P loads released from hypoxic sediments, become more prominent components of nutrient loading. P enrichment (i.e., declining N:P ratios) occurs during reduced NPS and elevated PS loading during summer months. This scenario is more conducive to the establishment of N_2-fixing species[48]. Diazotrophs may be accompanied by nondiazotrophic species, which are able to utilize N fixed and released into the water column by diazotrophs[51]. Buoyancy regulation helps maintain a near-surface existence for both metabolic types. This mechanism is particularly advantageous in highly productive, turbid waters. Mixed assemblages often persist as a bloom "consortium" throughout summer and fall months, until unfavorable physical conditions such as excessive cooling (<15°C) and water column turnover take place. *Anabaena, Aphanizomenon,* and *Microcystis* commonly co-occur under these circumstances.

N-fixing cyanobacterial dominance has been controlled by reducing P inputs, which, in addition to restricting P availability, promotes increased N:P ratios[13,45,49,50]. From logistic and economic perspectives, P input constraints are often the most feasible and least costly short-term nutrient management option[45,49]. In certain cases, P cutbacks can be highly effective on their own (without parallel N removal), because 1) they may reduce total P availability enough to reduce growth of *all* bloom taxa and 2) they may increase N:P ratios sufficiently enough to provide eukaryotic algae a competitive advantage over cyanobacteria. Examples of this scenario include: 1) Lake Washington, Washington, U.S., where reduction of sewage-based P inputs led to profound reversal of eutrophication[52] and 2) reduction of wastewater, agricultural, and industrial P discharges to Lake Erie, which caused a rapid (within only a few years) and sustained decline in nuisance cyanobacterial blooms[43]. In North America and Europe, phosphate detergent bans (starting in the late 1970s) have helped reduce P loads to many rivers and lakes. Reductions in wastewater and agricultural P inputs have also helped. Jointly, these efforts have helped decrease bloom activities in large European and Asian lakes (e.g., Lakes Constance and Lucerne, Germany-Switzerland; Lake Trummen, Sweden; Lago Maggiorre, Italy; Lake Biwa, Japan), and freshwater-brackish lagoonal segments of the Baltic Sea (Latvia, Lithuania, Estonia). Here, a marked reduction of blooms of the N_2-fixer *Aphanizomenon* and non-N_2-fixer *Microcystis* has been reported[53]. Elsewhere, parallel N and P reductions have been most effective in reducing bloom potentials. In N and P colimited large lake and river systems where large amounts of externally supplied and/or naturally occurring P have enriched sediments, both N and P reductions are required for significant reductions in the size and spatial extent of blooms. Examples include the Florida inland lakes and rivers, Lake Tahoe, Lake Superior, and lakes in the Mississippi River drainage basin.

In contrast to most freshwater systems, primary production in marine waters is generally N-limited, with some estuaries exhibiting N and P colimitation[12,54,55,56,57]. N-enriched estuarine and coastal waters have experienced a recent upsurge in algal blooms[58,59,60,61]. Therefore, management of N inputs has received considerable attention[62,63]. Marine sediments are rich repositories of biogenically deposited P. In shallow water estuarine and near-shore shelf systems, P is efficiently cycled between sediments and the water column, ensuring a readily available source of regenerated P to support productivity. In contrast, marine sediments are generally N-depleted, in large part because microbial denitrification converts substantial amounts of externally supplied N (as nitrate) to relatively inert N_2 gas[64]. In addition, sedimentary organic N and ammonium can be nitrified to nitrate, which can also be converted to N_2 via denitrification (coupled nitrification-denitrification). N_2 fixation rates in these waters appear insufficient to balance denitrification losses[64]. As such, these waters remain chronically N-deficient, with total (soluble plus particulate) N:P ratios ranging from 1 to 5.

In North Carolina's Neuse River estuary, N-driven eutrophication and deteriorating water quality have prompted calls for an N input "cap" and a mandated 30% reduction in N loading (NC DENR Draft Neuse Basin Management Plan, 1997). However, changes in N loading may result in shifts in the ratio of dissolved nitrogen to phosphorus (N:P) loadings and concentrations in the Neuse River Estuary. Alterations in N:P in the river water can have significant impacts on aquatic communities beyond a simple reduction in phytoplankton productivity and biomass. Included are shifts in species composition and possible selection for species adapted to growth in waters with reduced N:P[49,65]. The phytoplankton community could conceivably become dominated by N_2-fixing species that may circumvent N limitation imposed by the managed N depletion[51,66]. An assessment of the impact of N-loading reductions on phytoplankton communities is needed to determine if additional controls are necessary to effectively manage nuisance cyanobacterial growth in N-limited estuaries. N_2-fixing *Anabaena* and *Cylindrospermopsis* species have been observed in brackish estuarine, lagoonal, and coastal (Baltic Sea) waters[67,68,69], illustrating the *potential* for expansion. However, *Microcystis* does not seem to share this capability[70,71]. In a laboratory study[72], two toxic Baltic Sea *Nodularia* strains[73] were capable of growth and bloom formation in Neuse River Estuary water over a wide range of salinities (0 to >15 psu), again demonstrating the potential for estuarine expansion of nuisance species. These examples indicate that estuarine waters receiving increasing urban and agricultural nutrient inputs are susceptible to cyanobacterial expansion[13].

Organic Matter

Organic matter content has been mentioned as a possible modulator of cyanobacterial growth and dominance[9,47]. Organic matter (OM) exists in either dissolved (DOM) or particulate (POM) forms; the distinction is based on size fractionation. By designation, DOM is that fraction passing through a glass fiber filter (~0.7 mm pore size)[74]. Most colloidal OM, some bacteria, and virtually all viruses are smaller than this pore size and hence are included in the DOM pool. It is believed that DOM is more directly utilized than POM by microorganisms, because POM degradation (to DOM) must first occur before this fraction is available. Therefore, DOM content is generally considered the most useful indicator of biologically available OM. DOM may directly stimulate microalgal heterotrophic growth if the organisms possess appropriate uptake and assimilatory enzymes. Many species of cyanobacteria, some dinoflagellates, chrysophytes, and chlorophytes are known to be capable of heterotrophic growth[75]. DOM may also indirectly benefit microalgae by acting as a source of energy and nutrition for closely associated heterotrophic bacteria. Cyanobacteria, in particular, are able to form synergistic interactions with epiphytic heterotrophic bacteria. These associations have been shown to enhance growth of "host" cyanobacteria[76,77]. In some freshwater ecosystems, direct (positive) relationships between trophic state (i.e., oligotrophic systems having low DOM, to eutrophic having high DOM) and cyanobacterial dominance have been observed. Regional examinations however yield no consistent trend, and other coinciding factors, such as pH, alkalinity, and hardness hinder the establishment of simple, direct mechanistic relationships. To further confound matters, Fogg[9] and others[51,78,79] have shown that that elevated DOM may be a result (due to DOM excretion, bacteria and viral lysis, and "sloppy feeding" on cyanobacteria by grazing zooplankton) rather than a cause of cyanobacterial blooms. In summary, while there appear to be direct relationships between DOM enrichment and a preponderance of nuisance blooms (especially cyanobacterial) (Granéli et al., in preparation), it remains unclear what the role(s) of DOM in bloom dynamics are. Well-defined experimental work, utilizing experimental enclosures or whole water bodies will help resolve this perplexing problem.

Iron and Trace Elements

Iron (Fe) and a suite of trace elements are essential micronutrients for algal growth. Fe is an enzyme cofactor in numerous biochemical pathways. Specifically, enzymes involved in photosynthesis, electron transport, energy transfer, N (specifically nitrate and nitrite) assimilation, and (in the case of cyanobacteria) N_2 fixation require Fe. Because of its importance to phytoplankton growth, Fe can play a role as a limiting nutrient in some freshwater systems[80,81]. There are reports of Fe-limited CO_2 fixation and growth in lakes and reservoirs varying in trophic state[41], including waters supporting cyanobacterial blooms[82]. Fe limitation has not yet been shown for estuarine ecosystems, possibly because of their dynamic nature (i.e., land-based nutrient runoff and flushing events, periodic hypoxia and anoxia, and close coupling of sediment and water column biogeochemical cycling).

Under oxic conditions typifying surface waters, Fe exists largely in the oxidized ferric (Fe^{3+}) form; as insoluble oxides, hydroxides, and carbonates which readily precipitate and deposit in the sediments. Under anoxic conditions, Fe may be released from the sediments as more available reduced Fe^{2+}. Therefore, periodic anoxia may enhance Fe availability. Since nuisance blooms may promote anoxic bottom waters, the algae responsible for blooms may at times be controlling their own Fe^{2+} supplies. Bloom-forming cyanobacteria are particularly adept at taking advantage of this positive feedback, since they can migrate between oxygenated surface waters and anoxic bottom waters by altering buoyancy. They are also relatively tolerant of potentially toxic sulfides in the bottom waters[24]. Strongly stratified, poorly flushed systems favor these conditions.

Fe availability is also mediated by naturally occurring DOM that can form metal chelates. Colored humic and fulvic compounds capable of chelating Fe have received particular attention because they may be plentiful in some systems. In natural waters, the availability of Fe is likely to be mediated by multiple factors, including the forms and concentrations of Fe, organic matter content, irradiance, and the presence of other metals, which may compete with Fe for organic ligands and anions[83].

Bloom-forming cyanobacteria produce potent siderophore (hydroxamate) chelators capable of sequestering Fe at low ambient concentrations[84]. This may provide a competitive advantage over eukaryotic phytoplankton, especially when Fe availability is restricted[85]. However, it appears that Fe limitation is less common than N or P limitation in freshwater. Therefore, relative to the impacts of excessive P loading (and low N:P ratios), Fe limitation most likely plays a secondary role in determining the distributions and magnitudes of cyanobacterial blooms.

Cyanobacteria require a suite of trace metals for various metabolic, growth, and reproductive processes. Manganese, cobalt, copper, molybdenum and zinc are most frequently mentioned[86]. Photosynthesis and N_2 fixation require manganese, zinc, cobalt, copper, and molybdenum for synthesis and function. In the case of copper (Cu), there exists a fine line between potentially limiting and toxic ($>\mu M$) concentrations. The biologically available form (Cu^{2+}), may be strongly bound by organic ligands, such as humic and fulvic acids. Bioassays of the cyanobacteria-dominated (*Anabaena, Aphanizomenon*, *Microcystis*) Chowan River, North Carolina, a coastal river enriched with humic and fulvic acids from surrounding swamps, wetlands, and pulp mill effluent, showed that Cu additions ($CuSO_4$; $<1\ \mu M$) stimulated photosynthetic CO_2 fixation relative to untreated controls during a period of high humic discharge[87] (Fig. 5). Cu stimulation of productivity was not observed during low humic discharge, indicating that in the presence of elevated humic binding, limitation by Cu and possibly other chelatable metals (Fe) may exist in nature.

Molybdenum (Mo) is a cofactor of nitrogenase, the enzyme complex mediating N_2 fixation. Its availability

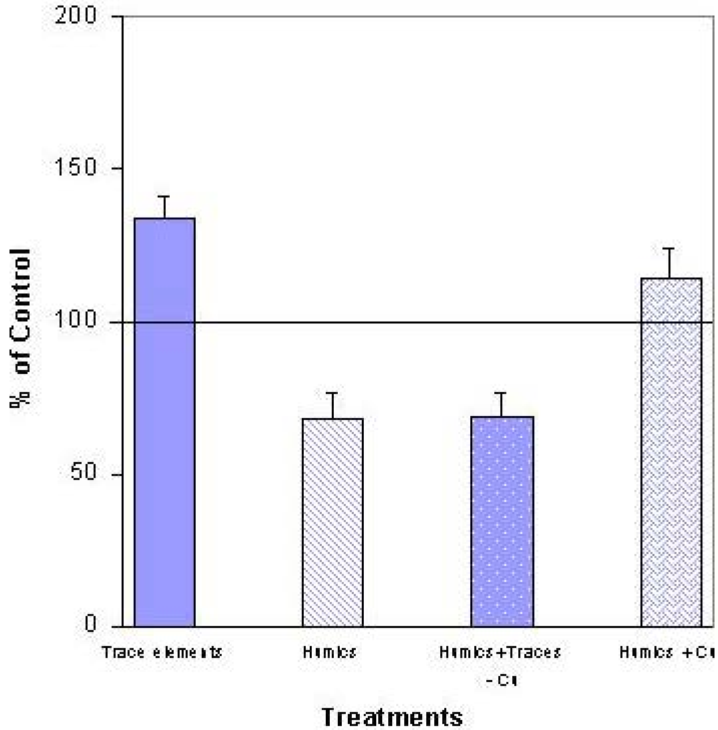


FIGURE 5. Results from an *in situ* bioassay of Chowan River (North Carolina) water. Photosynthetic growth of the resident phytoplankton community was assessed by measuring radiolabeled CO_2 uptake for 48 h. Controls were untreated samples and treatments were compared to controls as percent of control CO_2 uptake. Treatments included: trace element mix (Mn, Zn, Fe, Mo, B, Mg, Co), humic acid (from swampwater and pulp mill effluent entering the river) addition (at naturally occurring dilutions), with and without trace element mix minus Cu, and humic acid with only Cu added. All trace elements were added at 0.5 mM.

could therefore play a regulatory role in diazotrophic cyanobacteria. Howarth and Cole[88] proposed that the relatively high (>20 mM) concentrations of sulfate (SO_4^{2-}), a structural analogue of molybdate (MoO_4^{2-}, the dominant form of molybdenum in seawater), could competitively (via the uptake process) inhibit N_2 fixation, thereby limiting this process. Competitive inhibition of MoO_4^{2-} uptake by high SO_4^{2-} concentrations was shown by Cole et al.[89]. However, MoO_4^{2-} is highly soluble in seawater where concentrations of ~100 µM are commonly found. Ter Steeg et al.[90] and Paulsen et al.[91] showed that, despite the potential for SO_4^{2-} competition, Mo availability was maintained at concentrations much lower than 100 µM. In coastal and pelagic ocean (W. Atlantic) waters, N_2-fixing potentials of marine diazotrophs appear unaffected by this competition[91]. Furthermore, in freshwater, SO_4^{2-} concentrations are much lower (<10%) than seawater. Most likely, the small cellular Mo requirements for N_2 fixation are met through reduced but sufficient uptake and storage. In addition, there are "alternative" non-Mo-requiring nitrogenases in bacterial and cyanobacterial diazotrophs[92]. If such microbes are broadly distributed in nature, it would represent a mechanism by which Mo limitation could be circumvented.

Trace metal addition experiments with natural phytoplankton populations indicate that in most freshwater systems availability meets growth demands. Therefore, it is unlikely that trace metal limitation is a widespread modulator of growth and bloom potentials. Trace metals may, however play synergistic roles with major nutrients (N, P) in determining phytoplankton competitive interactions, activities, and composition.

Conductivity and Salinity

Salinity and ionic strength (conductivity) of waters have been mentioned as a potential regulators of CO_2 and N_2 fixation of bloom-forming cyanobacteria[67,68,69,70,71]. This may be true for some strictly freshwater species. However, recent work on the bloom-forming, N_2-fixing nuisance genus *Nodularia* argue against making generalities[68,69,72]. Two *Nodularia* species recently isolated from the Baltic Sea (original salinities ~4 to 15 psu) are able to grow in the laboratory from near 0 to >30 psu salinity (Table 5). Moreover, in laboratory experiments, these species were able to grow in Neuse River Estuary (North Carolina) water throughout these salinities, indicating a *potential* for expanding beyond its current geographic range[71]. The only nutrient requirement for expansion in Neuse estuary was adequate P supply. Similar results have recently been obtained for other common heterocystous diazotrophs, including *Anabaena* and *Anabaenopsis* (Table 5). On the other hand, the aggressively expanding (in eutrophying tropical and subtropical freshwater systems) heterocystous cyanobacterium *Cylindrospermopsis raciborskii*, and the ubiquitous non-N_2-fixing bloom-former *Microcystis aeruginosa,* cannot tolerate salinities in excess of 2 psu (Table 5). Among many other diazotrophic genera, salinity does not appear to be a barrier to growth and reproduction. For example the epiphytic and epibenthic N_2-fixing genera (e.g., *Calothrix, Nostoc, Scytonema*) are present in estuarine and coastal ecosystems worldwide[93,94]. Cyanobacterial N_2 fixation in some freshwater species may be particularly susceptible to osmotic stress[95], and organisms unable to adjust by the production of compensatory factors show inhibition of activity at increasing salt concentrations[96,97]. Cyanobacteria introduced from soils or freshwater into an estuarine environment may not be able to compensate for increasing salinities and osmotic stress[97,98]. Indigenous populations are often able to adjust to varying salinities by the production of compatible osmolytes[98]. There has been relatively little consideration of this as a factor regulating estuarine N_2 fixation.

Turbulence

Turbulence plays a fundamentally important role in regulating phytoplankton bloom dynamics. Cyanobacteria are especially sensitive to water column stability, including vertical stratification[2]. The ramifications of ecosystem-level physical constraints such as residence time or flushing rate have been alluded to already[2,6,10]. Combined with mesoscale circulation, transport, and vertical mixing controls, small-scale turbulence, or shear, is of central importance in determining growth potentials and dominance among N_2-fixing and non-N_2-fixing cyanobacteria[10,13,35]. Both the magnitude and duration of turbulence alter phytoplankton growth rates and structural integrity[99,100]. Among cyanobacteria, nondisruptive, low-level turbulence is known to promote localized

TABLE 5
Salinity Tolerance of Bloom-Forming Cyanobacteria

	Genus/Species	Salinity Limits for Growth (PSU)	Reference
N_2 fixing	*Anabaena aphanizomenoides*	0 – 15	Moisander et al. (in preparation)
	Anabaena torulosa	0 – >14.6	67
	Anabaenopsis	0 – >20	Moisander et al. (in preparation)
	Aphanizomenon	0 – 5	68
	Cylindrospermopsis	0 – 4	Moisander et al. (in preparation)
	Nodularia	5 – >30	68
		0 – 35	67
Non-N_2 fixing	*Microcystis*	0 – 2	69, 70
	Oscillatoria	0 –>30	24, 92

"phycosphere" nutrient cycling, alleviate certain forms of nutrient limitation (DIC, PO_4^{3-}, trace metals), and enhance growth[24,101]. Gently stirred cultures of bloom-forming heterocystous genera (including *Anabaena, Aphanizomenon, Nostoc,* and *Gloeotrichia)* frequently grow faster than static cultures[9,24]. Increases in turbulence either as stirring or shaking (Table 6) or more well-defined small-scale shear (Table 7) can, however, inhibit photosynthetic and N_2-fixing activities and growth, with excessive turbulence causing disaggregation, cell and filament damage, and rapid death "crashes" among diverse colonial genera in culture and in nature[51]. N_2 fixation, photosynthetic and growth performance in these genera often rely on mutually beneficial microbial (heterotrophic-autotrophic) consortial interactions with host cyanobacteria. Turbulence can disrupt consortial interactions, and thus act as a negative growth factor.

Cellular-scale turbulence, or shear, can disrupt filaments of heterocystous cyanobacteria. The narrow junctions between heterocysts and adjacent vegetative cells are prone to disruption and filament breakage[102,103]. Filament breakage at the heterocyst-vegatative cell junction cause heterocysts to lose their ability to fix N_2 and maintain O_2-free conditions, as witnessed by absence of tetrazolium salt (TTC) reduction[104].

Larger-scale (mesoscale) wind and tide-induced mixing affects vertical and horizontal distributions of cyanobacterial bloom taxa[105]. Most bloom genera can regulate buoyancy by varying the density and size of intracellular gas vesicles[10,106]. In turbulent waters, the ability to maintain optimal vertical positioning can be overcome by mixing[107]. Physical forcing of this sort is considered to play an important role in shaping phytoplankton resource (light, nutrient) competition, community composition, and succession[10,13]. Recently, we[51,108,109] showed that levels of shear stress representative of exposed large lake, estuarine, and coastal surface waters might control N_2 fixation in bloom-forming genera (*Anabaena, Nodularia*) (Moisander et al., in review), thus representing a potential barrier to their expansion. The observed negative impacts could be due to 1) breakage of cyanobacterial filaments and 2) disruption of growth-promoting phycosphere consortial bacterial-cyanobacterial associations[72,110].

Genetic Constraints on Cyanobacterial Expansion

Current research has shown broad *potential* for expansion into eutrophying mesohaline and euhaline waters among the genetically diverse array of N_2-fixing and nonfixing cyanobacteria. Molecular methods are now being employed in the detection of nuisance cyanobacterial bloom formers[111,112]. Analyzing the DNA present in a water sample is a more rapid method of detection and identification than traditional microscopy. Once the DNA from the phytoplank-

TABLE 6
Impact of Stirring Speed and Resultant Filament Breakage on Chlorophyll *a*-Specific N_2 Fixation (Nitrogenase Activity as Acetylene Reduction) in *Anabaena oscillarioides*

Stirring Speed (rpm)	Nitrogenase Activity (µmol C_2H_4 mg Chl a^{-1} h^{-1})
50	7.5 ± 0.5
100	7.2 ± 0.7
250	5.8 ± 1.2
400*	3.2 ± 0.5
550*	2.4 ± 0.7
750*	1.2 ± 0.4

Note: Filaments were exposed to a range of stirring speeds using a magnetic stirring table. Controls are slowly stirred (50 rpm) conditions. When observed, filament breakage is indicated as *. Controls and treatments were grown under N-limited conditions (Chu-10 medium minus N) under continuous illumination (200 µmol m^{-2} sec^{-1}) at 25°C. Standard errors among triplicate samples are shown (adapted from Paerl and Zehr[112]).

TABLE 7
Mean N_2- and CO_2-Fixation Rates as a Function of Exposure to Small-Scale Laminar Shear in Two Cultured Species of *Anabaena*

	Anabaena oscillarioides		*Anabaena circinalis*	
	N_2 Fixation (nmol C_2H_4 mg Chla^{-1} h^{-1})	CO_2 Fixation (mg C mg Chla^{-1} h^{-1})	N_2 Fixation (nmol C_2H_4 mg Chla^{-1} h^{-1})	CO_2 Fixation (mg C mg Chla^{-1} h^{-1})
Control	4.98 (± 1.8)	2.31 (± 0.5)	8.52 (± 1.2)	1.75 (± 0.6)
Low Shear	4.26 (± 1.5)	2.03 (± 0.4)	7.27 (± 1.1)	1.65 (± 0.4)
High Shear	3.29 (± 1.5)	1.34 (± 0.5)	4.29 (± 0.9)	1.32 (± 0.3)

Note: Shear was exerted by placing *Anabaena* populations in Couette chambers, which are capable of exerting specific, highly controllable shear fields. Shear mimicked wind-driven shear conditions in estuarine surface waters. It is expressed as low (0.93 to 5 rpm in the chamber) or high (15 to 36 rpm). Results are compared to Controls, in which no shear (i.e., no chamber rotation) was exerted. Triplicate N_2 fixation (acetylene reduction assay) and CO_2 fixation ($^{14}CO_2$ fixation) determinations were based on 2-h incubations following 4-h exposure to specific shear fields. Values in parentheses indicate standard error of the mean. Data adapted from Kucera[109].

ton in a sample is isolated, the genetic sequences of particular genes are determined and the cyanobacteria are identified based upon the comparison of these gene sequences with a database of previously identified genetic sequences[111,112]. These sequences are compared in a phylogenetic tree, which is used to visualize the degree of similarity between organisms based on genetic data. Organisms that are more closely related cluster together on the branches of the tree. All cyanobacteria contain the 16S rRNA gene, a structural gene present in prokaryotes, so this gene was used for comparing both N_2-fixing and non-N_2-fixing cyanobacteria (Fig. 6). Diazotrophs (N_2 fixers) contain the *nifH* gene, which encodes one of the proteins that makes up the nitrogenase enzyme that is necessary for N_2 fixation. *NifH* sequences are used to study relatedness of specific N_2-fixing cyanobacteria, but can also be used to identify noncyanobacterial heterotrophic diazotrophs. Heterocystous cyanobacteria consistently cluster closely together in *nifH* phylogenetic trees, demonstrating their high degree of genetic similarity (Fig. 7). Diazotrophs can be identified in this manner, regardless of whether they are actively fixing N_2.

Using these molecular methods, the genetic potential (i.e., presence of *nifH*) for N_2 fixation was identified in the Neuse River, North Carolina over both spatial and temporal scales. The presence of *nifH* was identified in both surface and bottom waters at stations ranging from the freshwater upstream portion of the river down to the mesohaline mouth where it empties into Pamlico Sound (Dyble, in preparation). *NifH* was also present throughout most of the year, even at times when cyanobacteria were not numerically dominant in the water column. Sequencing some of these *nifH* genes revealed genetic sequences that were most similar to heterocystous cyanobacteria (Dyble, in preparation). Thus, the use of molecular methods has revealed that cyanobacterial N_2 fixers are present in this river system, even at higher salinities and colder temperatures. However, for this genetic potential to be expressed into active N_2 fixation requires the environmental conditions described above to be satisfied..

Biotic Interactions

Interactions with Other Microbes

Bloom-forming cyanobacteria form close associations with other microorganisms and higher organisms (Table 8, Fig. 8). Cyanobacterial-microbial associations are common among bloom-forming genera, including *Anabaena*, *Aphanizomenon*, *Microcystis,* and *Nodularia*[113,114,115,116,117]. Associated microorganisms include eubacteria[76,78,107,115,118], fungi[76,116,117], phytoflagellates[119], and ciliated and amoeboid protozoans[120,121]. Most associations occur within and around colonies, aggregates of filaments, and within the fibrillar-mucilaginous sheaths, capsules, and exuded polymers[76,116,118,122] (Fig. 8).

Specific associations, where certain microbial populations exclusively attach to distinct cyanobacterial host cells (i.e., akinetes and heterocysts), have also been observed (Fig. 8). The intensity and specificity of these associations

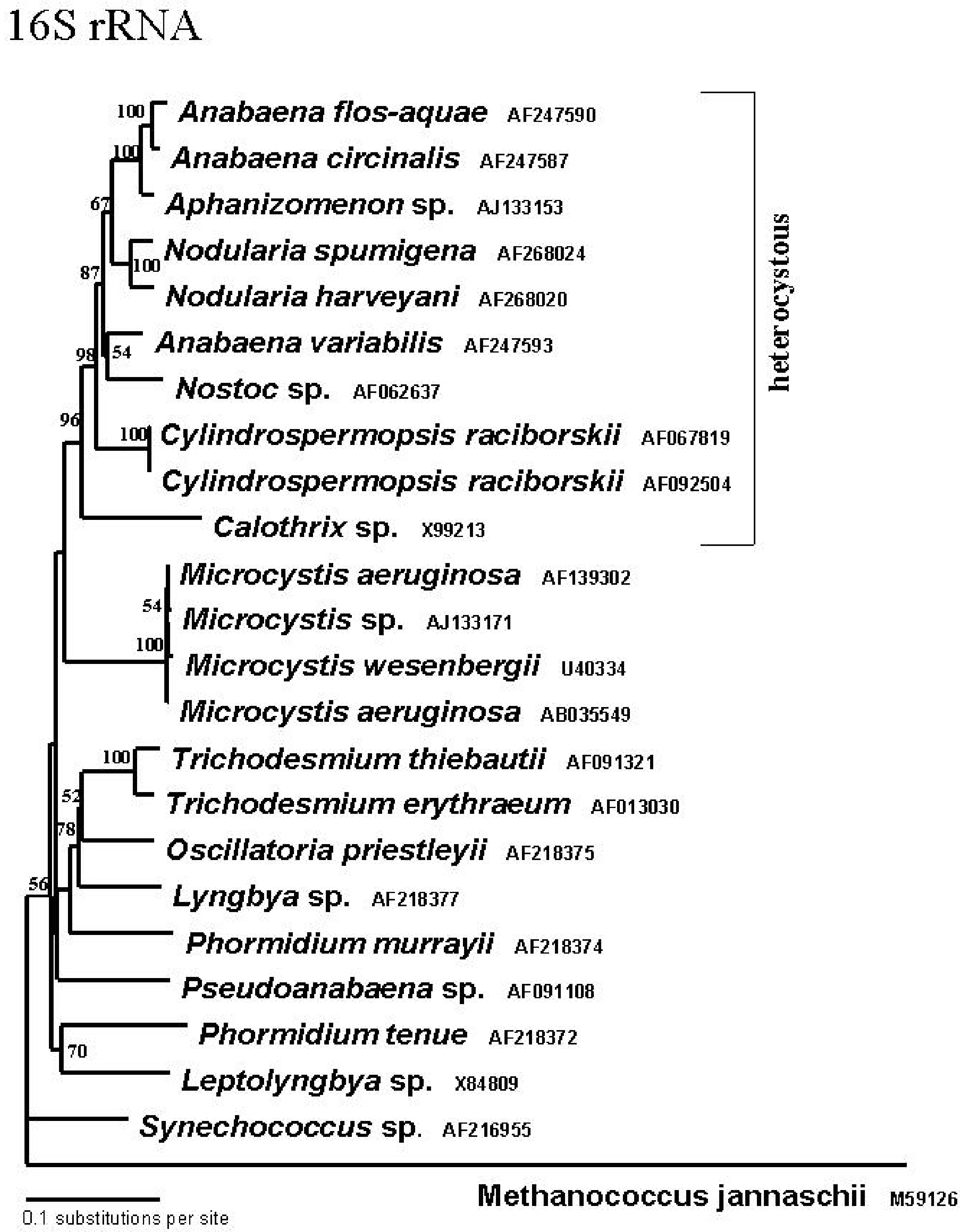


FIGURE 6. Cyanobacterial phylogenetic tree based upon 16S rRNA sequences. This tree was constructed by the neighbor-joining method and bootstrap values >50% are given above or beside the corresponding nodes.

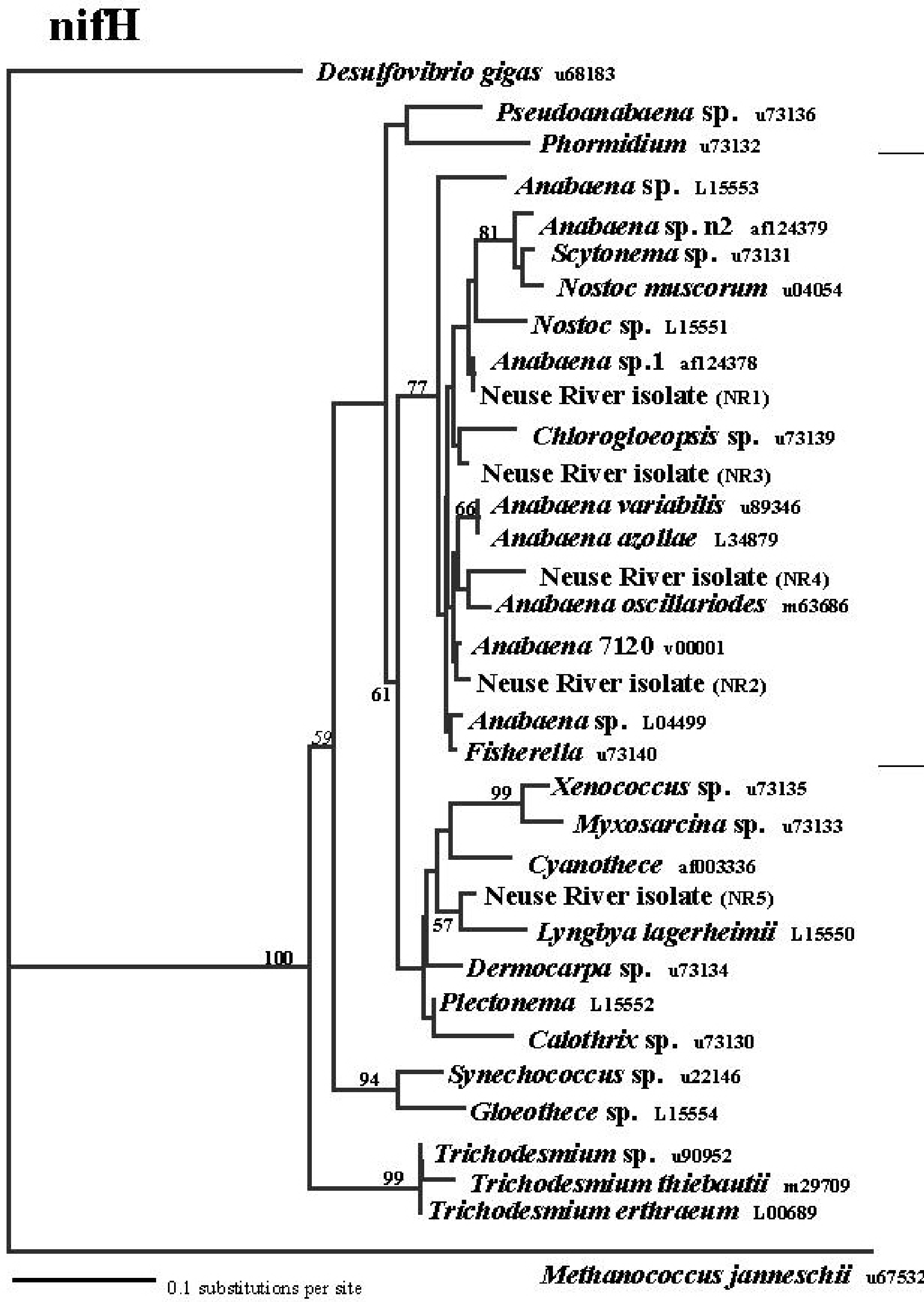


FIGURE 7. Cyanobacterial phylogenetic tree based upon *nifH* sequences. This tree was constructed by the neighbor-joining method and bootstrap values >50% are given above or beside the corresponding nodes

TABLE 8
Some Examples of Cyanobacterial Associations with Other Microorganisms, Higher Plants and Animals in Aquatic Ecosystems

Association	Cyanobacterial Genera Involved
Heterotrophic bacteria (as epiphytes)	*Anabaena, Aphanizomenon, Gloeotrichia, Microcystis, Nodularia, Nostoc*
Eukaryotic alga (as endosymbionts)	
Marine diatoms (*Rhizosolenia*)	*Richelia*
Freshwater diatoms (*Rhopalodia*)	*Synechococcus*
Fungi (lichens; as endosymbionts)	*Nostoc, Scytonema*
Bryophytes (as endosymbionts in *Blasia*)	*Nostoc*
Freshwater Ferns (as endosymbionts in *Azolla*)	*Anabaena*
Gymnosperms (as endosymbionts in *Gunnera*)	*Nostoc*
Protozoans (epizoic)	*Anabaena, Microcystis, Nodularia*
Protochordates (as endosymbionts)	*Prochloron**
Marine Gastropods (as endosymbionts)	*Synechococcus*
Mammals (in polar bear hairs)	*Synechococcus*

* Members of the phylum Prochlorophyta.

can vary dramatically[76,107,116]. During the initiation and proliferation of *Anabaena oscillarioides* blooms, when maximum biomass-specific rates of photosynthesis and N_2 fixation were observed, an association between the heterotrophic bacterium (*Pseudomonas aeruginosa*) and the heterocysts prevailed[123] (Fig. 8). Virtually all (~98%) of *P. aeruginosa* cells were found attached to heterocysts as opposed to non-N_2-fixing vegetative cells of *Anabaena* filaments[113,117,124]. The intensity and frequency of *P. aeruginosa* attachment to heterocysts exhibited a diel pattern[113], with maximum attachment occurring near midday. *P. aeruginosa* was chemotactically attracted to *A. oscillarioides* heterocysts and N-containing amino acids[119,123].

Cyanobacteria excrete organic compounds[79,125], including organic and amino acids, peptides, alkaloids, carbohydrates, and lipopolysaccharides[79,125,126,127,128]. Diverse excretion products chemotactically attract and support the growth of phycosphere-associated bacteria[124,129]. In N_2 fixation and fate experiments, some of the ^{15}N-labeled N_2 fixed by host *A. oscillarioides* was rapidly transferred to heterocyst-associated *P. aeruginosa*[130]. Axenic isolates of *A. oscillarioides* exhibited optimal growth and N_2-fixation rates when reinoculated with *P. aeruginosa*[113] (Fig. 9). When released in axenic *A. oscillarioides* cultures, *P. aeruginosa* re-established the heterocyst-specific association.

These findings suggest close metabolic coupling and mutually beneficial relationships. Culturable cyano-bacterial bloom species, including strains of *Microcystis aeruginosa* and an *Aphanizomenon flos-aquae* strain from North Carolina coastal rivers have not been successfully grown free of bacteria[76]. Among other cyanobacterial genera (e.g., *Oscillatoria, Lyngbya, Nodularia*), bacterized strains revealed higher growth rates and were easier to maintain in culture than axenic strains. Gibson and Smith[131] reported that both axenic *Oscillatoria redekei* and *O. agardhii* isolates "always appeared to grow better in the presence of contaminant heterotrophic bacteria". Similar findings were reported by Allen[132], Gorham[133], Staub[134], Meffert[135], Herbst and Overbeck[136], Caldwell[137], and Lehtimäki et al.[69]

The ecological mechanisms underlying cyanobacterial-bacterial synergism continue to be subjects of investigation. Proposed mutually beneficial mechanisms include exchange of metabolites and growth factors as well as detoxifying roles of associated bacteria. Kuentzel[114] and Lange[78] suggested that

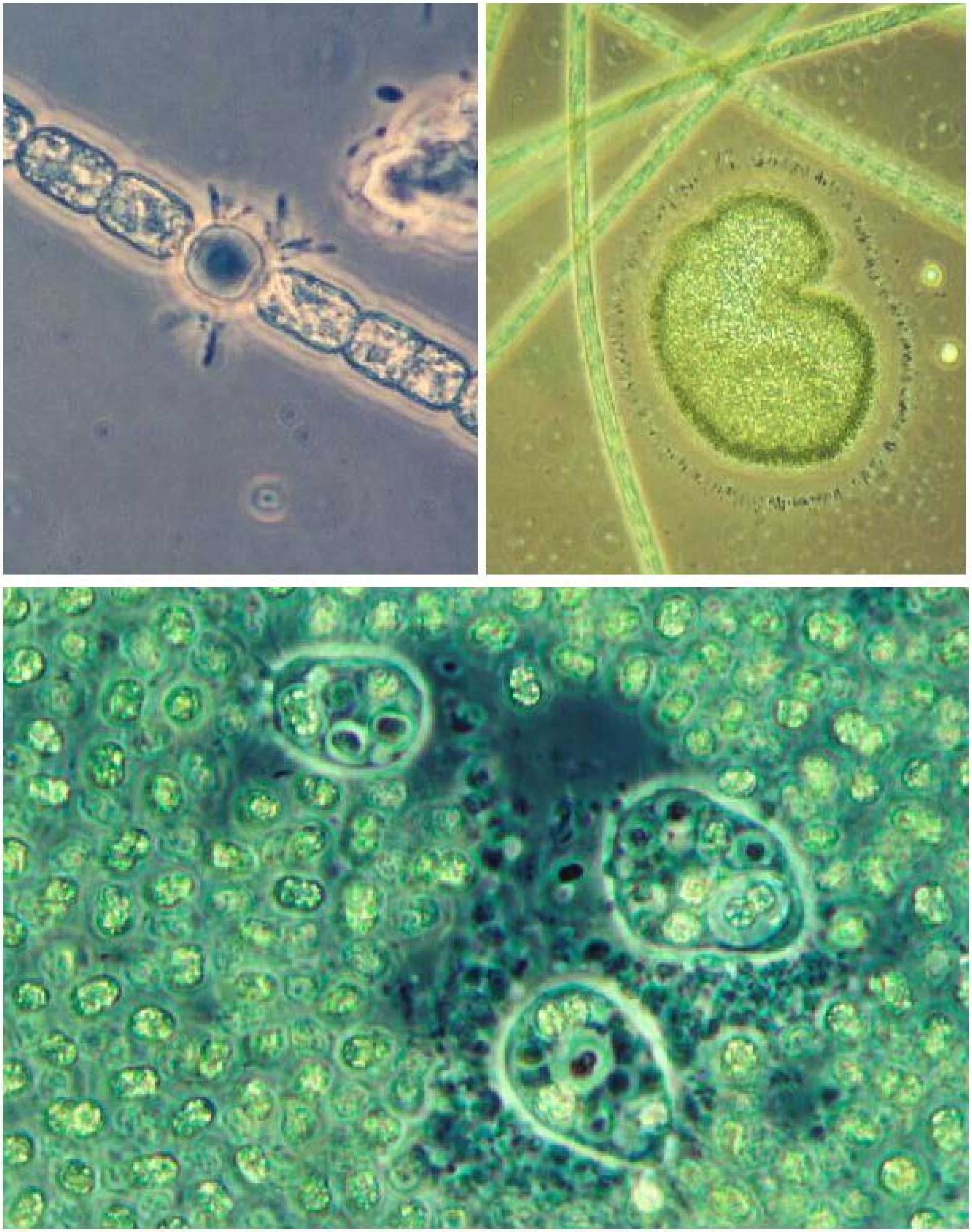


FIGURE 8. Examples of microbial associations with bloom-forming cyanobacteria. Upper left, heterotrophic bacteria specifically associated with the nitrogen-fixing cells, or heterocysts, of *Anabaena oscillarioides*. *A. oscillarioides* was originally isolated from the Waikato River, New Zealand (see References 112, 118, and 122 for the functional significance of this association); upper right, a bacterial "halo" commonly observed around colonial cyanobacteria (in this case the "host" cyanobacterium is *Gomphosphaeria*, freshly collected from the Neuse River, North Carolina); lower, amoeboid protozoans "grazing" inside a *Microcystis aeruginosa* colony freshly collected from the Neuse River, NC. Note the ingested *Microcystis* cells in the protozoans. (For details of this association, see Reference 120.)

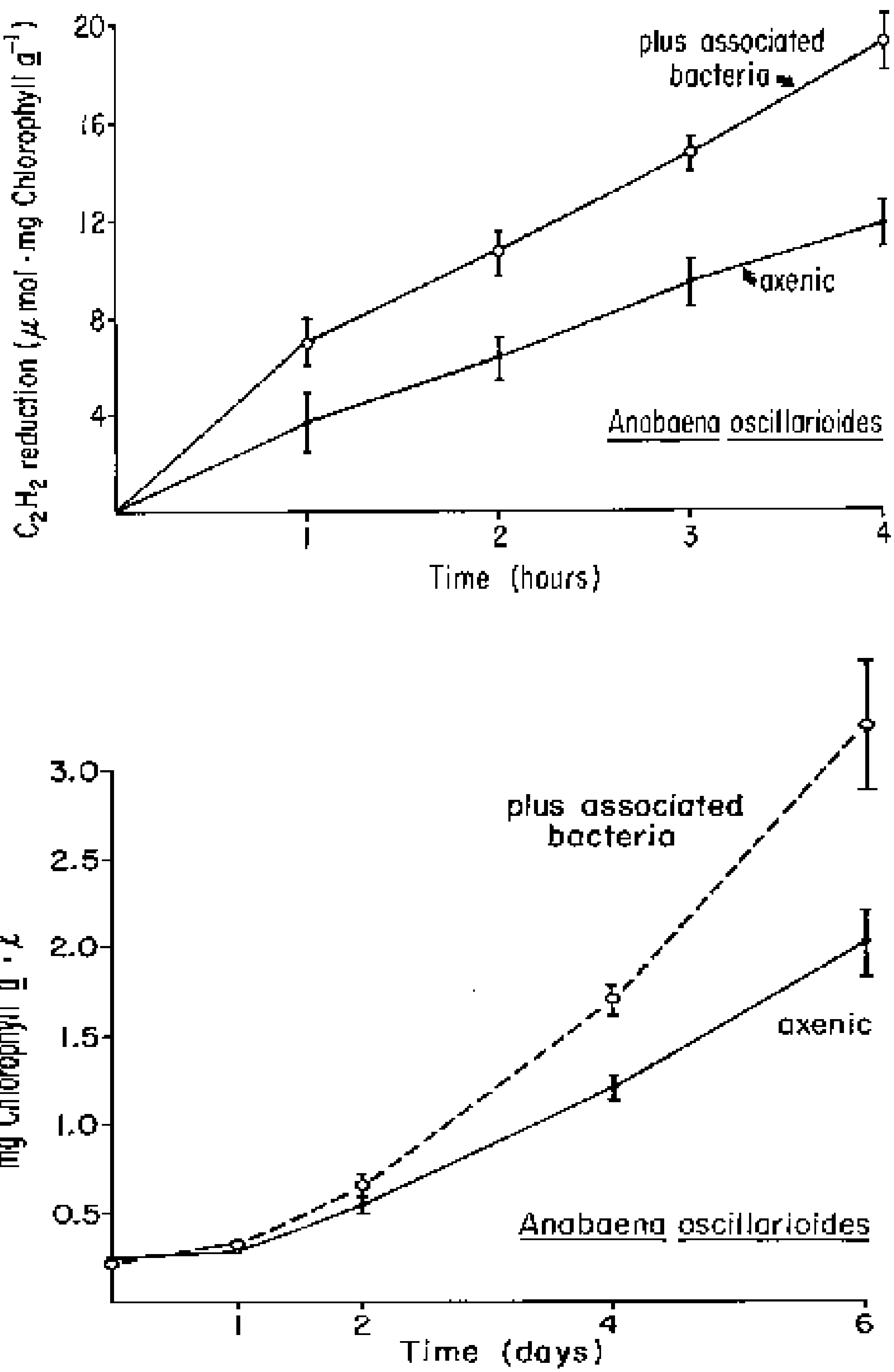


FIGURE 9. Nitrogen fixation and growth characteristics of *Anabaena oscillarioides* (same strain as shown in Fig. 8) grown under bacteria-free (axenic) and bacteria-associated conditions. Cultures were maintained on N-free Chu-10 media under 14 h illuminated/10 h dark conditions. Error bars indicate the standard deviation of triplicate measurements at each sampling point. Upper, nitrogen fixation (nitrogenase activity), measured as acetylene reduction per mg chlorophyll *a* per hour; lower, growth measured as mg chlorophyll *a* per liter. (For details, see References 118 and 120.)

CO_2 recycling by bacteria proved essential for optimal growth of cyanobacteria under inorganic carbon limited growth, which can occur in dense blooms[138]. Lange[78] demonstrated that the addition of metabolizable carbohydrates led to enhanced cyanobacterial growth, especially under inorganic carbon limited conditions. He attributed such photosynthetic stimulation to rapid mineralization followed by CO_2 release among associated bacteria. Schiefer and Caldwell[139], using CO_2-limited continuous cultures of *Anabaena* sp. and the epiphytic heterotrophic bacterium *Zoogloea* sp., demonstrated that CO_2 recycling by *Zoogloea* sp. optimized photosynthetic performance and growth of *Anabaena* sp. Paerl and Kellar[110] and Kellar and Paerl[140] showed that bacteria commonly associated with heterocysts of bloom-forming *Anabaena* and *Aphanizomenon* (Fig. 8) enhanced N_2-fixation potentials, when compared to axenic conditions (Fig. 9). Similarly, Lupton and Marshall[141] confirmed a positive impact of associated bacteria on *Anabaena* sp. growth. Associated bacteria may be instrumental in locally decreasing O_2 tension near cyanobacterial cells and filaments harboring biochemical processes (photosynthesis, N_2 fixation) that are O_2-sensitive[113].

Specific growth factors (e.g., vitamins) produced by associated bacteria may aid cyanobacterial growth. Associated bacteria may also detoxify cyanobacterial extracellular metal (Fe) chelates potentially autotoxic to host cyanobacteria[130].

Certain bloom-forming cyanobacterial strains produce peptides and alkaloids known to have potent cyto-, hepato-, and neurotoxic effects on mammals, fish, birds, and invertebrates residing in bloom-infested waters[15,31,142,143]. From ecological and evolutionary perspectives, it is difficult to rationalize such “toxin” production, since affected organisms are not natural consumers of cyanobacteria. More likely, mammalian and fish toxicity is coincidental, and because of higher animal and human health concerns, defined in an anthropomorphic rather than ecological context. In aquatic ecosystems, where microbial competition for dilute organic and inorganic compounds is intense[104,144], cyanobacterial toxin production may serve to select for and maintain mutualistic and symbiotic microbial relationships[145]. Toxins may deter protozoan and metazoan grazing, viral and bacterial lysis, while promoting mutually beneficial microbial associations. In this case, cyanobacterial toxins selectively create and condition microenvironments surrounding filaments and colonies. Understanding the means by which this form of “microbial gardening” is regulated by environmental factors (and their interactions) (including nutrient, light, temperature, salinity, desiccation, and other forms of stress) may yield mechanistic clues as to how toxin production is controlled and potentially managed[145].

In summary, it appears that cyanobacterial-microbial interactions are generally more indicative of synergism than antagonism. Such interactions 1) occur during periods of optimal cyanobacterial growth and bloom potentials, 2) reflect mutually beneficial physiological and ecological adaptations promoting cyanobacterial dominance, and 3) appear mediated by organic molecules produced by cyanobacteria. In this regard, what we perceive to be toxins may in fact be chemical mediators of microbial interactions, bloom dynamics, and (inadvertently) water quality and health impacts. Alternatively, it is possible that toxins (e.g., microcystins) rather than being secondary metabolites, play thus far unknown roles in the regulation of cellular metabolism, with toxicity being fortuitous (or unfortunate, depending on the target organism)[146].

Interactions with Competitors and Consumers

While cyanobacterial toxins may mediate microbial interactions, they may simultaneously inhibit potential competitors and consumers of cyanobacteria, including other phytoplankton[147,148,149,150], vascular aquatic plants[151,152], and protozoans[153,154]. However, Casanova et al.[155] concluded that normally occurring concentrations of dissolved microcystin did not affect aquatic plant germination, and that shading was the main cause of inhibition by cyanobacteria zooplankton and grazing fish.

There has been substantial study of interactions between cyanobacteria and herbivorous zooplankton, though often with conflicting results. Previous reviews of cyanobacteria-zooplankton interactions include Burns[156], Haney[157], Lampert[158], de Bernardi and Giussani[159] and Christoffersen[153]. Cyanobacterial blooms are often associated with decreases in abundance of large cladocerans of the genus *Daphnia* and increases in importance of smaller cladocerans, rotifers, and copepods[160,161,162,163,164,165,166]. There are exceptions, including the co-occurrence of large ungrazable flake-like colonies of *Aphanizomemon flos-aquae* with large *Daphnia*[167,168,169]. The more common pattern has sometimes been ascribed to increased predation on large cladocerans by planktivorous fish, which reduces grazing pressure, allowing algal blooms to occur. However, in some cases decreases in *Daphnia* appear unrelated to fish predation[170]. An alternative explanation is that the decline of large *Daphnia* is a direct effect of the cyanobacterial toxicity. There is considerable evidence that cyanobacteria can have deleterious effects on grazing zooplankton, and that large cladocerans are most adversely affected.

Inhibitory effects may be due to morphological factors (mechanical interference with feeding due to size or shape of filaments or colonies), chemical factors (toxicity, poor taste, poor nutritional value), or high densities during blooms, which may displace more nutritious algae or limit the ability of herbivores to utilize coexisting algae. Relatively few studies have attempted to distinguish among these related factors, but chemical factors appear to be more significant than mechanical interference. Fulton and Paerl[171,172,173] found that unicellular strains of *Microcystis aeruginosa* inhibited feeding rates of cladocerans on co-occurring nutritious algae more than did colonial strains, and toxic strains had the strongest inhibitory effects. The more important effect of the colonial morphology was that it made *M. aeruginosa* unavailable to cladocerans restricted to feeding on small particles (such as *Diaphanosoma brachyurum*). Rohrlack et al.[174] found evidence that the mucilage of colony-forming *M. aeruginosa* mechanically hindered *Daphnia* feeding, but lowest feeding rates occurred on a mucilage-lacking unicellular strain.

Filamentous cyanobacteria do have inhibitory effects on *Daphnia,* with the effects being strongest on larger-bodied species[169,175,176]. However, several studies indicate that chemical characteristics of cyanobacteria are more significant than the filamentous morphology. Webster and Peters[177] found both cyanobacterial filaments and cellulose fibers affected feeding behavior of zooplankton, but only filaments significantly reduced brood sizes. They concluded that mechanical effects of the cellulose fibers were not inhibitory to the cladocerans tested. Porter and Orcutt[178] found lower survivorship of *Daphnia* when fed unicells of a toxic strain of *Anabaena flos-aquae* than when fed filaments. Fulton[179] found that a toxic strain of *Anabaena flos-aquae* had stronger inhibitory effects on cladoceran feeding than did nontoxic filaments, and that most cladocerans, copepods, and rotifers tested could feed at high rates on a filamentous diatom. Other studies have also found significant consumption of some types of filamentous algae by *Daphnia* and other zooplankton[180,181]. Gilbert[182] found that extracts and mixtures of single cells and short fragments of a toxic strain of *Anabaena affinis* were just as inhibitory to growth and survivorship of cladocerans and rotifers as were intact filaments, indicating the inhibition was due to toxins, rather than to mechanical interference.

Cyanobacterial toxins can cause rapid mortality of herbivorous zooplankton[159,172,183,184,185,186,187], as well as long-term chronic effects on zooplankton growth and reproduction[148,188,189]. There is substantial variability in resistance to cyanobacterial toxins among zooplankton. Resistance to cyanobacterial toxins has been reported in rotifers[172,182,190], the small cladoceran *Bosmina longirostris*[184], and some strains of *Daphnia*[182]. Variations in susceptibility to toxins among clones of *Daphnia* indicate that toxic cyanobacteria can affect zooplankton communities at the clonal level as well as at the species level[191,192,193]. Selection acting on this clonal variability can apparently increase resistance by *Daphnia* populations to cyanobacterial toxins within decades of lake eutrophication[194]. Increased water temperature can increase the sensitivity of zooplankton to cyanobacterial toxins[193,195,196], perhaps exacerbating toxic effects at the high summer temperatures when cyanobacterial blooms often occur.

Unpalatability and poor nutritional value can also adversely affect herbivorous zooplankton[159,160]. Factors contributing to poor nutritional value include indigestibility[159,160] and deficiency of highly unsaturated fatty acids[197]. Although cyanobacteria are usually poor sole food sources for zooplankton, they can complement other food sources in mixed diets[198,199], suggesting that nontoxic cyanobacteria can contribute to zooplankton nutrition under nonbloom conditions in which they do not heavily dominate the phytoplankton community. Also, while living cyanobacteria may be poor food sources, detritus formed from decomposing cyanobacteria can be good quality food for herbivorous zooplankton[200,201].

In summary, the effects of cyanobacterial blooms on herbivorous zooplankton communities in large part reflect the interaction of chemical and mechanical inhibition. Large *Daphnia* are typically most inhibited by cyanobacteria because they are generally susceptible to toxins, are relatively unselective feeders so they cannot avoid consuming cyanobacteria, and limiting their feeding rates also limits consumption of more nutritious coexisting algae. Zooplankton species that are typically associated with cyanobacterial blooms exhibit a variety of different behaviors. One group of cyanobacteria-associated herbivores is susceptible to toxins, but avoids consumption of cyanobacteria. *Diaphanasoma bachyurum* exemplifies small cladocerans that are affected by cyanobacterial toxins, but avoid consumption of colonial or filamentous algae because they are restricted to feeding on small particles[171,172,173,179]. Copepods are also very sensitive to dissolved cyanobacterial toxins[197], but they are very selective feeders that strongly avoid consuming toxic cyanobacteria[171,172,173,179]. A second group of herbivorous zooplankton readily consume cyanobacteria, but are resistant to cyanobacterial toxins and obtain at least some degree of nutritional benefit from cyanobacteria. These include the small cladoceran *Bosmina longirostris*[184] and several rotifers[148,173,190].

Effects on Fish and Higher Trophic Levels

Cyanobacterial toxins may affect fish and other higher trophic level consumers through three mechanisms: 1) direct exposure to cyanobacterial toxins, 2) bioaccumulation of toxins in aquatic food chains, and 3) alterations to aquatic food chain structure.

Grazing fish, such as tilapia and silver carp, are potentially significant herbivores on cyanobacteria[202]. It is therefore not surprising to find that grazing rates of herbivorous fish are inhibited by toxic *Microcystis aeruginosa*[203,204]. Predatory fish would not be expected to directly consume significant amounts of cyanobacteria, but could be affected by dissolved toxins. Fish kills associated with cyanobacterial blooms are often attributed to oxygen depletion, but cyanobacterial toxins can also kill fish[205,206], and it has been suggested that some massive fish kills during blooms of toxic cyanobacteria were caused by toxins rather than by oxygen depletion[205,206,207].

Cyanobacterial toxins can accumulate in primary consumers, including freshwater clams[208,209], crayfish[210], zooplankton, and gastropods[211]. This indicates potential transfer to higher trophic levels, but evidence is lacking. Although microcystin-LR did occur in grazing zooplankton and gastropods, Kotak et al.[211] did not find it in fish or other macroinvertebrates in the same lakes. Codd and Bell[30] radiolabeled *Daphnia magna* with microcystin-LR, then fed the cladocerans to roach and found radioactivity in tissues of the fish, but it is not certain if the radiolabel in the fish was still associated with microcystin-LR. Laurén-Määttä et al.[212] followed accumulation of microcystin in a laboratory food chain of *Microcystis aeruginosa*, *D. pulex*, and *Chaoborus* larvae, and found accumulations in the *D. pulex*, but no significant toxin accumulation in the predatory *Chaoborus*. Finally, in another laboratory study, Walsh[213] found that feeding the cyanobacterium *Anabaena flos-aquae* to the rotifer *Brachionus calyciflorus* did not affect its susceptibility to predation by the predatory rotifer *Asplanchna sylvestrii*. However, *A. sylvestrii* fed *B. calyciflorus* cultured on the cyanobacterium grew more slowly than those fed the same prey cultured on a diet of *Euglena gracilis*, suggesting potentially negative effects of this toxic cyanobacterium on trophic transfer.

Although cyanobacterial blooms produce large biomass, their toxic and other inhibitory effects on grazers could produce alterations in aquatic food web structure that would reduce productivity of higher trophic levels. A shift in zooplankton composition from large *Daphnia* to smaller or more evasive cladocerans, rotifers, and copepods may reduce the feeding success of young-of-the-year and other planktivorous fish. If cyanobacterial blooms exclude more nutritious algae, even zooplankton relatively resistant to cyanobacterial toxins may dramatically decrease in abundance, potentially leading to fish recruitment failures. Senescence or herbicidal treatment of cyanobacterial blooms may release large amounts of dissolved toxins, affecting herbivores and other organisms that would not normally consume cyanobacteria. Much of the biomass from cyanobacterial blooms probably enters microbial or detrital trophic pathways. These trophic alterations may ultimately reduce finfish and shellfish productivity.

Domestic Animal and Human Health Effects of Cyanotoxins

Freshwater cyanobacteria produce several toxins impacting domestic animal (pets, livestock) and human health[29,30,31,32,142,143] (Table 3). These include hepatotoxins, neurotoxins, and dermatotoxins. Hepatotoxins are the most frequently found cyanobacterial toxins in fresh and brackish waters worldwide. The most common group, the microcystins and nodularins, are cyclic peptides consisting of 7 or 5 amino acids, respectively. About 60 different structural variants of microcystins and a few nodularins are known. Potency varies from highly toxic to nontoxic depending on the specific chemical structure. Microcystins have been characterised from planktonic *Anabaena*, *Microcystis*, *Oscillatoria/Planktothrix*, *Nostoc*, *Anabaenopsis* genera, and nodularin from *Nodularia spumigena* only[31,32]. An alkaloid hepatotoxin cylindrospermopsin is produced by *Cylindrospermopsis raciborskii*, *Umezakia natans*, and *Aphanizomenon ovalisporum*[142,143].

Three families of cyanobacterial neurotoxins are known: 1) anatoxin-a and homoanatoxin-a, which mimic the effect of acetylcholine; 2) anatoxin-a(S), which is an anticholinesterase; and 3) saxitoxins, which block nerve cell sodium channels[31]. In marine waters, benthic cyanobacteria may produce toxins causing severe dermatitis among swimmers. Aplysiatoxin and debromoaplysiatoxins are protein kinase C activators and potent tumor promoters[31]. Lyngbyatoxin A exposure has caused severe oral and gastrointestinal inflammations in humans[31]. *Trichodesmium* sp. contain an uncharacterized neurotoxin (Carmichael, personal communication). Cell wall components, particularly lipopolysaccharide endotoxins (LPS), from cyanobacteria may contribute to human health problems[31,142,143].

The cyanotoxins are collectively responsible for continued widespread poisoning of wild and domestic animals plus human fatalities. While these events document the continued concern for cyanotoxins, the emerging business of fresh and marine aquaculture could be affected most. Anthropogenic inputs from agriculture, industry, and municipal wastes coupled with heavy nutrient loading by aquaculture may stimulate nuisance cyanobacterial species in aquaculture facilities. Cyanotoxins, particularly microcystins, have already had significant impacts on aqua-cultured organisms including salmon, striped bass, shrimp, and catfish (Table 3). The most well defined is the loss of net-pen reared salmon from microcystins produced by as yet unknown organisms[31]. Losses have continued since 1991 and most recently have caused salmon losses in Washington State.

HARMFUL BLOOM MANAGEMENT

Management of nuisance blooms includes consideration of co-occurring physical, chemical, and biotic variables that synergistically and antagonistically act to control N_2 fixation, photosynthesis, growth, and reproductive potentials[145,214].

Widely used means of controlling blooms include (not in order of effectiveness or priority): 1) use of algicides, specifically copper sulfate; 2) nutrient input reduction and manipulation (e.g., N:P ratios); 3) vertical destratification, through mechanical mixing or bubbling; 4) enhanced water flushing to reduce retention time; and 5) biological control. Option 1 is most feasible in small impoundments, including ponds and artificial lakes used for scenic purposes (parks). This approach is neither practical nor advised in larger ecosystems, or any waters to be used for fishing, drinking, and other animal and human use. In small, relatively shallow (i.e., <5 m) systems destratification (option 3) warrants consideration. If abundant water supplies (i.e., upstream reservoirs) are available for flushing, option 4 may be possible. Biological manipulation (5) includes a number of approaches to change the aquatic food web to increase grazing pressure on cyanobacteria or to reduce recycling of nutrients. Biomanipulation approaches can include introducing fish and benthic filter feeders capable of directly consuming cyanobacteria from the water column and introduction of lytic bacteria and viruses. However, the most common biomanipulation approaches are intended to increase the abundance of herbivorous zooplankton by removing zooplanktivorous fish or introducing piscivorous fish. Alternatively, removal of benthivorous fish can reduce resuspension of nutrients from the bottom sediments. Questions have been raised about the long-term efficacy of curtailing cyanobacterial blooms by increasing grazing pressure, because this may lead to dominance by ungrazable or toxic strains[215]. Presently, biomanipulation is viewed as one component of an integrated approach to water quality management in circumstances in which nutrient reductions alone are insufficient to restore water quality[216,217,218]. Option 2 remains the most practical, economically feasible, and best long-term choice. The remainder of this section will address quantititative and qualitative considerations of nutrient manipulation strategies aimed at mitigating blooms.

Phosphorus Management

Phosphorus inputs to aquatic ecosystems are largely attributed to three land-based sources: 1) nonpoint source surface runoff; 2) point sources, including effluents from wastewater treatment plants, industrial and municipal discharges; and 3) subsurface drainage from septic systems and groundwater. Among these, point sources have been the focus of P input cutbacks. In many watersheds, targeting point sources is justified, for they can account for a highly significant share of P loading. Point sources are frequently easiest to identify, access, regulate, and (in terms of public expenditures) finance in the context of nutrient management.

In agriculturally expanding and urbanizing watersheds, nonpoint surface and subsurface P inputs are becoming issues of increasing concern. Expanding P fertilizer use, generation, accumulation, and discharge of P-laden animal waste, soil disturbance, and loss due to conversion of forests and grasslands to rowcrop and other intensive farming operations, and the proliferation of septic systems accompanying human population growth are rapidly increasing the importance and burden of nonpoint P loading. In many agricultural and urban watersheds, nonpoint sources can account for at least 50% of annual P loading. Because of their diffuse nature, they are far more difficult to identify and address from a nutrient management perspective. Nonpoint source P management will be an increasingly important nutrient control strategy in these watersheds.

As with nitrogen (see below), the manner in which P is discharged to P-sensitive waters is of paramount concern. Key considerations include: 1) total annual (i.e., chronic) P loading, 2) shorter-term seasonal and event-based pulse (i.e., acute) P loadings, 3) particulate vs. dissolved P loading, and 4) inorganic vs. organic P loading. In terms of overall ecosystem P budgets and long-term responses to P loadings (and reductions), annual P inputs are of fundamental importance. In terms of specific biological community responses (i.e., primary productivity and bloom formation), seasonal and shorter-term acute loading events are of critical, and at times, overriding importance. Experience has taught us that when and where P inputs occur can determine the difference between a bloom-plagued vs. bloom-free conditions. For example, if a large spring P discharge event precedes a dry, stagnant summer in a relatively long residence time water body, the spring P load will be available to support summer bloom development and persistence. Effective exchange and cycling between the water column and bottom sediments can retard P transport and hence retain P as it travels through a water body. As a result, acute P inputs during relatively high flow periods may be retained longer in the system than would be estimated based on water flushing/retention times. In effect, the water body can exhibit both rapid biological responses to, and a distinct "memory" for, acute P loads.

Unlike N, P exists in relatively few dissolved and particulate forms in natural waters. Furthermore, there are no gaseous forms of P that can be gained or lost by the system via biological transformations. Therefore, we need to be mainly concerned about dissolved and particulate forms of inorganic and organic P. Dissolved inorganic P (DIP) exists exclusively as orthophosphate (PO_4^{3-}). This form can be rapidly assimilated by phytoplankton, and in the case of most bloom-forming cyanobacteria, is accumulated intracellularly as polyphosphates. Polyphosphates can serve as internal stores of P, for subsequent use in the event of ambient P depletion[219]. Dissolved organic P (DOP) can be a significant fraction of the total dissolved P pool. DOP can be assimilated by a variety of microorganisms, including microalgae and cyanobacteria, although not as rapidly as DIP[220]. A large fraction of the assimilated DOP is microbially recycled to DIP, making it available for subsequent utilization.

The role of particulate P (inorganic or organic) in aquatic production and nutrient cycling dynamics is less well understood. Particulate P (PP) may provide a source of DIP and DOP via desorption and leaching processes, and it may serve as a sorption and precipitation site for DIP. PP therefore exists in dynamic equilibrium with the dissolved phases of P. It can be concluded that PP can serve as a source of biologically available P and as such play an important role in P cycling and productivity. Furthermore, on the ecosystem-level, sedimented PP serves as an important source of stored P for subsequent release, especially during hypoxic and anoxic periods, when large amounts of DIP are released from the sediments. These sources of stored and recycled P can serve to support additional phytoplankton blooms. Clearly, *both* dissolved and particulate forms of P input must be accounted for when formulating and managing P inputs and N:P ratios.

Nitrogen Management

N exists as dissolved and particulate, aqueous and gaseous forms. The multiple chemical forms of N create both scientific and management challenges because virtually all the forms are biologically available and readily exchanged within and between the water column and sediment. In addition, biological N_2 fixation and denitrification control the exchange (inputs and outputs, respectively) between inert gaseous atmospheric dinitrogen and biologically available combined N forms.

Combined forms of N include dissolved inorganic N (DIN; ammonium [NH_4^+], nitrate [NO_3^-], and nitrite [NO_2^-]), dissolved organic N (DON; e.g., amino acids and peptides, urea, organonitrates), and particulate organic N (PON; polypeptides, proteins, complex organic matter, organic detritus). These sources are supplied as diffuse nonpoint and distinct point sources. Nonpoint sources include surface runoff, atmospheric deposition and groundwater, while point sources are dominated by municipal, agricultural, and industrial wastewater effluent. In most rural and agricultural settings, nonpoint sources of N input tend to dominate (>50% of total N loading), while in urban centers, point sources often dominate. Agricultural and urban runoff, atmospheric deposition, and municipal/industrial effluents contain a variety of organic and inorganic chemical species in dissolved and particulate forms. These sources constitute a dynamic mixture of biologically available DIN, DON, and PON that plays a critical role in eutrophication. Depending on sources, chemical makeup, delivery mechanisms, and spatial distribution of N inputs, ecosystem response can vary dramatically.

N inputs are highly dynamic, reflecting land use, population and economic growth, and changes therein. For this reason, N has often been referred to as the "currency" of eutrophication in N-sensitive estuarine and coastal waters. The means and routes by which human N sources impact and mediate eutrophication are changing. Among the most rapidly growing (both in amount and geographic scale) sources of anthropogenic N loading are surface runoff, groundwater, and atmospheric deposition. Atmospheric N loading is a frequently overlooked, but expanding source of *new* N loading to N-sensitive waters. In coastal North Carolina, for example, the combined emissions of fossil fuel combustion (NO_x) and volatilization of NH_3 from animal waste (wastewater lagoons and land-applied) are a major (>30% of *new* N loading), rapidly growing source of biologically available N[61]. Surface and groundwater N releases from expanding animal operations and urbanization are of additional concern. The diversity and highly dynamic nature of these N sources provide several chemically distinct nitrogenous compounds such as nitrite, nitrate, ammonium, urea, and other organic N compounds.

The contribution of groundwater and atmospheric N to N-sensitive estuarine and coastal watersheds will increase substantially in the next millennium, when nearly 70% of North American and European populations will reside within 50 km of the coast. A significant fraction of atmospheric N is directly deposited to estuarine and coastal waters, bypassing the estuarine N "filter". In many locations, including the Eastern Seaboard of the U.S., atmospheric N is among the dominant sources of anthropogenic N to the coastal zone. When and where anthropogenic N inputs are intercepted are critical factors in determining ecosystem sensitivity, water quality responses and resourcefulness in response to upstream (watershed) and upwind (airshed) N enrichment. The biogeochemical, ecological, and cultural ramifications of this previously "out of sight out of mind", growing new N source must be clarified and incorporated in our understanding of estuarine and coastal ecosystem function and management.

Chronic anthropogenic N and P loading of our rivers, lakes, and estuaries has caused state and federal agencies to assign nutrient-sensitive status and impose total mean daily loads (TMDLs) to these waters. These designations require formulation and implementation of nutrient input reduction strategies aimed at arresting eutrophication and lowering nuisance bloom potential. The Neuse River Estuary, North Carolina has been the site of periodic massive blooms of the non-N_2-fixing, toxic, surface scum-former *Microcystis aeruginosa*, with incursions of the filamentous non-N_2-fixer *Oscillatoria* spp. Dominance by these non-N_2-fixers attests to the current N "overload situation"[12,221]. Dilution bioassays indicated that watershed loading of N would need to be reduced by 30 to 40% to obtain N-limited conditions during the critical spring bloom initiation period. A complicating aspect from nutrient dynamics and management perspectives is the presence (as subdominants) of N_2-fixing cyanobacteria, *Anabaena* and *Aphanizomenon*. This fact, combined with evidence that P loading also is excessive[12,222,223], suggests that if N loading is reduced by 30 to 40% without parallel P reductions, there may be potential for replacing non-N_2-fixing *Microcystis* with N_2-fixing *Anabaena* or *Aphanizomenon* blooms. Results from bioassays in which N was reduced but P was not confers the potential for selective stimulation of N_2-fixing cyanobacteria in freshwater and oligohaline segments of the eutrophying Neuse River and St. Johns River (Florida) systems (Paerl et al., in preparation). Work is currently under way to formulate parallel N and P reductions aimed at avoiding replacement of one type of cyanobacterial nuisance with another.

CONCLUDING REMARKS

Cyanobacterial water blooms are a worldwide phenomenon, and as such are regulated by an interplay of geographically and ecologically diverse environmental variables. The long evolutionary history of cyanobacterial bloom species has dictated a high degree of tolerance and adaptability to both short-term (i.e., diel, seasonal, decadal) and long-term (geological) environmental change, essentially making these photosynthetic prokaryotes a "group for all seasons".

In this review, we have explored the myriad physical, chemical, and biotic factors implicated in the development, proliferation, and expansion of cyanobacterial blooms. Despite their seemingly infinite adaptation to environmental change on both geological and biological time scales, cyanobacterial nuisance characteristics (e.g., large anoxia-generating and toxic blooms) are, to a large extent, products of human alteration of water- and airsheds for aquatic environments. The most notable and controllable alterations include: 1) nutrient (especially N and P) enrichment; 2) hydrological changes, including freshwater diversions, the construction of impoundments such as reservoirs, and excessive water use for irrigation, drinking supplies, flood control, etc., all of which affect water residence time or flushing rates; 3) biological alterations of aquatic ecosystems, including manipulations of grazers (from zooplankton to fish); and lastly 4) the use and introduction of toxins and xenobiotic compounds (e.g., heavy metals, herbicides and pesticides, industrial and domestic chemicals, antibiotics, and other synthetic growth regulators), all of which exert phytoplankton community growth and composition altering effects.

Effective long-term management of nuisance, particularly toxin-producing, cyanobacterial blooms must address the above-mentioned suites of environmental factors, in combination with knowledge of the ecological and physiological adaptations that some species possess to circumvent certain controls derived from our knowledge of these factors. Examples include: 1) the ability of certain N_2 fixers to take advantage of N-limited conditions; 2) the ability of buoyant taxa to counteract mixing and other means of man-induced destratification aimed at minimizing cyanobacterial dominance; and 3) specific mutualistic and symbiotic associations that cyanobacteria have with other microorganisms, higher plants and animals, which may provide clues as to the roles toxins and other chemical factors play in shaping biotic community structure and function.

Progress in identifying and understanding the roles toxins and other metabolites play in the physiology and ecology of bloom-forming cyanobacteria will be achieved by integrating physiological, toxicological, and ecological perspectives and expertise. This includes hypothesis testing and problem solving using interdisciplinary experimental, monitoring, and assessment approaches. In addition, the synthesis of well-defined laboratory experimental work with ecosystem-level studies utilizing similar techniques and measurements will be essential to unraveling the complexity of environmental regulation of cyanobacterial bloom dynamics. We are at the threshold of more holistic approaches to environmental problem solving. In this regard, the incorporation of novel analytical and molecular quantification and characterization techniques in environmental biology and management will prove invaluable.

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EXHIBIT 8

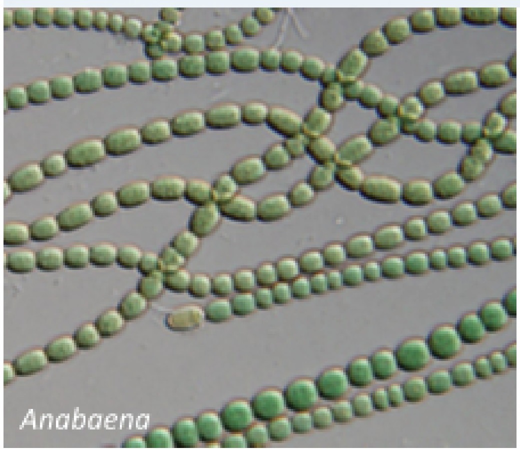
RTD-236

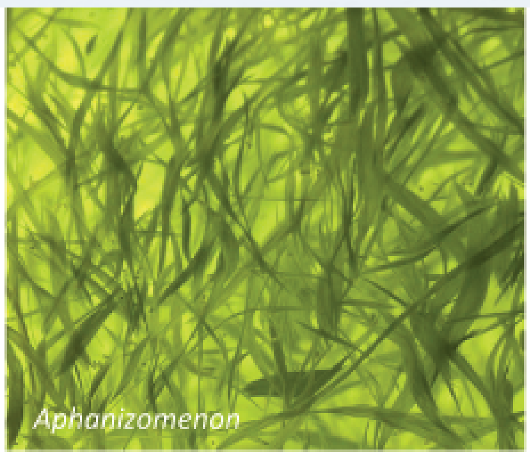
Factors Affecting Growth of Cyanobacteria

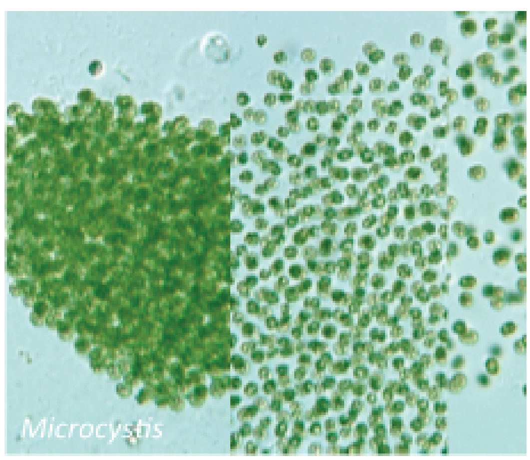
With Special Emphasis on the Sacramento-San Joaquin Delta

APPLIED MARINE SCIENCES

SCCWRP Established 1969







Mine Berg
Martha Sutula

Southern California Coastal Water Research Project

SCCWRP Technical Report 869

Factors Affecting the Growth of Cyanobacteria with Special Emphasis on the Sacramento-San Joaquin Delta

Prepared for:
The Central Valley Regional Water Quality Control Board
and
The California Environmental Protection Agency
State Water Resources Control Board
(Agreement Number 12-135-250)

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Southern California Coastal Water Research Project

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Technical Report 869

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EXECUTIVE SUMMARY

A world-wide increase in the incidence of toxin-producing, harmful cyanobacterial blooms (cyanoHABs) over the last two decades has prompted a great deal of research into the triggers of their excessive growth. Massive surface blooms are known to decrease light penetration through the water, cause depletion of dissolved oxygen following bacterial mineralization of blooms, and cause mortality of aquatic life following ingestion of prey with high concentrations of toxins. Additionally, humans coming in contact with the water may develop digestive and skin diseases, and it may affect the drinking water supply.

The Central Valley Regional Water Quality Control Board (Water Board) is developing a science plan to scope the science needed to support decisions on policies governing nutrient management in the Delta. Blooms of cyanoHABs are one of three areas, identified by the Water Board, that represent pathways of potential impairment that could be linked to nutrients. The Water Board commissioned a literature review of the factors that may be contributing to the presence of cyanoHABs in the Delta. The literature review had three major objectives:

1) Provide a basic review of biological and ecological factors that influence the prevalence of cyanobacteria and the production of cyanotoxins;
2) Summarize observations of cyanobacterial blooms and associated toxins in the Delta;
3) Synthesize literature to provide an understanding of what ecological factors, including nutrients, may be at play in promoting cyanobacterial blooms in the Delta.

This review had four major findings:

#1. Five principal drivers emerged as important determinant of cyanobacterial blooms in a review of the global literature on factors influencing cyanobacteria blooms and toxin production. These include: 1) Water temperature, 2) Water column irradiance and water clarity, 3) Stratified water column coupled with long residence times, 4) Availability of N and P in non-limiting amounts; scientific consensus is lacking on the importance of N: P ratios as a driver for cyanoHABs, and 5) Salinity regime.

#2. Existing information is insufficient to fully characterize the threat of CyanoHABs to Delta ecosystem services because cyanoHABs are not routinely monitored. Based on existing data, the current risk to Delta aquatic health is of concern and merits a more thorough investigation. This observation is based total microcystin levels found in Delta fish tissues that are within the range of sublethal effects to fish as recently reviewed by the California Office of Environmental Health Hazards (OEHHA 2009), and dissolved toxin concentrations that occasionally exceed both the OEHHA action level and the World Health Organization (WHO) guideline of 1000 ng L^{-1} in certain “hotspots” of the Delta.

#3. Comprehensive understanding of the role of nutrients vis-à-vis other environmental factors in influencing cyanoHAB presence in the Delta is severely hampered by the lack of a routine monitoring program. Drawing on available information on the five factors influencing cyanoHABs, we can conclude the following:

- Temperature and irradiance appear to exert key roles in the regulation of the onset of blooms. Cyanobacteria require temperatures above 20°C for growth rates to be competitive with eukaryotic phytoplankton taxa, and above 25°C for growth rates to be competitive with diatoms. In addition, they require relatively high irradiances to grow at maximal growth rates.
- It appears that N and P are available in non-limiting amounts in the Delta; moreover, concentrations, or ratios, do not change sufficiently from year–to–year in order to explain year–to–year variation *Microcystis* biomass or occurrence. Therefore the initiation of *Microcystis* or other cyanoHAB blooms are probably not associated with changes in nutrient concentrations or their ratios in the Delta. However, as with all phytoplankton blooms, once initiated, cyanoHABs cannot persist without an ample supply of nutrients.
- Salinity is controlling the oceanward extent of cyanobacteria blooms in the Delta, but salinity gradients do not explain the spatial distribution of cyanoHABs in the Delta. Notably, salinity regime is not a barrier to toxin transport, as cyanotoxins have been detected in SF Bay.
- Turbidity, low temperatures, and higher flows during most of the year are likely restricting cyanobacteria blooms to the July-August time period.

#4. Climate change and anthropogenic activity associated with land use changes have the potential to alter cyanoHAB prevalence in the future. Climate change will likely result in warmer temperatures and increased drought, the latter of which could result in reduced flows, increased residence time and water column stability leading to higher light availability in the Delta. Both temperature and reduced flows would presumably result in a greater prevalence of cyanoHABs. It's noteworthy that phytoplankton biomass and primary productivity are depressed relative to available nutrients in the Delta, so it's unclear what the effect of modifying nutrient loads will have on frequency and intensity of cyanoHAB occurrence in the future.
Given these findings, two major science recommendations are proposed:

R1: Implement Routine Monitoring of CyanoHABs. DWR is currently conducting a monitoring program which routinely samples many of the variables of interest known to influence cyanoHABs. Comprehensive cyanoHAB monitoring should be added as a component to this program. To begin, a work plan should be developed which specifically scopes the needed changes in the program to comprehensively monitor cyanoHABs. This report details specific components that should be considered in this workplan. The workplan should also consider monitoring needed to develop and calibrate an ecosystem model to further investigate controls on primary productivity and phytoplankton assemblage (see R2 below). The workplan should be peer-reviewed by subject matter experts. After an initial period of 3-5 years, the monitoring data should be used to comprehensively report on the status and trends of cyanoHABs and the factors that favor bloom occurrence in the Delta.

R2: Develop an Ecosystem Model of Phytoplankton Primary Productivity and HABs Occurrence to further Inform Future Risk and Hypotheses on Factors Controlling CyanoHABs. Because nutrients are not currently limiting cyanobacterial blooms, it is critical that an improved understanding is gained of the factors that are controlling phytoplankton primary productivity in the Delta, since increased phytoplankton growth could lead to increased risk of cyanoHAB blooms. To inform management action moving into the future, an ecosystem model of phytoplankton primary productivity and HABs occurrence should be developed. This model should have the capability to provide information on primary productivity and biomass as well as planktonic food quality and transfer of carbon to higher trophic levels. To step into model development, three actions should be taken: 1) examine existing models already available to determine suitability for this task, 2) utilize existing data to explore, to the extent possible, the relationships between chlorophyll a, phytoplankton composition, climate variables *et al*. factors. This analyses should inform hypotheses that can be tested through model development as well as potential future scenarios, and 3) a work plan should be developed that lays out the modeling strategy, model data requirements, and implementation strategy.

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1. INTRODUCTION, PURPOSE AND ORGANIZATION OF THE REVIEW

1.1 Background and Context

The Sacramento–San Joaquin River Delta, is an inland river delta and estuary approximately 1300 square miles in size, found in Northern California. Formed at the western edge of the Central Valley by the confluence of the Sacramento and San Joaquin Rivers, the Delta is a key component of the State's water resource infrastructure and a region that is rapidly urbanizing, yet serves as critical habitat or fish, birds and wildlife. Water from the 45,000 square mile Delta watershed fuels both local and statewide economies, including important agricultural commodities. The Delta is widely recognized as in "crisis" because of human effects on the environment and competing demands for the Delta's resources. The consequences of these competing demands include point and non-point discharges, habitat fragmentation and loss, modified flow regimes, introduction of non-native species, all of which combine to threaten ecosystem health, including the continued decline of threatened and endangered species

In 2009 the California legislature passed the Delta Reform Act creating the Delta Stewardship Council. The mission of the Council is to implement the coequal goals of the Reform Act and provide a more reliable water supply for California while protecting, restoring, and enhancing the Delta ecosystem. The Council wrote and adopted a Delta Plan in 2013 to implement these goals. Chapter 6 of the Delta Plan deals with water quality and contains recommendations to implement the coequal goals of the Delta Reform Act. Recommendation # 8 states, in part, "…the State Water Resources Control Board and the San Francisco Bay and Central Valley Regional Water Quality Control Boards (Water Board) should prepare and begin implementation of a study plan for the development of objectives for nutrients in the Delta … by January 1, 2014. Studies needed for development of Delta… nutrient objectives should be completed by January 1, 2016. The Water Boards should adopt and begin implementation of nutrient objectives, either narrative or numeric, where appropriate, in the Delta by January 1, 2018. Potential nutrient related problems identified in the Delta Plan for evaluation are:

1) Decreases in algal abundance and shifts in algal species composition,
2) Increases in the abundance and distribution of macrophytes, including water hyacinth and Brazilian waterweed,
3) Increases in the magnitude and frequency of cyanobacterial blooms

To provide better scientific grounding for the study plan, the Water Board commissioned two literature reviews centered on these three potential areas of impairment. This document provides a synthesis of literature on cyanobacterial blooms in the Delta. Technical Adivory Group and Stakeholder comments on the review are provided in Appendices B and C, respectively.

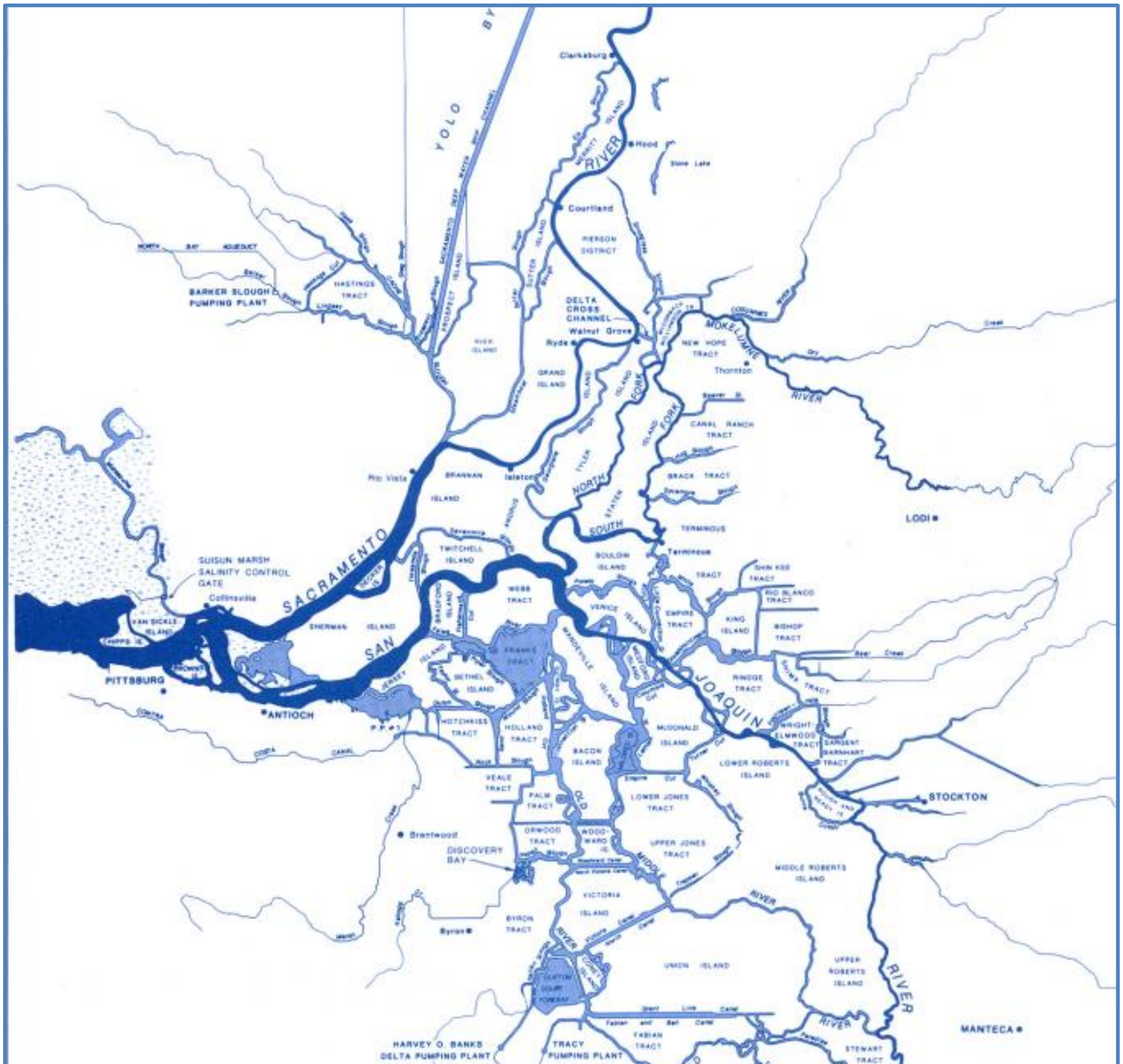

Figure 1.1. The Sacramento-San Joaquin Delta Region.

1.2 Goal and Organization of Cyanobacterial Literature Review

The goal of the cyanobacterial literature review is to synthesize available information to provide insight into cyanobacterial blooms in the Delta. The review had three major objectives:

1) Provide a basic review of biological and ecological factors that influence the prevalence of cyanobacteria and production of cyanotoxins;
2) Summarize observations of cyanobacteria blooms and associated toxins in the Delta;
3) Synthesize literature to provide an understanding of what ecological factors, including nutrients, may be at play in promoting cyanobacteria blooms in the Delta.

This review, and the recommended next steps, will contribute to a science plan to determine whether or how to proceed with the development of nutrient objectives for the Delta. The document is organized as follows:

Section 1: Introduction, Purpose and Organization of the Review

Section 2: Basic Biology and Ecology of Cyanobacteria

Section 3: Factors Influencing Cyanobacterial Blooms and Toxin Production

Section 4: Prevalence of CyanoHABs and Potential for Effects on Ecosystem Services in the Delta

Section 5: Synthesis of Factors Influencing CyanoHABs Presence and Toxin Production in the Delta

Section 6: Recommendations

Section 7: Literature Cited

2. Basic Biology and Ecology of Cyanobacteria

2.1 Overview

Cyanobacteria are a versatile group of bacteria that were the ancient colonizers of Earth and the photosynthetic ancestors of chloroplasts in eukaryotes such as plants and algae. As pioneers of photosynthesis, cyanobacteria were responsible for oxygenating Earth's atmosphere 2.5 billion years ago. In addition to being photosynthetic, cyanobacteria can differentiate into specialized cell types called heterocysts and fix nitrogen (N), exhibit gliding mobility, and tolerate a wide range of temperatures as evidenced by their ability to thrive in hot springs and ice-covered Antarctic lakes. Cyanobacteria also produce an array of bioactive compounds, some of which possess anti-microbial, anti-cancer and UV protectant properties. However, a subset of these bioactive compounds is highly toxic to humans and wildlife.

Blooms of cyanobacteria that produce these toxins, collectively known as harmful cyanobacterial algal blooms (cyanoHABs), has garnered a great deal of attention due to their increased occurrence in recent decades (Chorus and Bartram 1999, Carmichael 2008, Paerl and Huisman 2008, Hudnell 2010). The geographical distribution of these blooms has also increased with blooms appearing in areas previously unaffected (Lehman *et al*. 2005, Lopez *et al*. 2008). CyanoHABs can have major negative impacts on aquatic ecosystems. Toxins produced by cyanobacteria can lead to mortality in aquatic animals, waterfowl and domestic animals (Havens 2008, Miller *et al*. 2010). Moreover, toxins in drinking water supplies can pose a variety of adverse health effects and therefore require expensive treatment options such as filtration, disinfection, and adsorption with activated carbon (Cheung *et al*. 2013). In addition to the threat of toxins, oxygen depletion due to organic matter decomposition following the die-off of blooms can result in massive fish kills. CyanoHABs can also lead to revenue losses and impact local economies by reducing business in affected water bodies during the peak of tourism season. Considerable costs are associated with mitigation of blooms and lake restoration (Dodds *et al*. 2009).

The San Francisco Bay Delta is an area where cyanoHABs were previously undetected but have become commonplace since early 2000 (Lehman *et al*. 2005). In addition to providing a home for several species of pelagic fish and other wildlife, the Delta serves as a critical source of drinking water, and freshwater for irrigation of farms, to communities locally as well as farther south including the Los Angeles Metropolitan Water District. In concert with the occurrence of cyanoHABs, concentrations of the toxins they produce have been detected in the water and in higher trophic levels including zooplankton and fish (Lehman *et al*. 2010). The purpose of the following sections summarizes the basic biology of cyanobacteria beginning with classification, light harvesting, carbon metabolism, buoyancy regulation, nitrogen metabolism, cellular N:P ratios and toxin production, in order to build fundamental concepts that are later utilized in the review.

2.2 General Characteristics

2.2.1 Classification, Distribution and Akinete Production

Classification

Traditionally, morphological traits have been used to subdivide the cyanobacteria into five sub-groups (Rippka *et al*. 1979). The major division is between cyanobacteria that are single celled and/or colonial and those that grow filaments (Table 2.1). Each category contains a mixture of marine and freshwater species. In the former category are the Group I Croococcales including the freshwater *Microcystis* and *Synechocystis*, and the marine *Synechococcus* and *Prochlorococcus*. Group II Pleurocapsales include *Pleurocapsa* and *Xenococcus* (Table 2.1). The filamentous algae, Groups III, IV, and V, are further subdivided into the Oscillatoriales that produce only vegetative cells, including the freshwater planktonic *Planktothrix* species, the benthic *Oscillatoria* and *Lyngbya* species, as well as the marine *Trichodesmium* sp. (Table 2.1). Group IV, the Nostocales, contain filamentous algae that differentiate into heterocysts and fix N_2. This group includes *Aphanizomenon*, *Anabaena*, *Nostoc* and *Cylindrospermopsis* (Table 2.1). Additionally, the Nostocales is known for differentiation into resting cells called akinetes during unfavorable conditions. Group V, the Stigonematales include species with filaments that grow in complex branching patterns.

Table 2.1. Cyanobacterial groupings based on morphological traits. Adapted from Rippka *et al.* 1979.

<table>
<tr><td colspan="3">Croococcales
Unicellular, reproduce by binary fission
GROUP 1</td><td>Gloeothece (N)
Microcystis
Prochlorococcus
Prochloron
Synechococcus
Synechocystis</td></tr>
<tr><td colspan="3">Pleurocapsales
Unicellular, reproduce by multiple fission
GROUP 2</td><td>Pleurocapsa
Staniera (N)
Xenococcus (N)</td></tr>
<tr><td rowspan="3">Filamentous chain (trichome) forming; reproduce by random trichome breakage, hormogonia, germination of akinetes</td><td>Trichome composed of vegetative cells</td><td>Oscillatoriales
1 plane division
GROUP 3</td><td>Lyngbya (N)
Oscillatoria (N)
Phormidium
Prochlorothrix
Trichodesmium (N)</td></tr>
<tr><td rowspan="2">In the absence of fix d N, trichome contains heterocysts; some produce akinetes</td><td>Nostocales
1 plane division
GROUP 4</td><td>Aphanizomenon
Anabaena
Cylindrospermum
Nodularia
Nostoc</td></tr>
<tr><td>Stigonematales
Divisien in more than 1 plane
GROUP 5</td><td>Chlorogleopsis
Fisherella</td></tr>
</table>

It was originally thought that N_2 fixation primarily existed in the Nostocales which had the ability to differentiate into heterocyst cells. More recent investigations tracking the *nifD* and *nifH* gene diversity has uncovered that N_2 fixation occurs in a range of unicellular, non-filamentous cyanobacteria dispersed throughout the five original groups first proposed by Rippka *et al*. (1979). These species are indicated by an (N) after their name in Table 2.1. Depending on which functionality of the cyanobacteria is emphasized, recent gene-based groupings of cyanobacteria have created as many as ten different sub-categories (Turner *et al*. 1999, Tomatini *et al*. 2006). However, there appears to exist no general consensus over the best manner in which to categorize the cyanobacteria based on functionality and marker genes. Most cyanobacteria are planktonic and are dispersed throughout the five groups. The benthic cyanobacteria are found mainly in the Oscillatoriales subgroup. The toxic cyanoHAB-forming cyanobacteria are mostly freshwater planktonic species dispersed throughout groups I, III and IV and include the N_2 fixing genera *Anabaena*, *Aphanizomenon*, *Cylindrospermopsin*, and *Nodularia*; the benthic N_2 fixing genera *Lyngbya* and some *Oscillatoria*; and the non-N_2 fixing genera *Microcystis* and *Planktothrix* (Paerl and Paul 2012).

Akinete formation

Akinetes are the resting cells produced by the Nostocales in order to survive adverse environmental conditions such as cold and desiccation (Tomatini *et al*. 2006). Akinete cells maintain low levels of metabolic activity (Thiel and Wolk 1983, Sukenik *et al*. 2007), are dispersed in sediments (Baker 1999, Kim *et al*. 2005, Rucker *et al*. 2009), and are distinguishable from vegetative cells by their larger size (Figure 2.1). They germinate in response to improved environmental conditions such as light and temperature (Baker and Bellifemine 2000, Karlsson-Elfgren *et al*. 2004, Yoshimasa and Nakahara 2005, Kaplan-Levy *et al*. 2010) and provide an inoculum of Nostocales vegetative cells to the water column from the sediments where the akinete “seed bank” may remain viable for decades (Stockner and Lund 1970, Livingstone and Jaworski 1980). Therefore, eradication of Nostocales from a system once it has become “infected” is very difficult.

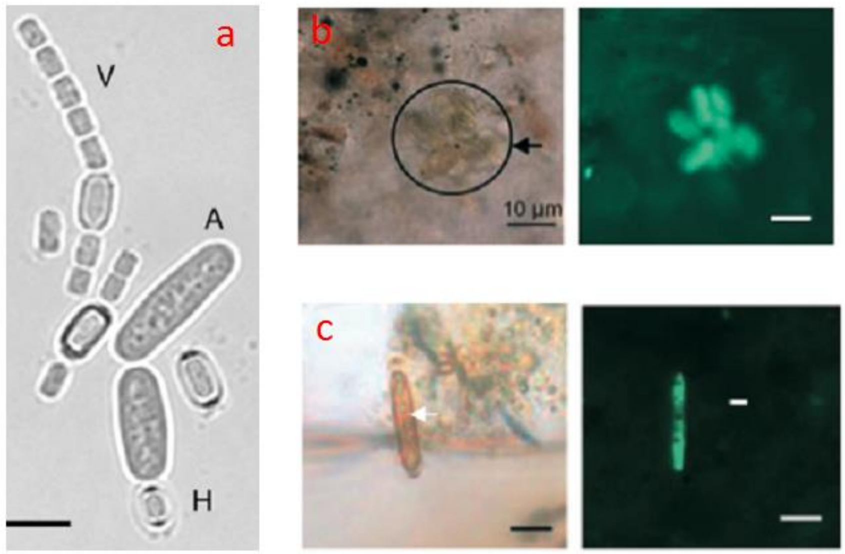

Figure 2.1. Akinetes of a) Anabaena cylindrica culture grown in medium without nitrogen; A=akinete; H=heterocyst; V=vegetative cell (picture from Tomatini *et al.* 2006), b) Anabaena lemmermanni, and c) Cylindrospermopsis raciborskii in lake sediments under light microscopy and hybridized with probe under fluorescence microscopy; scale bar is 10μm (pictures from Ramm *et al.* 2012).

2.2.2 Light Harvesting, Photosynthesis and Carbon Fixation

Cyanobacteria are distinct from all other algae in that most of them possess two light harvesting systems (as opposed to one). Maintaining two light harvesting system is costly in terms of protein and N requirements and manifests strongly in their cell biology. For example, the extra protein requirement means that cyanobacteria have a high tissue nitrogen:phosphorus (N:P) ratio and a high N requirement for growth (discussed below). Despite this, light harvesting is necessary in photosynthetic organisms to 1) collect light energy from the sun and 2) convert it to chemical energy in the form of electrons and ATP that can be used to power carbon fixation.

Light harvesting pigments and photosynthesis

Light harvesting is performed by chlorophyll *a* (Chl *a*) pigment molecules that are associated with two photosystems (PSI and PSII) that comprise the centers of the photosynthetic process which starts with the liberation of an electron from the splitting of water and ends with the production of ATP. Sitting in each of the photosystems is a specialized Chl *a* molecule that initiates the flow of electrons through the electron transport chain that eventually powers ATP synthesis. The other Chl *a* molecules, 40 and 90, together with 12 and 22 carotenoid pigment molecules, in PSI and PSII respectively, funnel light energy to the reaction core (DeRuyter and Fromme 2008). This complex of Chl *a* and carotenoid pigment molecules, coordinated by a large number of proteins, is very similar in its structure to the light-harvesting complex (LHC) embedded into the thylakoid membranes of vascular plants and eukaryotic phytoplankton (Fromme *et al*. 2001, 2002).

What makes the cyanobacteria unique is that they have a second light harvesting antenna complex peripheral to the thylakoid membrane that is water soluble (e.g. not membrane bound). This pigment complex, comprised of pigmented proteins arranged in rods fanning out from a core attached to the thylakoid membrane, called the phycobilisome (PBS), is what gives cyanobacteria their name (Grossman *et al*. 1993, Grossman 2003). Similar to the carotenoid pigments mentioned above, the PBS chromophores absorb light inbetween the Chl *a* absorption peaks of 440nm and 670nm (Grossman *et al*. 1993). Interestingly, the PBS proteins are not exclusive to cyanobacteria; they also occur in photosynthetic eukaryotes.

Up to 50% of cyanobacterial cellular protein content is bound in the PBS complex taking a large proportion of the cell's resources, particularly its nitrogen (N) allocation. Therefore, under stress condition such as N starvation, the entire PBS can be degraded within a few hours and the N can become reused within the cell (Sauer *et al*. 1999). When conditions improve, the PBS will be re-synthesized and re-assembled (Collier and Grossman 1994, Grossman *et al*. 2001).

Carbon fixation

The ATP produced and the electrons liberated during photosynthesis are used to power the fixation of carbon into sugars in the Calvin Cycle. They are also used to reduce oxidized sources of N to ammonia during N assimilation (discussed below). The primary and rate-limiting enzyme in carbon fixation is Rubisco which catalyzes the first step in the Calvin Cycle. To deal with the rate-limiting nature of Rubisco, cyanobacteria have evolved specialized structures called carboxysomes. In addition to housing Rubisco, the carboxysomes contain a number of other enzymes that help concentrate CO_2 in its vicinity to speed its reaction rate (Kaplan and Reinhold 1999). Cyanobacteria fix carbon to provide the skeletons needed to assimilate N into amino acids and build protein and cellular biomass; fixed carbon can also be used to accumulate carbohydrate storage products (carbohydrate ballasting) in order to make the cell heavier during buoyancy regulation.

2.2.3 Buoyancy Regulation

One distinct advantage of many cyanobacterial genera such as *Microcystis*, *Planktothrix*, *Anabaena* and *Aphenizomenon* is their ability to regulate their buoyancy by a combination of producing gas vesicles and carbohydrate storage products (Oliver 1994, Beard *et al*. 1999, Brookes *et al*. 1999). The former renders them positively buoyant whereas the latter does the opposite (Walsby 1994, 2005). The carbohydrate storage products are derived from C-fixation and the amount produced varies depending on the species and on irradiance (Howard *et al*. 1996, Visser *et al*. 1997, Wallace and Hamilton 1999). At an irradiance that is specific to each species and strain, the amount of carbohydrate storage product will perfectly balance the upward lift created by the gas vesicles and the cyanobacteria will become neutrally buoyant (Walsby *et al*. 2004). In addition to producing and storing the carbohydrates, cyanobacteria also consume the storage products to produce energy.

By regulating the amount of carbohydrate storage products consumed, cyanobacteria control their vertical position in the water column (Thomas and Walsby 1985, Konopka *et al*. 1987, Wallace and Hamilton 1999). Models demonstrate that filamentous cyanobacteria can sink or float at speeds up to 0.3 m per day in order to position them at a depth where irradiance is such that it maximizes their growth potential (Walsby 2005). These speeds are only achievable for filaments of a certain size and weight; picocyanobacteria and small filaments do not have enough momentum to respond by vertical repositioning to changes in irradiance (Walsby 2005). Of course, carbohydrate production, therefore buoyancy regulation, is affected by nutrient availability; nitrogen starved cells have excess carbohydrate stores and tend to lose buoyancy more easily than nutrient sufficient cells (Klemer *et al*. 1982, Brookes *et al*. 1999, Brookes and Ganf 2001).

2.2.4 Nitrogen Metabolism

Cyanobacteria use a wide variety of N sources for growth including ammonium (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-), urea, amino acids, cyanate, and several species are also capable of dinitrogen gas (N_2) fixation to satisfy their cellular N demand. Below we discuss the pathways of N transport, metabolism and assimilation, and their regulation.

Ammonium transport and assimilation of N into amino acids

Being a charged molecule, NH_4^+ cannot diffuse freely into the cell and has to be transported via active transport. Transport of NH_4^+ into cyanobacteria (as well as in eukaryotic algae) occurs via the Amt family of transporters. These transporters are either expressed constitutively or differentially depending on external N concentrations. At environmental concentrations, most of the NH_4^+ is transported into the cell via the high-affinity transporter Amt1 encoded by the gene *amt1* (Muro-Pastor *et al*. 2005).

Before it can be assimilated, all N sources, whether N_2, NO_3^- or organic N containing molecules, first have to be converted to NH_4^+. The NH_4^+ is then assimilated into amino nitrogen through the GS/GOGAT pathway. The primary NH_4^+ assimilating enzymes in cyanobacteria (as well as in vascular plants and eukaryotic algae) are glutamine synthetase (GS) and glutamate synthase (also called glutamine-2-oxogluterate-amido transferase, GOGAT) acting in concert to aminate 2-oxogluterate (2-OG). Photosystem I (PSI)-reduced ferredoxin (Fd_{red}) is typically used as a reductant in this reaction:

GS:	Glutamate + NH_3 + ATP → Glutamine +ADP +P_i
GOGAT:	Glutamine + 2-OG + 2[H] → 2 Glutamate
GS/GOGAT:	2-OG + NH_3 + ATP + 2[H] → Glutamate + ADP +P_i

An alternate route of NH_4^+ assimilation involves the enzyme glutamate dehydrogenase (GDH) but it's postulated that this occurs only during select conditions such as stationary growth:

GDH: 2-OG + NH_3 + 2[H] → Glutamate + H_2O

In all photosynthetic cells the link between the carbon (C) and N cycles in the cell occurs at the GS/GOGAT reactions because the two key ingredients in N assimilation is 1) 2-OG derived from carbon fixation, and 2) Fd_{red} derived from PSI. GOGAT (and also GDH) will not proceed without their presence, which avoids wasteful consumption of glutamine, and ensures that even in the presence of excess N, assimilation will not proceed unless an adequate supply of C skeletons is available (Flores and Herrero 2005, Muro-Pastor *et al*. 2005).

Nitrate transport and reduction to $NH_4^{\pm}$

As NO_3^- is also a charged molecule it's transported into the cell via active transport. Cyanobacteria use two different transport systems. Most freshwater species, including *Anabaena*, *Synechocystis* and *Gloebacter*, use the high affinity ATP-binding cassette (ABC) transporter NrtABCD (Flores *et al*. 2005). Most marine species (*Synechococcus* and others) take up NO_3^- and NO_2- via the major facilitator superfamily transporter NrtP, also a high-affinity transporter (Flores *et al*. 2005). Some species also have a NO_2^--specific transporter NIT (Maeda *et al*. 1998). Nitrate uptake is tightly regulated by the external concentration of NH_4^+; when NH_4^+ becomes available, cells cease NO_3^- uptake and switch to use NH_4^+ which is preferred. This process is regulated at the level of NO_3^- uptake (Flores and Herrero 1994). In addition, CO_2-fixation (regulated by irradiance) is required to maintain active NO_3^- uptake, a regulatory link that ensures that the product of NO_3^- reduction (ammonium) can be incorporated into carbon skeletons (Luque and Forchhammer 2008).

Reduction of NO_3^- to NH_4^+ is a two-step process catalyzed by the enzymes nitrate reductase (NR) and nitrite reductase (NiR). The power for the reduction reaction, in the form of 2 electrons for NR and 6 electrons for NiR, is provided by Fd_{red} via PSI providing a strong link between the light reactions and NO_3^- use by the cell (Flores *et al*. 2005).

In cyanobacteria, the genes encoding NR, narB, and Nir, nirA, and the NO_3^- transporter NrtP, are typically clustered in the same operon. An operon is a unit that tells the cells to transcribe a sequence of genes simultaneously. In cyanobacteria, the transcription of operons associated with N metabolism is tightly regulated by the transcription factor NtcA (discussed below).

The only cyanobacteria discovered to date that is not able to use NO_3^- is *Prochlorococcus* which lives in the open ocean. While it was initially thought that some species could assimilate NO_2^-, sequencing of their genomes demonstrates that they all lack the *nirA* genes and therefore cannot reduce NO_2^- (Garcia-Fernandez *et al*. 2004).

Urea transport and metabolism

Many, but not all, cyanobacteria can use urea as a source of N for growth. Because urea is not a charged molecule it diffuses freely into the cell; however, environmental concentration are not such that diffusion can supply the needed concentration of urea for the urease enzyme (based on its K_m). Both in freshwater and marine cyanobacteria, an ABC-type active transport system specific for urea has been identified (Valladares *et al*. 2002). The subunits of this transporter are encoded by the five genes urtA-E. In *Anabaena*, the urea transporter genes are in the same NtcA-activated promoter and subject to metabolic repression by NH_4^+ (Valladares *et al*. 2002).
Urea is metabolized to two molecules of NH_3 and CO_2 by the enzyme urease, also called urea amidohydrolase (Mobeley *et al*. 1995). The urease enzyme is well-conserved throughout the bacteria and eukaryotic organisms and consists of two small and one large subunit encoded by at least seven genes, three which encode the structural subunits (*ureA, ureB, ureC*) and the other four (*ureD, ureE, ureF, ureG*) encoding accessory polypeptides required for the assembly of the nickel metallocenter (Collier *et al*. 1999, Palinska *et al*. 2000).

Amino acid transport

All cyanobacteria tested to date have at least one transport system for amino acids. These transporters appear to have broad specificity (i.e. they can transport more than one type of amino acid) and different species have different combinations of transporters (Herrero and Flores 1990, Montesinos *et al*. 1997). For example, freshwater *Synechocystis* sp. has four different amino acid transporters, including the ABC transporter Nat for glutamine and histidine, the ABC transporter Bgt for basic amino acids, and two glutamate-specific transporters GHS and Gtr (Quintero *et al*. 2001). Once in the cell, cyanobacteria possess a variety of deaminase enzymes that can deaminate the amino acids to NH_3 which then enters the GS/GOGAT pathway.

Cyanate transport and metabolism

Cyanobacteria, including freshwater and marine species, can use cyanate (a toxin) as a N source for growth since they have the genes encoding a transporter (*cynA, cynB, cynC*) and the gene encoding the cyanase enzyme (*cynS*) which hydrolyzes cyanate to NH_3 and CO_2 (Kamennaya and Post 2011). In freshwater cyanobacteria, these genes are repressible by NH_4^+ suggesting that they are under NtcA regulation.

Nitrogen fixation

Arguably the most expensive (energetically speaking) source of N for cyanobacteria is molecular dinitrogen gas (N_2). Nitrogen fixation, the process of reducing N_2 to NH_3, is catalyzed by the nitrogenase enzyme. The nitrogenase has two subunits. The first is the dinitrogenase subunit which catalyzes the reduction of N_2 to NH_4^+, composed of the NifD and NifK polypeptides encoded by the *nifD* and *nifK* genes. The dinitrogenase contains an iron-molybdate active site and two iron-sulfur clusters. The second is the dinitrogenase reductase subunit (NifH polypeptide encoded by the *nifH* gene) which contains a central iron-sulfur cluster whose function it is to donate electrons derived from ferredoxin to dinitrogenase. Reduction of N_2 to NH_3 requires 8 electrons and 15 molecules of ATP in the following reaction:

$$N_2 + 8[H] + 16ATP \rightarrow 2\ NH_3 + H_2 + 16ADP + 16P_i$$

It was recently discovered that under conditions of molybdate limitation, some *Anabaena* species express an alternative nitrogenase containing a vanadium-iron cofactor instead of the molybdate-iron cofactor (Thiel 1993, Boison *et al*. 2006). Both these variants require iron cofactors to function and N_2 fixation cannot proceed under iron-limiting conditions.

The nitrogenase enzyme is very sensitive to oxygen (O_2), and O_2 is evolved as a byproduct of the water-splitting reactions at photosystem II (PSII), requiring the nitrogenase enzyme to be kept separate from PSII. Accordingly, freshwater cyanobacteria have evolved heterocysts (Wolk *et al*. 1994). These are specialized cells where PSII is inactivated, the PBS antenna proteins are degraded, and energy to power the cell is derived from cyclic electron flow around PSI. Rates of respiration in these cells are also high to scavenge any O_2. The ATP and reductant needed for N_2 reduction is generated by carbohydrate metabolism inside the heterocyst. The carbohydrate is synthesized in the non-heterocyst, vegetative cells flanking the heterocyst and transported inside. In turn, NH_3 produced inside the heterocyst is exported to the vegetative cells in the form of amino acids (Wolk *et al*. 1994). However, many species of cyanobacteria that fix N_2 do not form heterocysts; these species either separate N_2 fixation from photosynthesis in time (e.g. by fixing N_2 at night such as *Lyngbya aestuarii* and *Crocosphaera watsonii*) or in different regions of filaments as is hypothesized to be the case for *Trichodesmium* sp. (Frederiksson and Bergman 1997).

Because nitrogen fixation is such an energy expensive process, from the formation of the heterocysts to the reduction of N_2, it is tightly regulated by NtcA and is only induced under N starvation and in the absence of any other fixed N source (Herrero *et al*. 2004).

Regulation of nitrogen metabolism

As evident from the preceeding sections, the transcription factor NtcA (encoded by the gene *ntcA*) regulates most of the cyanobacterial genes associated with nitrogen uptake and assimilation, and is therefore considered the master regulator of N metabolism (Herrero et al 2004). NtcA binds to and activates the operons for heterocyst differentiation, N_2 fixation, NO_3^- uptake and reduction, urea uptake and hydrolysis, and glutamine synthetase to mention a few. In other words, none of the genes related to N metabolism are transcribed and their enzymes synthesized unless NtcA binds to their promoter in the genome (Luque *et al*. 1994, Wei *et al*. 1994, Forchammer 2004, Luque and Forchammer 2008). The exception to this rule are some NH_4^+ transport proteins which are not under NtcA control and are transcribed constitutively, i.e.

always “on” (Herrero *et al*. 2001). NtcA also controls signaling proteins that fine-tune cellular activities in response to fluctuating C/N conditions (Herrero *et al*. 2001).

NtcA is under negative control by NH_4^+, meaning that when NH_4^+ is detectable by the cell, *ntcA* gene transcription is repressed (Herrero *et al*. 2001, Lindell and Post 2001). There is an inverse relationship between NH_4^+ concentration and *ntcA* expression in all cyanobacteria tested to date, with basal levels of *ntcA* expression observed in the presence of high external NH_4^+ concentrations and maximal levels of *ntcA* expression observed under N starvation (Frias *et al*. 1994, Lindell *et al*. 1998, Lee *et al*. 1999, Sauer *et al*. 1999, Lindell and Post, 2001). Ammonium regulates expression of *ntcA* via 2-OG which is synthesized in the Calvin cycle and consumed in the GS/GOGAT cycle. Thus 2-OG is at the crossroads between C and N metabolism and is ideally suited to “sense” NH_4^+ concentrations (Vazquez-Bermudez *et al*. 2002, Tanigawa *et al*. 2002, Forchammer 2004).

The repression of *ntcA* expression by NH_4^+ places NH_4^+ at the top of the hierarchy of N substrates utilized and assimilated by cyanobacteria. The order in which N substrates other than NH_4^+ is assimilated differs depending on species. For example, in N_2 fixing cyanobacteria, NH_4^+ represses both N_2 fixation and NO_3^- assimilation. Nitrate, in turn, represses N_2 fixation. Therefore N_2 fixation is at the bottom of the hierarchy in some cyanobacteria (Ramasubramanian *et al*. 1994). But in others such as marine *Trichodesmium* sp., NO_3^- does not repress N_2 fixation genes and the process of N_2 fixation is on a more even footing with NO_3^- assimilation (Post *et al*. 2012).

2.2.5 Cellular Nitrogen:Phosphorus (N:P) Requirement

In 1958 Redfield published his discovery that phytoplankton particulate matter was composed of N and P in a molar ratio of 16, similar to the ratio of dissolved N:P in the water (Redfield 1958). Redfield suggested that the ratio of dissolved N:P in the ocean was driven by the remineralization of phytoplankton particulate matter, a theory which has since taken hold (Falkowski 2000, Geider and LaRoche 2002). Given that the average N:P ratio was discovered to be 16 in phytoplankton, it was deduced that under nutrient limiting conditions phytoplankton would become limited by N at dissolved N:P less than 16 and limited by P at dissolved N:P ratios greater than 16.

Shortly after Redfield’s discovery of the universality of the N:P ratio of 16, investigators turned to phytoplankton cultures to examine how closely phytoplankton cellular N:P ratios varied around 16. Parsons *et al*. (1961) published the first investigation demonstrating variability in cellular N:P ratios depending on the phytoplankton species. Subsequent investigations noted that diatoms and dinoflagellates tended to have cellular N:P ratios below 16 whereas chlorophytes and cyanobacteria typically had ratios above 25 (Geider and LaRoche 2002; Ho *et al*. 2003; Quigg *et al*. 2003; Klausmeier *et al*. 2004; Hillebrand *et al*. 2013; Figure 2.2). This difference among the taxa stems from slight variations in macromolecular composition of the phytoplankton, principally in their ratio of protein, the largest store of N in the cell, to nucleic acids, the largest store of P in the cell (Terry *et al*. 1985, Falkowski 2000, Elser *et al*. 2000, Geider and LaRoche 2002). As mentioned above in section 2.2.2, cyanobacteria have two light-harvesting complexes requiring a greater association of proteins with the light-harvesting pigments compared with eukaryotic cells which only have one light harvesting complex (Raven 1984, Geider and LaRoche 2002). The "excess" protein associated with the peripheral phycobilisomes substantially increase the cellular N:P ratios of cyanobacteria. Once it was realized that that there were significant departures in the cellular N:P ratio depending on taxa, it also became clear that the ratio of N:P uptake differed with respect to taxa and that this was a major basis of resource-based competition among taxa (Rhee 1978). That phytoplankton take up N:P in proportion to their tissue composition was subsequently confirmed in culture experiments (Droop 1974, Elrifi and Turpin 1985, Tett *et al*. 1985, Quigg *et al*. 2003, Leonardos and Geider 2004). In other words, phytoplankton do not take up nutrients according to the ratio that occurs in water, but rather the ratio dictated by the macromolecular composition of their tissues.

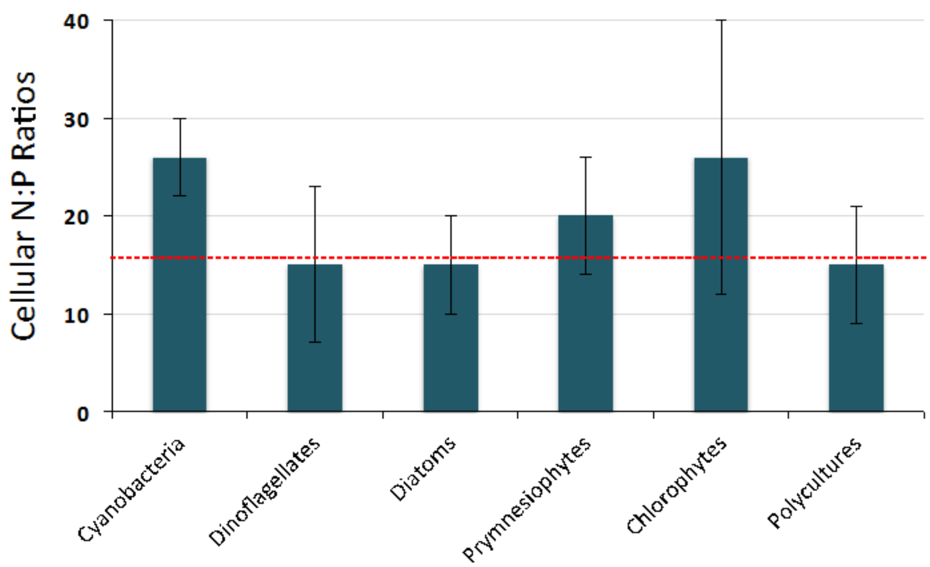

Figure 2.2. Cellular N:P ratios (mole:mole) in different phytoplankton taxa. Dashed red line indicates the average phytoplankton cellular N:P ratio of 16, also called the Redfield ratio. Data from Hillebrand *et al.* 2013.

Tissue N:P composition is not a fixed trait and phytoplankton are able to adjust it, within certain limits, in order to keep growing when environmental conditions change for the suboptimal. When limited for a nutrient, uptake of the non-limiting nutrient can proceed for a while skewing cellular ratios. But, severe limitation by one nutrient will eventually prevent the uptake of the other, non-limiting nutrient, even when the other is present in excess. This quirk of nature constrains the extent to which cellular ratios vary (Droop 1974, Tett *et al*. 1985, Leonardos and Geider 2004, Hillebrand *et al*. 2013). For example, a summary of nearly 50 phytoplankton studies demonstrates that the N:P ratio of P-limited phytoplankton converge around 28 and the N:P ratio of N-limited phytoplankton converges around 16 (Hillebrand *et al*. 2013).

Irradiance may also change the cellular N:P ratio through its influence on the cellular protein content (LaRoche and Geider 2002). Pigments (Chl *a* and light harvesting antenna pigments) are bound in pigment-protein complexes rich in N that increase as irradiance decreases, and decrease under high light as cells reduce the size of the light harvesting complex to avoid photodamage (Wynne and Rhee 1986, Falkowski and LaRoche 1991, Nielsen 1992, Leonardos and Geider 2004). The irradiance-dependent change in N:P ratios is even more pronounced among cyanobacteria due to the greater association of protein with the phycobilisome than in the eukaryotic light harvesting complex (Raven 1984, Geider and LaRoche 2002).

In contrast with limiting nutrient concentrations or changes in irradiance, changes in the medium N:P ratio when nutrient concentrations are in excess of demand was found not to affect cellular N:P ratios in phytoplankton in early experiments (i.e. Tilman *et al*. 1982, Tett *et al*. 1985, Reynolds 1999, Roelke *et al*. 2003, Sunda and Hardison 2007) and has not been pursued by the scientific community.

2.2.6 Toxin Production

Cyanobacteria produce a large variety of toxins with a number of different actions in animals and humans leading to significant health risks and drinking water issues globally (c.f. Chorus and Bartram 1999, Chamichael 2008, Cheung *et al*. 2013). The toxin-producing cyanobacteria, and the suite of different toxins that each species produces, is discussed below.

Toxin-producing taxa

The cyanobacterial toxins were named according to the species that they were originally discovered in and isolated from. For example, microcystin was discovered in *Microcystis aeruginosa* and anatoxin was originally isolated from *Anabaena*. However, most cyanobacteria produce several different types of toxins, with the exception of nodularin which is only produced by *Nodularia spumigena*.

The toxin most widely produced by different cyanobacterial taxa is the recently discovered neurotoxin Beta-N-methylamino-L-alanine (BMAA, Cox *et al*. 2005). This is followed by the microcystins which are produced by nine different taxa (Table 2.2). Chief among the microsystin producing taxa are *Microcystis* (the toxin was originally isolated from *Microcystis aeruginosa*), followed by *Planktothrix* and *Anabaena*. Another widely distributed toxin is anatoxin-a, which is produced by eight different cyanobacterial taxa, principally *Anabaena*, the genus from which the toxin was originally isolated.

Table 2.2.Toxins produced by cyanobacteria. Based on data from Cox *et al.* 2005, Sivonen and Borner 2008, Cheung *et al.* 2013.

	Microcystin	Nodularin	Cylindro-spermopsin	Anatoxin-a	Anatoxina(S)	Saxitoxin	Dermatotoxin	BMAA
Microcystis	X							X
Planktothrix	X			X		X		X
Anabaena	X		X	X	X	X		X
Nostoc	X							X
Anabaenopsis	X							
Radiocystis	X							X
Synechococcus	X							X
Phormidium	X			X				X
Oscillatoria limosa	X			X				
Oscillatoria				X			X	
Nodularia		X						X
Cylindro-spermopsis			X			X		X
Aphanizo-menon			X	X		X		X
Raphidiopsis			X	X				X
Cylindro-spermum				X				X
Lyngbya						X	X	X
Shizothrix							X	
Umezakia natans			X					

Anabaena species, including *flos-aquae*/ *lemmermannii*/ *circinalis*, may be the most toxically versatile of all the cyanobacteria as they can produce all the toxins, including BMAA, microcystins, cylindrospermopsin, anatoxin-a, anatoxin-a(S) and saxitoxins, save nodularin (Table 2.2). Nodularin is only produced by *Nodularia spumigena*. Another versatile toxin producer is *Aphanizomenon flos-aquae* which produces BMAA, cylindrospermopsin, anatoxin-a and saxitoxins (Table 2.2). *Planktothrix* also produces four different toxins including BMAA, microcystins, anatoxin-a and saxitoxins. The cyanobacteria *Cylindrospermopsis raciborskii* from whence cylindrospermopsin was originally isolated also produces saxitoxins (Table 2.2). Benthic cyanobacteria are also versatile when it comes to toxin production. For example, *Oscillatoria limosa* can produce microcystins as well as anatoxin-a while *Lyngbya wollei* can produce saxitoxins and dermatotoxins (Table 2.2).

Toxin types and their biosynthetic pathways

The toxins produced by cyanobacteria can be divided into three main groups: hepatotoxins that damage the liver of the organisms ingesting them, neurotoxins that cause respiratory arrest, and dermatoxins that cause rashes and inflammations. Each is discussed separately below.

Hepatotoxins. The most well-known hepatotoxins are microcystins and nodularin which are serine/threonine protein phosphatase inhibitors (Table 2.3). A large variety of different microcystins (close to 80) have been identified, with the most toxic being microcystin-LR. These cyclic heptapeptides contain seven amino acids, including a unique beta amino acid ADDA (MacKintosh *et al*. 1990, Yoshizawa *et al*. 1990). In contrast with microcystins, only a few varieties of nodularin have been identified (Yoshizawa *et al*. 1990). The toxicity of cyanobacterial toxins is typically measured by injecting them into mice and calculating the lethal dosage to half the population (LD_{50}; Table 2.3).

Biosynthesis of the microcystis and nodularin peptides occurs by non-ribosomal peptide synthases (NRPS) and polyketide synthases (PKS) found mainly in bacteria (Welker and von Dohren 2006). Both of these enzyme classes are needed for both the microcystin and nodularin biosynthesis pathways which have been sequenced from a number of cyanobacterial species including *Microcystis*, *Planktothrix* and *Anabaena* (Borner and Dittman 2005). For example, the *mcyA*, *mcyB* and *mcyC* genes encode the NRPS that synthesize the pentapeptide portion of microcystins. The *mcyD*, *mcyE*, *mcyF* genes encode the PKS which synthesize the ADDA amino acid unique to microcystins. Finally, the *mcyF*, *mcyG*, *mcyH*, *mcyI*, *mcyJ* genes encode the proteins that tailor and transport specific microcystins (Table 2.3). Similarly, the *nda* gene cluster specific to nodularin encode the NRPS and PKS synthases as well as the tailoring and transport proteins (Table 2.3). Although not verified through functional investigations, the cylindrospermopsin gene cluster, encoding the genes *cyrA*, *cyrB*, *cyrC*, has recently been characterized in *Aphanizomenon flos-aquae* (Stuken and Jakobsen 2010).

Table 2.3. Common cyanobacterial toxins. ND: Not determined.

Toxin	Chemical Class	Action	Effect	LD_{50}	Reference	Gene Name	Gene Reference
Micro-cystins	Cyclic heptapeptides; 80 variants; microcystin-LR is most toxic	Serine/threonine protein phosphatase (1 and 2A) inhibitors	Hepatotoxin; damages liver	50 µg kg^{-1}	MacKintosh *et al.* 1990, Yoshizawa *et al.* 1990	*mcyA-I*	Tillett *et al.* 2000, Christiansen *et al.* 2003
Nodularin	Cyclic pentapeptide; only a few variants identified	Serine/threonine protein phosphatase 1 and 2A inhibitor	Hepatotoxin; damages liver	50 µg kg^{-1}	Yoshizawa *et al.* 1990	*ndaA-I*	Moffitt and Neilan 2004
Cylindro-spermopsin	Cyclic guanidine alkaloid	Protein synthesis inhibitor	Hepatotoxin/Cytotoxin; affects liver as well as kidney, spleen, thymus and heart	200 µg kg^{-1} at 6 days 2000 µg kg^{-1} at 24 hrs	Runnegar *et al.* 1994, Terao *et al.* 1994, Ohtani *et al.* 1992	*cyrA-C*	Stuken and Jakobsen 2010
Anatoxin-a	Alkaloid	Competitive inhibitor of acetyl choline	Neurotoxins: causes death by respiratory arrest	200-250 µg kg^{-1}	Devlin *et al.* 1977, Carmichael *et al.* 1990, Skulberg *et al.* 1992	*ana*	Mejean *et al.* 2010
Anatoxin-a(S)	Phosphate ester of cyclic N-hydroxyguanine	Anticholin-esterase	Neurotoxins: causes death by respiratory arrest	20 µg kg^{-1}	Carmichael *et al.* 1990	*ana*	Mejean *et al.* 2010
Saxitoxins	Carbamate alkaloids; the most potent are saxitoxins and neosaxitoxins	Sodium channels blocker	Neurotoxin	10 µg kg^{-1}	Sivonen and Jones 1999	*stxA-Z*	Kellmann *et al.* 2008
BMAA	Non-protein amino acid		Neurotoxin: linked with neuro-degenerative diseases (e.g. Parkinson's Dementia Complex)	ND	Cox *et al.* 2005	ND	
Dermato-toxins	Aplysiatoxins	Protein kinase C activators	Dermatotoxin: tumor promoters; dermatitis and oral/ gastrointestinal inflammations	ND	Mynderse *et al.* 1977, Fujiki *et al.* 1990	ND	

Neurototoxins. By far the most potent toxins are the neurotoxin saxitoxin that causes paralytic shellfish poisoning (PSP) syndrome and respiratory arrest in humans and animals. This neurotoxin is produced both by cyanobacteria and dinoflagellates and is an alkaloid that acts as a sodium channel blocker. Another alkaloid neurotoxin, anatoxin-a, competitively inhibits acetyl choline, and a variant, anatoxin-a(S), acts as an anti-cholinesterase (Devlin *et al*. 1977, Myderse *et al*. al 1977, Carmichael *et al*. 1990, Sivonen and Jones 1999). The LD_{50} of these toxins vary from 200-250 $\mu g\ kg^{-1}$ in the case of anatoxin-a, 20 $\mu g\ kg^{-1}$ in the case of anatoxin-a(S), to 10μg kg^{-1} in the case of saxitoxins (Table 3). The gene clusters encoding the saxitoxin biosynthesis and anatoxin biosynthesis pathways were very recently elucidated via functional homology and each contains 20 or more genes (Kellmann *et al*. 2008, Mejean *et al*. 2010). The recently discovered neurotoxin BMAA, a non-protein amino acid that is potentially linked to neurogenerative diseases such as Parkinson Dementia Complex (PDC), is produced in almost all cyanobacteria tested to date (Cox *et al*. 2005).

Dermatotoxins. Benthic cyanobacteria, including *Lyngbya*, *Oscillatoria* and *Schizothrix*, produce a number of different toxins including aplysiatoxins, debromoaplysiatoxins and lyngbyatoxin-a. These toxins are protein kinase C activators that cause dermatitis and oral and gastrointestinal inflammations, and can also promote tumor formation (Mynderse *et al*. 1977, Cardellina *et al*. 1979, Fujiki *et al*. 1990). The pathways and genes involved with the production of the dermatotoxins have yet to be elucidated.

Potential functions of toxin production

Interestingly, researchers have not been able to determine the purpose of toxin production in cyanobacteria, or under what conditions toxins are most likely to be produced (Sivonen and Borner 2008). Moreover, under environmental conditions cyanobacteria that produce toxins co-exist with cyanobacteria of the same genus that do not produce toxins; it's unclear whether the possession of, or lack of, the toxins confers an ecological advantage (Sivonen and Borner 2008, Baxa *et al*. 2010).

Despite these complications, several explanations for the potential function of toxin production exist. Originally it was thought that cyanotoxins acted as allelochemicals and that their secretion into the surrounding water would suppress the growth of competitors (Keating 1977, Keating 1978, Flores and Wolk 1986, Klein *et al*. 1995). But, when the distribution of toxins, such as microcystins, was compared between cells and the surrounding medium using immunodetection combined with electron microscopy, most of the toxin was found to be cell-bound (Rapala *et al*. 1997, Wiedner *et al*. 2003, Tonk *et al*. 2005, Gerbersdorf 2006). Because, live (i.e. non-lysed) cyanobacteria do not secrete the toxins they produce it is doubtful that they act as allelopathic chemicals. Consistent with this notion, most investigations that demonstrate allelopathic effects do so at concentrations of extracted toxins far above what is ecologically relevant, leading investigators to conclude that the ability of cyanobacterial toxins to work as allelophathic chemicals appears unlikely (Babica *et al*. 2006, Berry *et al*. 2008, Holland and Kinnear 2013).

One explanation that is gaining ground is that the primary role of toxins is probably not to be toxic (Llewellyn 2006). Rather, investigators are hypothesizing that toxins may be produced to protect the cells from abiotic stresses. For example, microcystins are produced during all phases of growth but the greatest accumulation typically occurs under conditions that support optimal growth, including growing under optimal light levels (Sivonen and Jones 1999, Wiedner *et al*. 2003). Several lines of evidence point towards increases in irradiance as being a trigger for microcystin production. These include accumulation of intraceullular microcystin-LR with increased irradiance, the association of intracellular microcystins with the thylakoid membranes, and increased microcystis gene expression with increased irradiance (Kaebernick *et al*. 2000, Tonk *et al*. 2005, Borner and Dittman 2005, Gerbersdorf 2006). As such, it makes sense that microcystins are produced across a number of cyanobacterial taxa, such as *Microcystis*, *Anabaena*, and *Planktothrix*, that grow well in high-light environments (Paerl and Paul 2012).

Microcystins may also be implicated in preventing iron-stress by acting as siderophores to scavenge iron (Utkilen and Gjolme 1995, Lyck *et al*. 1996), an idea supported by the discovery that the iron-regulator factor Fur binds to the genes that produce microcystins in cyanobacteria (Martin-Luna *et al*. 2006). As such, microcystin production may provide an advantage to cyanobacteria in early stages of iron-limiting conditions (Alexova *et al*. 2011, Holland and Kinnear 2013) vis-à-vis eukaryotic competitors (Molot *et al*. 2014).

Another potential role for cyanotoxins is to act as a grazing deterrent (Burns 1987, Gilbert 1996). However, recent research using *Microcystis aeruginosa*, has demonstrated that it's not the toxic microcystins that deters Daphnia from grazing *M. aeruginosa* but other substances it produces. In other words, the substances causing toxicity and deterrence are not identical and the non-toxic substances may be much important in terms of grazing deterrence (Rohrlack *et al*. 1999, 2003).

While the toxic substances are by far the most well-known, there are hundreds of other, secondary metabolites similar in structure to the toxins that are produced by cyanobacteria. Just as the toxins, these cyclic or linear peptides may not be needed for growth but may serve protective functions. For example, the grazing deterrents discussed above belong to a class of depsipeptides called microviridins (originally isolated from *Microcystis viridis*) and has since their isolation been found in a range of cyanobacteria (Rohrlack *et al*. 2003). These secondary metabolites may also have important pharmacological applications. An alkaloid produced by *Nostoc*, called nostocarboline, is a cholinesterase inhibitor which has an effect comparable to galanthamine, a drug approved for Alzheimer's disease (Becher *et al*. 2005). Also isolated from *Nostoc* is a compound called cyanovirin-N which has antiviral activity and is under development as an antiviral agent against HIV (Boyd *et al*. 1997, Bolmstedt *et al*. 2001).

3. FACTORS INFLUENCING CYANOBACTERIAL BLOOMS AND TOXIN PRODUCTION

The world-wide increase in the incidence of cyanoHABs such as the N_2 fixing genera *Anabaena*, *Aphanizomenon*, *Cylindrospermopsin*, and *Nodularia*; the benthic N_2 fixing genera *Lyngbya* and some *Oscillatoria*; and the non-N_2 fixing genera *Microcystis* and *Planktothrix* has prompted a great deal of research into the conditions that favor the growth of these species (Chorus and Bartram 1999; Carmichael 2008; Paerl and Huisman 2008; Hudnell 2008, 2010; O'Neill *et al*. 2012; Paerl and Paul 2012). These conditions typically include favorable salinity, ample supply of nutrients, calm water and stratified conditions, plenty of irradiance and warm water temperatures (Figure 3.1). In contrast, the most successful strategies to mitigate blooms of cyanoHABs include reducing the supply of nutrients, increasing the flow of water to promote mixing and destratify the water column (Figure 3.1). In the following sections, we will focus on the conditions that are favorable for the growth of the cyanoHAB genera.

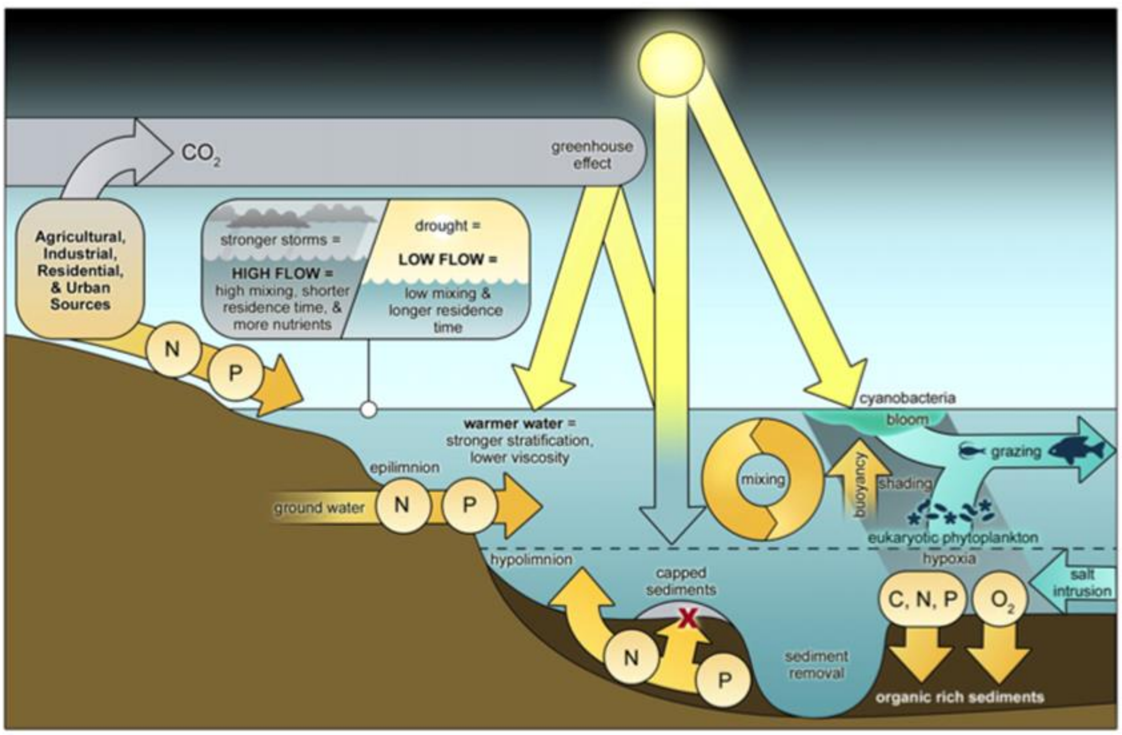

Figure 3.1. Conceptual model of factors affecting cyanobacteria blooms including warmer water, drought and decreased flow, decreased mixing, increased residence time, and increased N and P inputs from agricultural, industrial and urban sources. From Paerl *et al*. 2011.

3.1 Salinity

Most harmful algal bloom-forming and toxin-producing cyanobacteria (cyanoHABs) are freshwater species. In contrast, marine cyanobacteria such as *Prochlorococcus*, *Synechococcus* sp. and *Trichodesmium* sp. are not toxic and do not form cyanoHABs. However, laboratory investigations of freshwater cyanoHAB species demonstrate that these have quite wide salinity tolerance ranges. For example, the least tolerant, *Cylindrospermopsis* only thrives up to 2.5 ppt salinity, but the most tolerant, *Anabaenopsis* and *Nodularia* spp., thrive at salinities from 5-20 ppt (Moisander *et al*. 2002). *Microcystis aeruginosa* tolerates up to 10 ppt salinity without a change in its growth rate compared to that on freshwater (Tonk *et al*. 2007). What these studies suggest is that given optimal growth conditions, these species could also bloom in brackish-water regions. Indeed, recent decades have witnessed a spread in the geographical extent of these species into the mesohaline (5-15 ppt) reaches of coastal systems (Paerl and Paul 2012). For example, blooms of *Microcystis aeruginosa* have occurred in the Baltic Sea (Maestrini *et al*. 1999) and the San Francisco Estuary (Lehman *et al*. 2013) suggesting 1) that factors other than salinity are regulating their geographical distribution and that 2) those factors are currently changing to allow cyanoHAB growth to occur in regions where they previously did not exist. In summary, salinity may not be the strongest "barrier" in terms of restricting the occurrence and geographical distribution of toxic cyanoHABs.

3.2 Nutrient Concentrations and Ratios

As with other photosynthetic phytoplankton, given optimal temperatures and irradiance, cyanobacterial biomass accumulation is directly proportional to the amount of nutrients (N and P) available in the water column. Therefore, strategies to reduce the accumulation of cyanoHAB biomass and severity of their blooms frequently focus on reductions of nutrient concentrations (Paerl 2008).

3.2.1 Influence of N and P Loadings and Concentrations in Stimulating Cyanobacterial Growth

Cyanobacterial growth in freshwater systems (rivers and lakes), which tend to become limited by P sooner than by N, is frequently linked with excessive P loading (Likens 1972, Schindler 1977, Edmondson and Lehman 1981, Elmgren and Larsson 2001, Paerl 2008, Schindler *et al*. 2008). In contrast with freshwater systems, estuarine and marine systems tend to be more sensitive to N loading (Figure 3.2), and eutrophication due to cyanobacterial growth is frequently linked with excessive N loading (Ryther and Dunstan 1971, Nixon 1986, Suikkanen *et al*. 2007, Paerl 2008, Conley *et al*. 2009, Ahn *et al*. 2011).

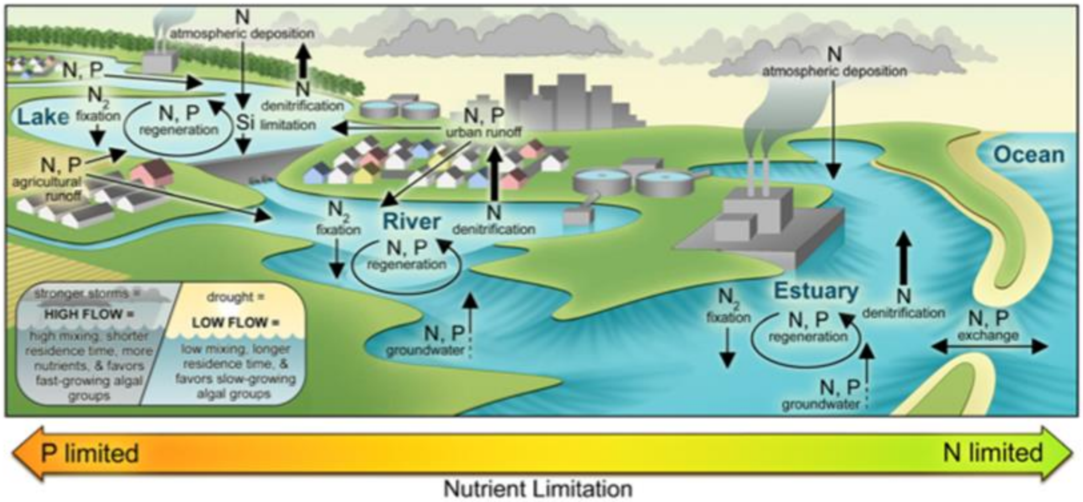

Figure 3.2. Conceptual diagram of interaction of nutrient inputs, cycling processes, and limitation of primary production along the freshwater to marine continuum. From Pearl *et al.* 2014b.

However, both non-point and point source nutrient contributions, such as agriculture and wastewater effluent, tend to increase N and P concentrations simultaneously (Paerl and Paul 2012, Paerl *et al*. 2014b). For example, human population growth-induced intensification of wastewater discharge and agriculture has led to hypereutrophication of China's third largest lake, Taihu (Qin *et al*. 2007). Increased nutrient loads, combined with low water column depth and increased water temperatures, has led to an explosive growth of cyanobacteria and a change in total phytoplankton community composition from being mainly diatom-dominated to being dominated by *Microcystis aeruginosa* (Qin *et al*. 2010, Paerl *et al*. 2014a). Bioassay experiments during summer months when cyanobacterial biomass is at its maximum, and nutrient concentrations at a minimum, demonstrate that N and P exert equal control over biomass accumulation in this system (Paerl *et al*. 2014a).

In general, dominance of both N_2-fixing and non-N_2 fixing cyanobacteria such as *Aphenizomenon flos aquae*, *Nodularia spumigena*, *Microcystis aeruginosa* and *Cylindrospermopsin raciborskii*, have increased world-wide in concert with increased loads of both N and P (Chapman and Schelske 1997, Jacoby *et al*. 2000, Gobler *et al*. 2007, Burford *et al*. 2006, Burford and O'Donahue 2006, Hong *et al*. 2006, Suikkanen *et al*. 2007, O'Neill *et al*. 2012).

3.2.2 Influence of Changes in N:P Ratios on Stimulation or Limitation of Cyanobacterial Growth

At low and intermediate nutrient loadings, reduction in only N or P may be sufficient to control blooms of cyanobacteria. But with elevated loadings of both N and P, reduction of only one type of nutrient can lead to an imbalance in the N:P ratio of the water column potentially leading to a worsening of the cyanoHAB problem, or even lead to a eukaryotic HAB problem (Smith 1983; Paerl 2008; Pearl *et al*. 2011, 2014b).

Low nutrient concentrations

Pioneering studies by Smith (1983, 1990) predicted that phytoplankton community composition would be dominated by cyanobacteria when N:P ratios were < 15, and by eukaryotic phytoplankton when N:P ratios > 20. This was because many nuisance freshwater cyanobacteria that fix N_2 were hypothesized to thrive at very low ambient concentrations of fixed N, therefore at N:P < 15. In comparison, growth rates of eukaryotic phytoplankton that could not fix N_2 were predicted to slow down at N- limiting concentrations, resulting in eukaryotic species becoming outcompeted at N:P < 15. At N:P > 20, growth rates of eukaryotic phytoplankton would not be limited by N and therefore they could dominate phytoplankton community composition (Smith 1983, 1990). These predictions suggested that one could control growth of cyanobacteria by increasing the dissolved N:P ratio above 20. Consequently, many investigators who study lakes with low to intermediate nutrient loadings advocate for reductions in "P only" as a way to control cyanobacterial growth (Schindler 1977, Schindler *et al*. 2008). However, increasing the dissolved N:P ratio >15 becomes less important as a way to control cyanobacterial growth at high concentrations of nutrients, for a number of reasons, including: 1) nutrient concentrations are high relative to biomass and non-limting; 2) the prevalence of N_2 fixation in N_2-fixing cyanobacteria is not as great as initially hypothesized; 3) the cellular N:P ratio of cyanobacteria, and their N requirement, is high; 4) analysis of lake data by several investigators have demonstrated that absolute concentrations of N and P are more important in supporting blooms of N_2 fixing cyanobacteria rather than specific ratios of dissolved N:P.

High and non-limiting nutrient concentrations

In order for changes in nutrient ratios to affect phytoplankton growth, nutrient concentrations must be so low (relative to the phytoplankton biomass) that either P or N will eventually limit their growth rates. In the last decades, both N and P loadings have increased to the point that they exceed the assimilative capacity of the resident phytoplankton in many systems (Chapman and Schelske 1997, Jacoby *et al*. 2000, Burford *et al*. 2006, Burford and O'Donahue 2006, Hong *et al*. 2006, Gobler *et al*. 2007, Suikkanen *et al*. 2007, Paerl 2008, Paerl *et al*. 2011, Dolman *et al*. 2012, O'Neill *et al*. 2012, Paerl and Paul 2012, Paerl *et al*. 2014a). Therefore, changes in the N:P ratio have little effect on the growth of any of the phytoplankton taxa present in the water column (Paerl 2008, Davidson *et al*. 2012, but see also Glibert *et al*. 2011 with respect to diatoms).

Prevalence of N_2 fixation

An assumption that must be met in order that N_2 fixing cyanobacteria dominate the community at low N:P ratios (and N limiting conditions) is that they mostly use N_2 gas rather than fixed N for growth. However, investigations demonstrate that the proportion of the N demand of N_2

fixers that is met by N_2-fixation is typically less than 25% (Levine and Lewis 1987, Findlay *et al*. 1994, Laamanen and Kuosa 2005). For example, in Baltic Sea phytoplankton communities dominated by the N_2 fixers *Aphanizomenon flos aquae* and *Nodularia spumigena*, less than 20% of N utilization is due to N_2 fixation under N-limiting conditions (Sorensson and Sahlsten 1987; Berg *et al*. 2001, 2003; Laamanen and Kuosa 2005). As mentioned in section 2.2.4, N_2 fixation is repressed in the presence of NH_4^+; culture studies of the N_2 fixing cyanobacterium *Cylindrospermopsis raciborskii* demonstrate that N_2 fixation is shut down in the presence of NH_4^+ and that it's competitive for fixed N (Sprosser *et al*. 2003, Moisander *et al*. 2008). Based on a wide range of investigations, the assumption that most of the N demand of cyanobacteria is met by N_2 fixation does not hold.

Cellular N:P composition

As discussed above (Section 2.2.5), the cellular N:P requirement of cyanobacteria is greater than any other eukaryotic group due to the large protein demand of the peripheral light harvesting antennae. At N-limiting conditions, cyanobacteria would need to provide most, if not all, of their N demand by N_2 fixation in order to meet their high tissue N demand. This would lead to a sharp divide in the distribution of genera that fix N_2 from those that do not; the latter group would be much better suited to dominate high N:P ratio (>25) than low N:P ratio environments. On the flip side, many genera of eukaryotic phytoplankton, such as diatoms and dinoflagellates, have relatively high tissue P requirements and have cellular N:P ratios <16 (Geider and LaRoche 2002, Quigg *et al*. 2003, Hillebrand *et al*. 2013) rendering them better suited for environments with N:P <16 (Arrigo *et al*. 1999, Mills and Arrigo 2010). Based on their cellular N:P ratios, cyanobacteria are better suited to dominate high N:P ratio systems (>25) and some eukaryotes low N:P ratio systems (<16) which is opposite of the conclusions reached by Smith (1983).

Confounding factors

Because the height of a phytoplankton bloom, including blooms of N_2 fixers, frequently coincides with a depletion in N and N:P <15, it is often assumed that the major control on the cyanobacteria is the nutrient ratio, rather than the other way around. Additionally, there may be time lags between nutrient uptake and increased biomass such that a correlation between the two variables at a given point in time may not imply causality. Blooms of N_2 fixers also coincide with a warm, stratified water column coupled with adequate or high irradiance. Because all these parameters (warm water, high irradiance, stratification, depletion of N, overall increase in Chl *a*) occur in concert, it's difficult to separate out the impact of nutrients from other co-occurring environmental variables in order to quantify the most important effect on increases in cyanobacterial biomass. Investigations that separate out the effect of changes in absolute concentrations from ratios, find that changes in absolute concentrations of nutrients, or changes in total Chl *a* biomass, are more strongly related to changes in cyanobacterial biomass than changes in the ratio of N:P (Trimbee and Prepas 1987, Downing *et al*. 2001, Dolman *et al*. 2012).

Meta analyses of Lake Studies

Consistent with the problems of assigning shifts in phytoplankton community composition to changes in N:P ratios described above, Trimbee and Prepas (1987) and Downing *et al*. (2001) demonstrated that changes in cyanobacterial biomass was more strongly associated with changes in the absolute concentrations of N and P than with changes in the dissolved N:P ratio in 99 different freshwater systems. In a study of 102 lakes in Germany, Dolman *et al*. (2012) found that the more enriched in both N and P the lakes were, the greater was their total cyanobacterial biomass. The cyanobacterial taxa that responded most to nutrient enrichment included *Planktothrix agardhii*, *Microcystis* and *Anabaenopsis*. Moreover, differences between cyanobacterial taxa were not consistent with the hypothesis that N fixing taxa were favored in low N:P conditions as the greatest biomass of *Aphaenizomenon* and *Cylindrospermopsis raciborskii* were found lakes with the greatest N:P ratios (Dolman *et al*. 2012).

3.2.3 Influence of Type of N on Growth of Cyanobacteria

As previously mentioned, NtcA is central in cyanobacterial N regulation and is under negative control by NH_4^+ (Section 2.2.4). Other than NH_4^+-transporters, transcription of all N related enzymes requires binding of the NtcA transcription factor in order to be transcribed. Therefore, uptake and metabolism of sources other than NH_4^+ does not take place unless NH_4^+ is at limiting concentrations (Lindell and Post 2001, Lindell *et al*. 2005). In contrast, NH_4^+ transporters are constitutively expressed, or always "on", regardless of external concentration of NH_4^+ (Berg *et al*. 2011). In addition, the *amt1* NH_4^+ transporter gene is one of the most highly expressed in cyanobacterial genomes. In the marine cyanobacteria *Synechococcus* and *Prochlorococcus*, *amt1* is expressed on par with, or at a greater level, respectively, than the gene encoding the C-fixation enzyme Rubisco (Berg *et al*. 2011). Considering the countless other critical processes happening within cells, it is noteworthy that the protein responsible for NH_4^+ uptake is one of the most abundant proteins in cyanobacteria.

Given that NH_4^+ exerts such a strong control over the use of other N sources in cyanobacteria, is the preference for NH_4^+ reflected in different rates of growth on different N sources? There is no clear answer to this question. From a theoretical perspective it should not be the case because the magnitude of reductant and ATP needed for carbon fixation dwarfs the energetic costs of N assimilation, even assimilation of "expensive" sources such as NO_3^- or N_2 gas (Turpin 1991). The type of N should not affect the rate of growth other than under conditions of very low irradiance where assimilation of NO_3^- may compete with carbon fixation for reductant and ATP, thereby lowering the growth rate (Turpin 1991). Culture investigations appear to bear this out as faster rates of growth are typically not observed when cyanobacteria are grown on NH_4^+ versus NO_3^- (i.e. Berman and Chava 1999, Hawkins *et al*. 2001, Post *et al*. 2012, Saker and Neilan 2001, Solomon *et al*. 2010). Differences in growth rates when growing on NO_3^- versus on NH_4^+ are frequently detected for individual strains (i.e. Saker and Neilan 2001), but there is no pattern that can be generalized with respect to cyanobacteria as a whole. Even within the same species, some strains may be growing faster on NH_4^+ and some on NO_3^-, but the difference with N source in most cases is smaller than the difference in growth rate among different strains (Figure 3.3). Therefore, observations of fast growth of cyanobacteria using NH_4^+ in the field are most likely due to 1) factors that promote fast growth of cyanobacteria generally (i.e. high temperature and high irradiance) combined with 2) high enough availability of NH_4^+ such that NtcA is repressed and only NH_4^+ is taken up and utilized by the cell.

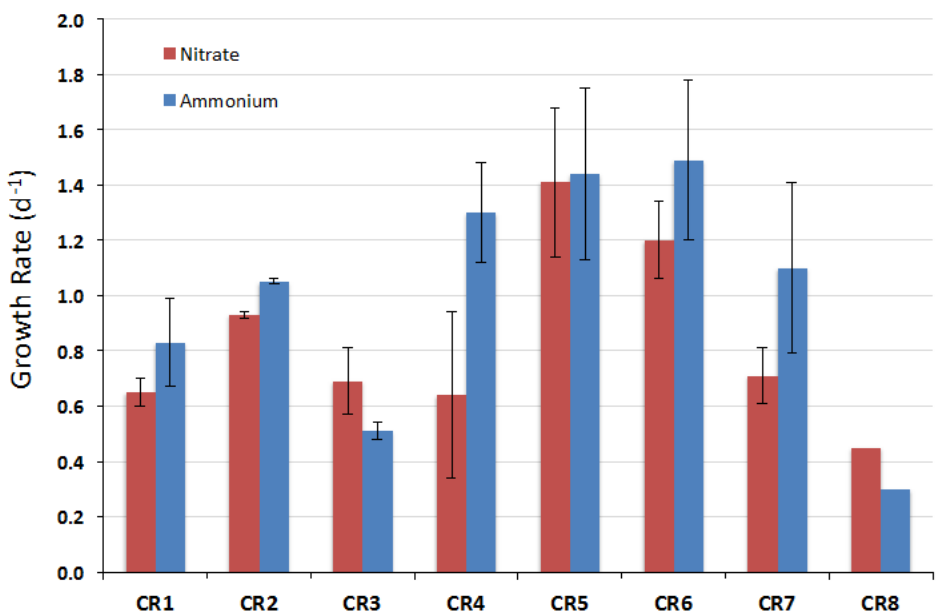

Figure 3.3. Difference in growth rates of *Cylindrospermopsin raciborskii* when growth on NO_3^- (red bars) versus NH_4^+ (blue bars) for eigth different strains. Data from Saker and Neilan 2001 and Stucken *et al.* 2014.

3.3 Irradiance and Water Clarity

Cyanobacteria have a distinct advantage with respect to other photosynthetic organisms in the amount of carotenoid pigments per cell volume (Section 2.2.2). These pigments serve a photoprotective function by dissipating excess light energy when required allowing cyanobacteria to be exposed to high irradiances without experiencing photoinhibition (Paerl *et al*. 1983, 1985). Recent investigations also demonstrate that the toxic peptides produced by cyanoHAB species accumulate in the thylakoid membranes potentially serving a role in photoprotection of the cells (Kaebernick *et al*. 2000, Borner and Dittman 2005, Gerbersdorf 2006). Interestingly, many cyanoHAB species are not strong competitors for light in a well-mixed environment due to their poor light absorption efficiency (Huisman *et al*. 1999, Reynolds 2006). Among the cyanoHAB species tested to date, *Microcystis* appears to possess the least efficient rate of photosynthesis for a given light intensity (Figure 3.4). The upshot of these traits is that cyanobacteria grow ineffectively at low and mixed light, but very effectively when exposed to high light, particularly the toxic peptide-producing varieties (Huisman *et al*. 2004, Reynolds 2006, Carey *et al*. 2012).

Aided by their positive buoyancy, cyanobacteria such as *Microcystis*, can grow very close to the surface by tolerating irradiance levels that are inhibitory to other members of the phytoplankton community. As a result, these cyanobacteria can increase their cell densities past the point where they would ordinarily become light-limited by self-shading. Growing close to the surface can also help cyanobacteria avoid light limitation if there is a high concentration of suspended sediment matter in the water. In contrast, phytoplankton than are not positively buoyant can become shaded by the cyanobacteria growing at the surface (Carey *et al*. 2012).

In contrast with *Microcystis* and *Aphanizomenon*, other cyanoHAB species such as *Cylindrospermopsis raciborskii* and *Planktothrix* sp. are good competitors at low light. Cultures of *C*. *Raciboskii* can grow at optimal rates at very low irradiances (Briand *et al*. 2004, Dyble *et al*. 2006, Wu et al. 2009) and it grows well in deep water columns where it's exposed to fluctuating light levels as it mixes from the surface to the bottom (McGregor and Fabbro 2000, Burford and Donohue 2006, O'Brien *et al*. 2009). Not only is the rate of photosynthesis in *C*. *raciborskii* efficient at low irradiances, it's also efficient at high irradiances, making this a very versatile cyanoHAB species (Figure 3.4).

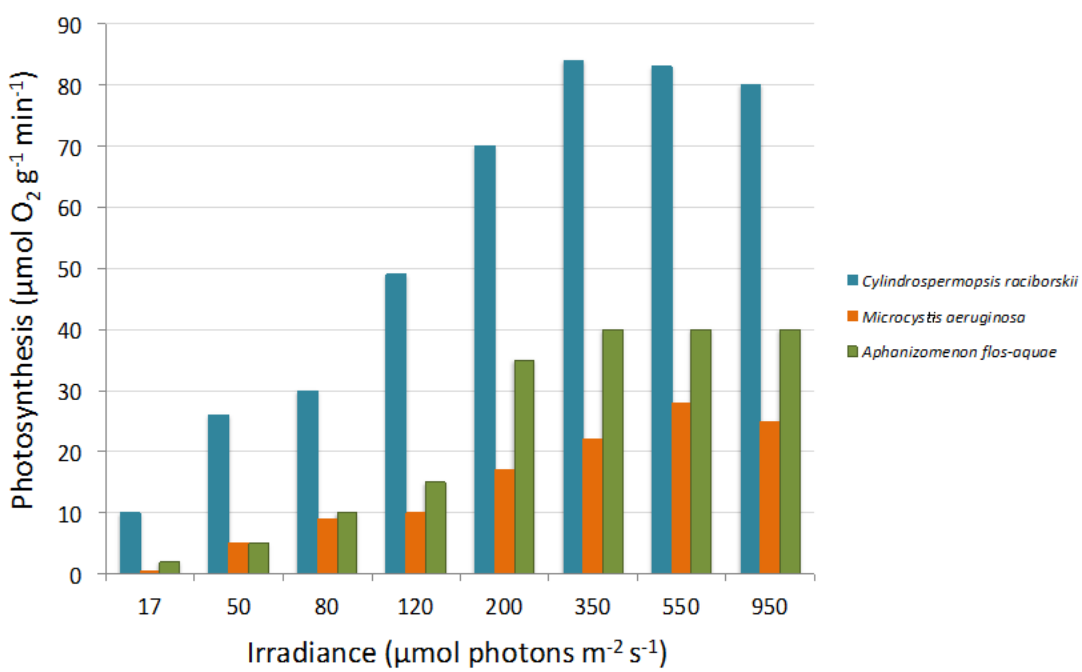

Figure 3.4. Photosynthesis as a function of irradiance in three cyanoHAB species. Data from Wu *et al.* 2009.

3.4 Factors Impacting Toxin Production and Degradation

While a large number of different toxins are produced by cyanoHAB species, the literature is heavily tilted towards investigations of factors impacting the production and degradation of microcystins. Therefore the information presented here is focused on microcystin-LR.

3.4.1 Toxin Production

Just as there is substantial discussion surrounding the purpose of toxin production in cyanobacteria, the conditions under which toxin production is enhanced is also vigorously debated. Previous studies have concluded that the greatest intracellular toxin concentrations are detected under favorable growth conditions, including high irradiance as discussed above, with maximal toxin production occurring at maximal rates of cell division and in late log phase (Watanabe and Oishi 1985, Orr and Jones 1998, Sivonen and Jones 1999, Van Der Westhuizen and Eloff 1985).

Investigations specifically focused on changes in nutrient concentrations and ratios, demonstrate that microcystin content reaches a maximum under maximum growth rates, regardless of medium N:P ratio, but that the microcystin content of the cells correlates with total cellular N and protein content (Lee *et al*. 2000, Vezie *et al*. 2002, Downing *et al*. 2005). These results make sense as the toxins, being peptides, require ample N in order to be synthesized. Consistent with this, total toxin production per cell decreases at N-limiting concentrations (Tonk *et al*. 2008).

Not only does toxin concentration per cell vary in strains that produce toxins (i.e. are toxigenic), but natural populations are typically comprised of a mix of toxigenic and non-toxigenic strains of the same species. It is also of interest to know whether the proportion of toxigenic:non-toxigenic strains within a population changes with nutrient concentrations or ratios. Laboratory culture investigations comparing growth of toxigenic and non-toxigenic strains of *Microcystis* demonstrated that toxigenic strains of *Microcystis* grew faster than non-toxigenic strains at N concentrations of 6000 µmoles L^{-1} and at N:P ratios >> 200 (Vezie *et al*. 2002). The reason for this is not clear, but could include microcystin conferring protection from NO_3^- toxicity in the toxin-producing strains at such unnaturally high concentrations of NO_3^-.

While results obtained with unnaturally high nutrient concentrations and ratios do not easily translate to natural systems, a nutrient enrichment bioassay investigation has demonstrated that toxigenic strains within a *Microcystis* population were promoted to a greater degree with N (and P) additions than non-toxigenic strains (Davis *et al*. 2010). However, the pattern of selective stimulation of toxigenic strains with increased nutrient concentrations is not evident in natural communities which typically exhibit a high degree of variability across small spatial scales in the proportion of toxigenic:non-toxigenic strains within a population. This variability appears not to be related to nutrient concentrations or ratios which do not exhibit the same spatial variability (Vezie *et al*. 1998, Baxa *et al*. 2010, Mbedi *et al*. 2005, Dolman *et al*. 2012).

3.4.2 Toxin Degradation

Together with labile dissolved organic carbon, toxins are rapidly degraded by the natural microbial community following sedimentation (and subsequent release of cellular material) of a cyanobacterial bloom (Jones *et al*. 1994, Rapala *et al*. 2005). In addition to non-specific degradation by the whole community, specific degradation of toxin peptides occurs due to bacteria belonging to the *Sphingomonadaceae* family (Bourne *et al*. 1996, 2001), and other more recently discovered families (Rapala *et al*. 2005, Yang *et al*. 2014). Bacteria that degrade microcystins may also degrade nodularin (Rapala *et al*. 2005). The predominance of these specialized bacteria in the microbial community may determine the length of time it takes (i.e. lag period) before bacterial degradation of toxins takes place. For example, Rapala *et al*. (1994) found the lag time decreased in waters with previous cyanobacterial blooms, compared with no previous cyanobacterial blooms, presumably due to a greater proportion of toxin-degradading bacteria in the former environment. Once degradation of toxin commences, it proceeds rapidly and toxin concentrations typically decrease in an exponential fashion (Figure 3.5), with a loss rate of 0.5 to 1 d^{-1}, corresponding to a half-life of only one day (Christoffersen *et al*. 2002, Jones and Orr 1994). While 95% of the toxins may be degraded within the first 3 days, a more recalcitrant fraction may remain for 20 days or more (Jones and Orr 1994). Other sinks for microcystin-LR include UV degradation (Tsuji *et al*. 1995), and adsorbtion onto clay particles (Morris *et al*. 2000). In the absence of bacteria, clay particles and UV light, microcystins are very stable in the environment and degrade slowly. At temperatures below 40°C the half-life of microcystin toxin increases to 10 weeks; this conservative estimate is used by the Office of Environmental Health Hazard Assessment to determine the risk of the toxin to wildlife (OEHHA 2009). Because there probably exists a great deal of variation in the relative importance of biological, chemical and physical processes in the degradation of microcystins depending on location, accounts in the literature regarding the half-life and recalcitrance of cyanoHAB toxins tend to be conflicting (i.e. Jones and Orr 1994, Gibble and Kudela 2014). Added to this uncertainty is the difference in toxin concentrations obtained using different methods of measurements (See Section 4.2.3 below).

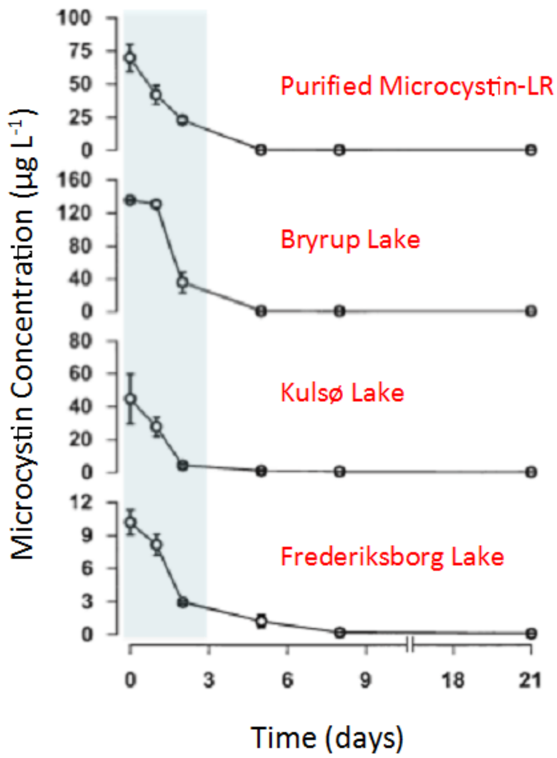

Figure 3.5. Concentration of dissolved microcystin-LR equivalents in bioassays as a function of time after addition of purified microcystin (top panel) or lysed bloom material (bottom 3 panels) to lake water containing natural microbial assemblages. Shaded area corresponds with time period of degradation of 95% of original microcystin concentration. Data from Christoffersen *et al.* 2002.

3.5 Temperature

Perhaps one of the most important factors in controlling the growth rate of cyanobacteria is temperature (Robarts and Zohary 1987, Butterwick *et al*. 2005, Reynolds 2006, Paerl and Huisman 2008). Cyanobacteria isolated from temperate latitudes (i.e. excluding polar regions) typically have temperature growth optima between 25 and 35°C (Reynolds 2006, Lurling *et al*. 2013). For example, in a survey of eight cyanobacteria the growth optima of two *Microcystis aeruginosa* strains were 30-32.5°C and that of *Aphanizomenon gracile* was 32.5°C. Lower growth temperature optima were observed in *Cynlindrospermopsis raciborskii* and *Planktothrix agardhii*, both at 27.5°C while *Anabaena* sp had an optimum of 25°C (Lurling *et al*. 2013). The optima of these freshwater HAB-forming cyanobacteria are greater than for marine cyanobacteria which typically have growth temperature optima ranging from 20-27.5°C (Breitbarth *et al*. 2007, Boyd *et al*. 2013).

Compared with other phytoplankton taxa, cyanobacteria typically demonstrate lower growth rates at colder temperatures and higher growth rates at higher temperatures. For example, diatoms typically have a 6-fold higher growth rate at 15°C, 3-fold higher growth rate at 20°C and a similar growth rate at 25°C, compared with cyanobacteria (Figure 3.6). Growth rates of dinoflagellates typically peak at 25°C. Above 25°C both chlorophytes and cyanobacteria have faster growth rates than diatoms and dinoflagellates (Figure 3.6). The difference in the optimum growth temperatures of the various phytoplankton taxa is hypothesized to become increasingly important in determining phytoplankton community composition as global temperatures continue to increase above 20°C (Lehman *et al*. 2005, Paerl and Huisman 2008). For example, the acceleration of growth rate with a 10°C increase in temperature (Q_{10}) commonly varies from 1-4 for cyanobacteria and 1-3 for chlorophytes (Reynolds 2006). However, it varies from 4-9 for *M. aeruginosa*, the highest recorded for any phytoplankton (prokaryotic or eukaryotic) species (Reynolds 2006). These data suggest that in a mixed phytoplankton assemblage, all else being equal, cyanobacteria will be able to grow faster and outcompete other phytoplankton taxa as the temperature increases. With continued climate change and global warming, there's an increased risk that cyanoHABs will become increasingly competitive vis-à-vis diatoms which often dominate community composition in temperate regions.

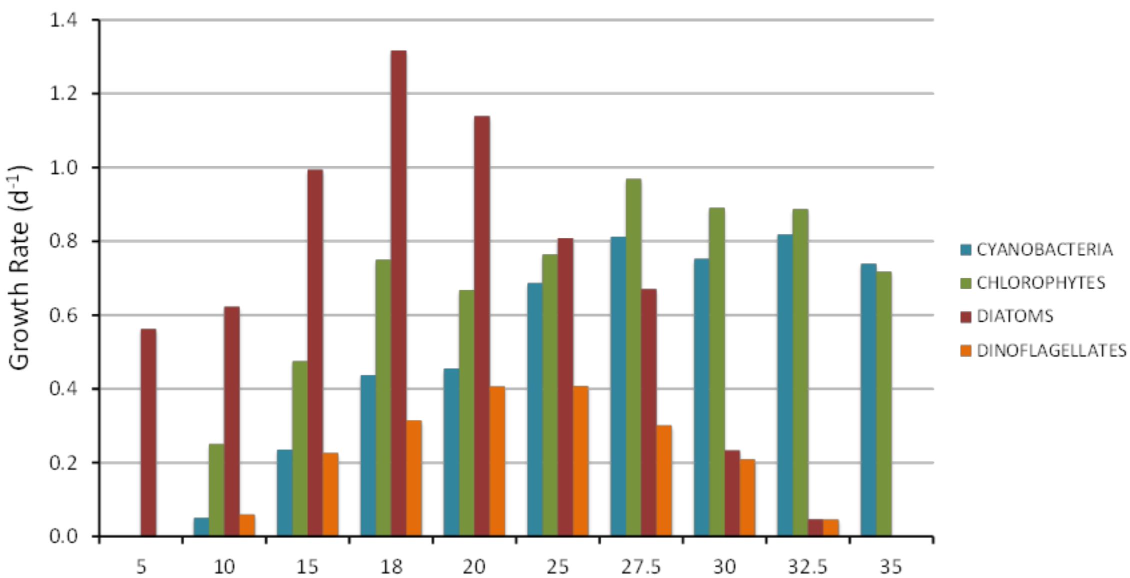

Figure 3.6. Changes in growth rate with temperature for diatoms (red ± 0.35 d^{-1}, T_{opt}= 20 ± 1.8 °C), Chlorophytes (green ± 0.21 d^{-1}, T_{opt}= 29 ± 3.8), Cyanobacteria (cyan ± 0.13 d^{-1}, T_{opt}=29 ± 4.5) and dinoflagellates (orange ± 0.1 d^{-1}, T_{opt}= 21 ± 2.8). Data from Kudo *et al.* 2000, Butterwick *et al.* 2005, Yamamoto and Nakahara 2005, Boyd *et al.* 2013, Lurling *et al.* 2013.

3.6 Stratification and Residence Time

3.6.1 Stratification

CyanoHAB blooms tend to occur during times of calm, stratified water columns (Huber *et al*. 2012). The degree of statification and water column stability increases with increased temperature, therefore stratification and temperature are closely linked (Paerl and Huisman

2008). The reasons that stratified conditions promote blooms of cyanobacteria are at least three-fold. First, growth rates will increase as a result of the increase in the temperature in the top layer of the water column. Second, cyanobacteria will remain in the top layer of the water column where irradiance is greater, and not become mixed down to the bottom and into lower light, allowing them to maintain higher growth rates. Third, stratification may be a sign of increased residence times (reduced flushing rates), which minimizes loss of cyanobacterial biomass from the system and allows cyanobacteria to use all the nutrients available in the water column (Jeppesen *et al*. 2007). In other words, it's likely that stratification does not directly promote cyanobacterial blooms, but rather it promotes blooms indirectly through increased temperatures, irradiance and reduced loss rates (Elliott 2010).

3.6.2 Residence Time

Because residence time is determined by the flushing rate, the direct effect of increased residence time is to decrease the loss rate of cyanobacteria (Romo *et al*. 2013). Indirect effects of residence time are the same as those for stratification; this is because residence time and stratification typically covary such that stratification is maximal when residence time is minimal, and vice versa. Studies that report on the effect of residence time suggest that cyanobacterial abundance, cell size and toxin concentration are positively related to increased residence time (Elliott 2010, Romo *et al*. 2013).

3.7 Other Factors

Additional to the above-mentioned factors, a number of others may influence cyanobacterial blooms including grazing by higher trophic levels and exposure to toxic compounds such as herbicides and pesticides. Grazing in the Delta region is dominated by *Corbicula fluminea* (Jassby 2008). It is not known to what extent *C. fluminea* impacts cyanoHAB species versus the rest of the phytoplankton community in the Delta. The same is true for grazing by zooplankton. Another factor that may differentially impact cyanoHAB species versus the rest of the phytoplankton community is resistance to herbicides and pesticides. Investigations demonstrate substantial variability in sensitivity to herbicides of cyanobacteria compared with other phytoplankton such as green algae and diatoms (Peterson *et al*. 1997, Lurling and Roessink 2006)

4. PREVALENCE OF CYANOHABS AND POTENTIAL FOR EFFECTS ON ECOSYSTEM SERVICES IN THE DELTA

The Sacramento-San Joaquin Delta (hereafter Delta) is formed at the intersection of two of California's largest rivers, the Sacramento and the San Joaquin Rivers, and contains 700 miles of sloughs and waterways that drain 47% of the runoff in the State of California (Figure 1.1). The land surrounding the waterways is composed of 57 leveed island tracts, many of which provide wildlife habitat. In the Delta, freshwater from the rivers mix with saltwater from the San Francisco Bay; together the Bay and the Delta form the West Coast's largest estuary.

4.1 Ecosystem Services

The Delta region has many ecosystem services including agriculture, drinking water supplies, and wildlife habitat, all of which translate directly to the beneficial uses designated in the Water Board Basin Plan (Appendix A). The population surrounding the Delta region, numbering 500,000 people, is principally engaged in agriculture and produce crops that bring in revenues exceeding $500 million annually. While there is some local demand on the water from the Delta, most of the water is distributed via the State Water Project and Federal Central Valley Projects to the Central Valley to irrigate farmland and to provide drinking water to Southern California (http://www.water.ca.gov/swp/delta.cfm). According to the California Department of Water Resources, about two thirds of Californians and millions of acres of irrigated farmland rely on the Delta for their water. Besides acting as a source of drinking water, the Delta is a popular recreation spot and many people use it for sport fishing.

In addition to the human demand, the Delta supplies critical habitat to a large wildlife ecosystem and intersects migration paths for several fish species, including salmon, traveling between the Pacific Ocean and the Sacramento River and beyond. This habitat is in a fragile state with close to 20 of its endemic species listed as endangered. A recent and unexpected decline in four pelagic fish species including the endangered Delta Smelt and the Longfin Smelt, as well as juvenile-Striped Bass and Threadfin Shad, has caused concern among resource managers and renewed calls for conservation of the fragile Delta ecosystem (Sommer *et al*. 2007).

Set against this backdrop of competing resource use by human populations and wildlife, a new threat to Delta ecosystem services and designated beneficial uses is emerging in the form of toxic cyanoHABs. The impact of toxic cyanobacteria on the aquatic ecosystem differs widely depending on whether their density is low or high. At low concentrations, they are not dense enough to affect light penetration or dissolved O_2 concentration; therefore, they do not affect the growth of other members of the aquatic community. However, even at low concentrations toxins released (upon death and cell lysis, or by grazing) can accumulate in tissues of higher trophic levels (Lehman *et al*. 2010). At high densities, cyanoHABs increase the turbidity of the water column to the point where light penetration is severely restricted suppressing the growth of other phytoplankton, macrophytes, and benthic microalgae (Jeppesen *et al*. 2007, Paerl and Paul 2012). CyanoHABs also can cause night-time dissolved oxygen depletion via bacterial decomposition and respiration of dense blooms which results in fish kills and loss of benthic fauna (Paerl 2004, Paerl and Fulton 2006). At dense concentrations, mortality to aquatic animals such as sea otters, birds and seals may result from liver failure following ingestion of prey with high concentrations of toxin, or coming into physical contact with the toxin (Jessup *et al*. 2009, Miller *et al*. 2010). Humans coming in contact with the water may develop digestive and skin diseases (Section 2.2.6) and it may affect the drinking water supplies (Cheung *et al*. 2013). In the following sections, cyanoHAB abundance and toxin levels in the Delta vis-à-vis published guidance on alert levels are summarized in order to place the threat of cyanoHABs in the Delta into context.

4.2 Prevalence and Trends of CyanoHABs in the Delta

Since 1999 blooms of the toxin producing cyanobacteria *Microcystis aeruginosa* in the Delta have been observed by the Department of Water Resources (DWR), and have been reported in the scientific literature. In the beginning, only blooms of *Microcystis* were observed; these were documented visually appearing as little flakes of lettuce in the water (Lehman and Waller 2003). Later investigations (post 2005) employing microscopic enumeration and molecular characterizations have documented blooms comprised of a mix of *Aphanizomenon* sp. and *Microcystis*, with *Anabaena* sp. also present in much smaller densities (Lehman *et al*. 2010, Mioni *et al*. 2012).

While environmental indicators such as salinity, turbidity, temperature, total phytoplankton biomass (as Chl *a*), and phytoplankton species composition are monitored on a monthly basis by DWR, surface concentrations of cyanobacteria and cyanotoxins, which require special sampling, are not routinely monitored. As such, the information on the chronology of cyanoHAB occurrences presented here is taken from a handful of publications and reports, and varies somewhat in geographical extent according to where the authors sampled. Because *Aphanizomenon* and *Anabaena* densities have only been documented for two time points, the following sections will focus on *Microcystis* biomass and microcystin toxin concentrations. Additionally, these sections will focus on aquatic health rather than human health whose risks may be better evaluated from sampling of surface scums.

4.2.1 Spatial Distribution of Microcystis throughout the Delta

The Central Delta, between Antioch and Mildred Island, is typically the region with the highest surface *Microcystis* and *Aphanizomenon* concentrations. In 2003, the stations with the greatest recorded abundance of Chl *a* due to *Microcystis* (as determined by horizontal surface tows with a 75-µm mesh plankton net) were Jersey Point (D16), Mokelumne River Mouth and Navigation Marker 13 in the San Joaquin River, followed by San Mound Slough, Mildred Island, (D29) and Rancho del Rio (D28) in Old River (Figure 4.1). In following years, greatest abundance of

Microcystis has repeatedly occurred in the same areas in the San Joaquin and Old Rivers (Lehman *et al*. 2008, Mioni *et al*. 2012, Lehman *et al*. 2013). In 2012, abundant *Microcystis* colonies were also observed in the South-East Delta region in the Turning Basin of the Stockton Shipping Channel (Spier *et al*. 2013). Moving west from Antioch into Suisun Bay, *Microcystis* abundance decreases substantially to almost non-detectable by Chipps Island (Lehman *et al*. 2005, 2008, 2010). The same holds true when moving north where abundances detected at Antioch decline to almost zero by Collinsville at the entrance of the Sacramento River (Figure 4.1).

Whether or not the spatial distribution of *Microcystis* and other cyanoHAB species is affected favorably or unfavorably by concentrations of herbicides entering the Delta as run-off, or from the Sacramento and San Joaquin Rivers is not known. Recent reports suggest that a broad swath of herbicides and fungicides associated with agriculture is present at concentrations high enough to affect aquatic life (Orlando *et al*. 2014). As such, the impact of herbicides common to the Delta in selectively promoting certain phytoplankton species, including possibly cyanoHAB species, may deserve greater attention.

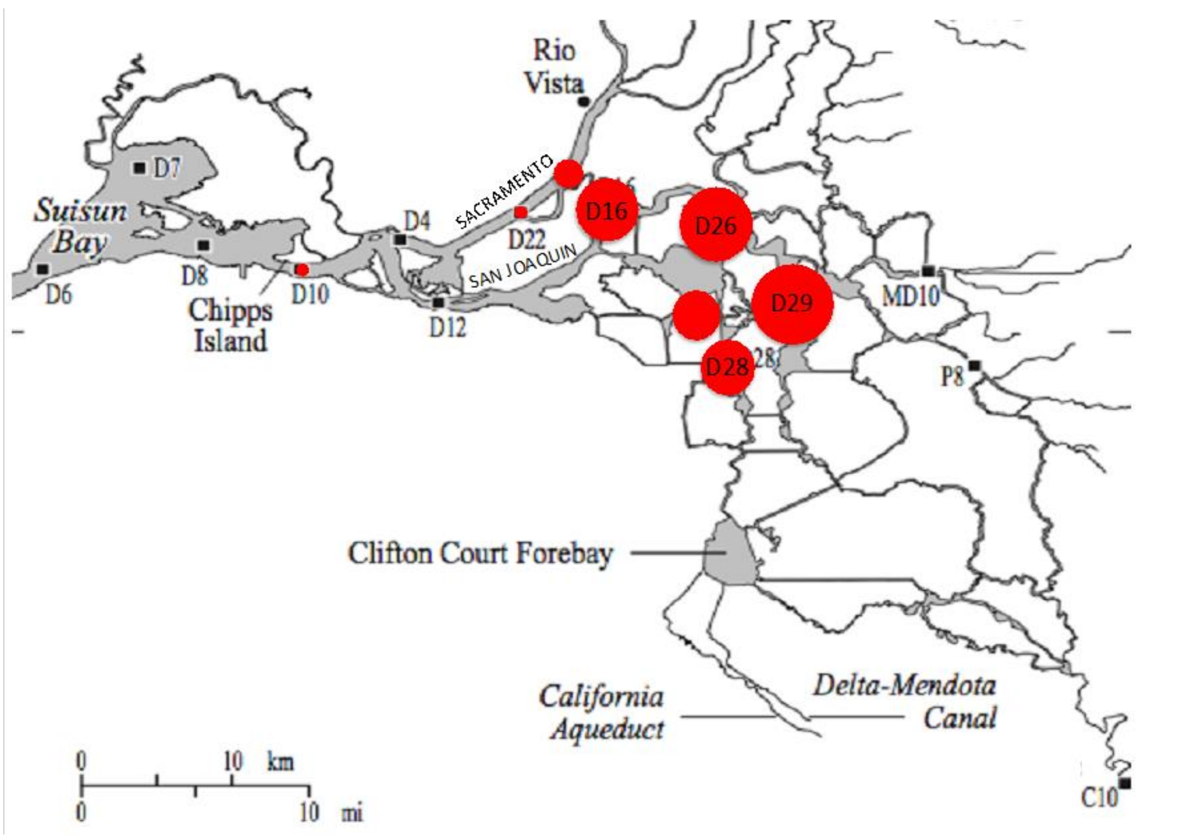

Figure 4.1. The Sacramento-San Joaquin Delta Region. Red bubbles mark locations with greatest Microcystis-associated surface Chl a concentrations (largest bubble=0.55 μg Chl a L^{-1}). Data from Lehman *et al.* 2005.

4.2.2 Interannual variability in Microcystis biomass in the Delta

Since 2003, *Microcystis* cell abundance in depth-integrated surface waters has varied from 4-40×10^{3} cells mL^{-1} in the Delta (Lehman *et al*. 2008. The biomass (as surface Chl *a*) has also varied approximately 10-fold (Figure 4.2). Not only is *Microcystis* biomass patchy between years, its distribution in the years that it blooms is also variable. Even within a station, the distribution of *Microcystis* colonies is patchy, as evidenced by the low concentration of surface Chl *a*, sampled with horizontal net-tows normalized to total towed volume, which to date has not been above 0.6 µg Chl a L^{-1} (Figure 4.2). In the years following 2005, *Microcystis* was also present in the phytoplankton community together with *Aphanizomenon flos-aqua*, and to a lesser extent *Anabaena* sp. (Lehman *et al*. 2008, Mioni *et al*. 2012).

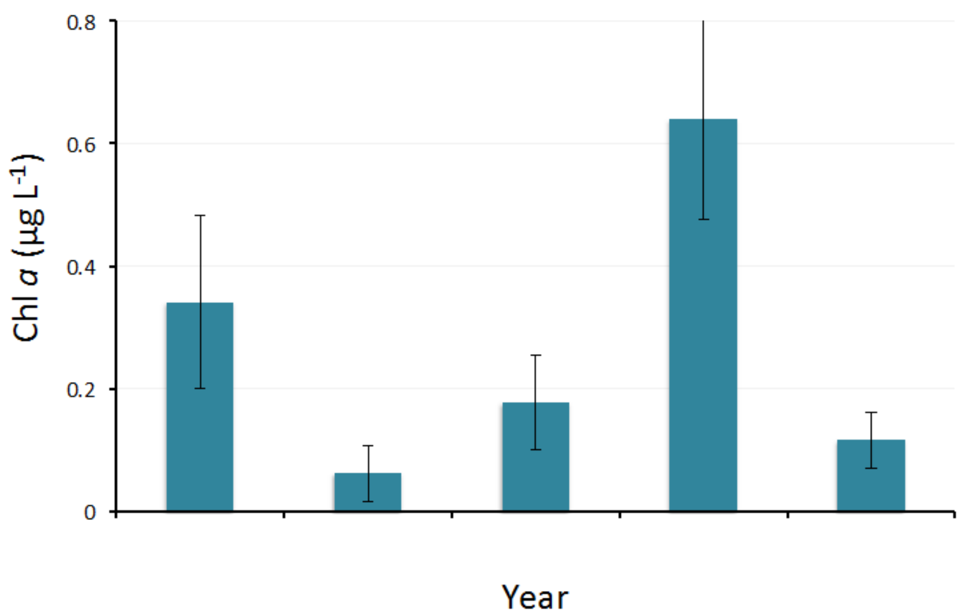

Figure 4.2. Interannual changes in surface Chl a due to abundance of Microcystis colonies. Means and standard deviations of 9 different stations in the San Joaquin River (Antioch (D12), Jersey Point (D16), Frank's Tract (D19), Potato Point (D26), Prisoners Point (D29), San Joaquin River at Turner Cut, Sand Mound Slough, Mildred Island, and Old River at Rancho del Rio (D28). Data from Lehman *et al.* 2005, 2013.

In addition to a high degree of horizontal variability, *Microcystis* cell densities and biomass also varies vertically in the water column, decreasing from the surface to almost zero at 1 m depth. The density of *Microcystis* in surface waters at the Central Delta Stations does not affect phytoplankton community composition in a measurable way. For example, at four stations where *Microcystis* dominated abundance of phytoplankton at the surface, the communities at 1m depth was a variable mix of different species of phytoplankton that was equally variable at stations containing no *Microcystis* in the surface. Rather than decreasing, the biomass of other phytoplankton taxa increased in tandem with increasing *Microcystis* biomass (Lehman *et al*. 2010).

Compared with lakes widely recognized for severe CyanoHAB problems, *Microcystis* (and other cyanoHAB species) biomass appears low. For example, in Clear Lake spring and early summer Chl *a* concentrations average 11.5±8 µg Chl *a* L^{-1} but increase to 352±295 µg Chl a L^{-1} in the summer once *Microcystis* starts to bloom (Figure 4.4). Here, *Microcystis*-associated Chl *a* concentration is a factor of 100 to 1000 greater than it is in the Delta (Figure 4.4). One important caveat with respect to determining surface Chl *a* concentrations is that it depends on the method used to collect the surface Chl *a*. The difference between using a surface net tow (akin to what is used in Lehman *et al*. 2013) and a grab sample from the middle of a patch (akin to Mioni *et al*. 2012) can be close to be 100-fold, i.e. 0.2 µg Chl a L^{-1} versus 20 µg Chl a L^{-1}, respectively. This is because the former is an integrated measure and the latter is not, suggesting that the "coverage" of *Microcystis* colonies in surface waters of the Central Delta is around 1%. This is in sharp contrast with Clear Lake where surface Chl *a* is uniformly high (above 150 µg Chl a L^{-1}) at all stations during a bloom (Richerson 1994, Mioni *et al*. 2012).

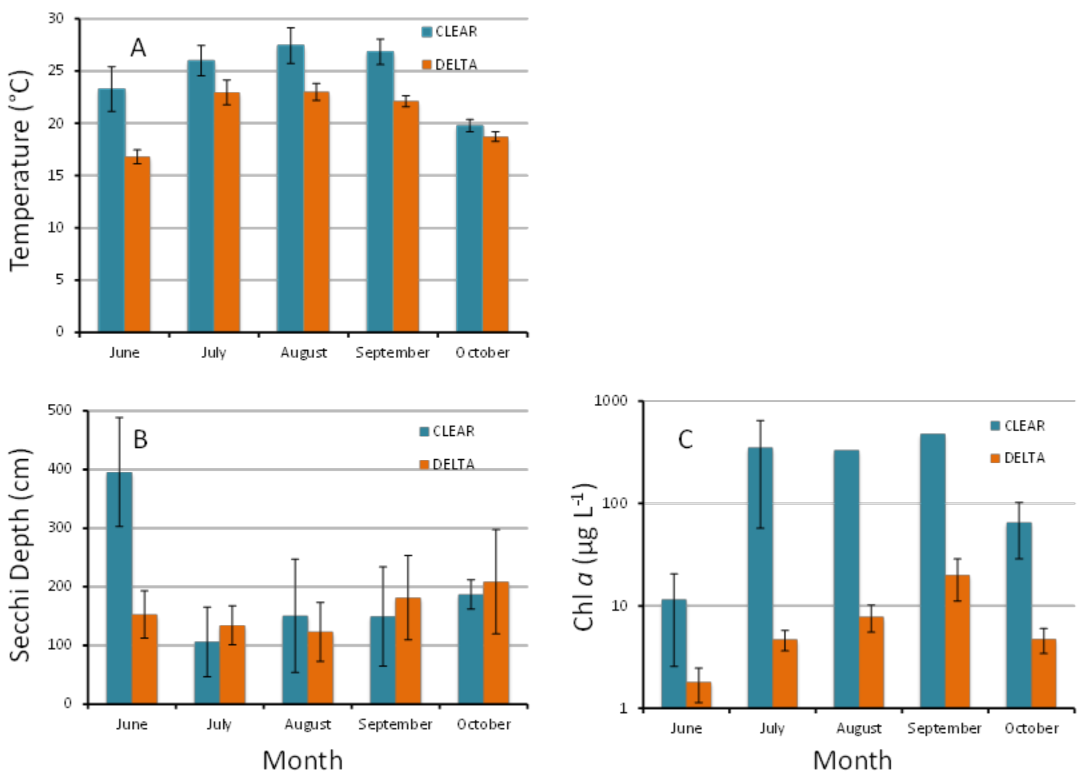

Figure 4.3. Comparison of environmental variables and Chl a in Clear Lake (Cyan) and the Delta (orange) using in-patch grab samples during the summer months of 2011. (A) Temperature, (B) Secchi disk depth, (C) Chl a. Data from Mioni *et al.* 2012.

4.2.3 Microcystin toxin concentrations in the Delta and San Francisco Bay

Given the number of different toxins produced by each cyanoHAB species, and the number of different genera present in Central California, one would expect a number of different toxins to be present in the water column. However, toxins other than microcystin are not frequently encountered (Kudela pers. com, Gibble and Kudela 2014). Based on the data available for the Delta, this section describes total microcystin concentrations and how they relate to *Microcystis* cell abundance.

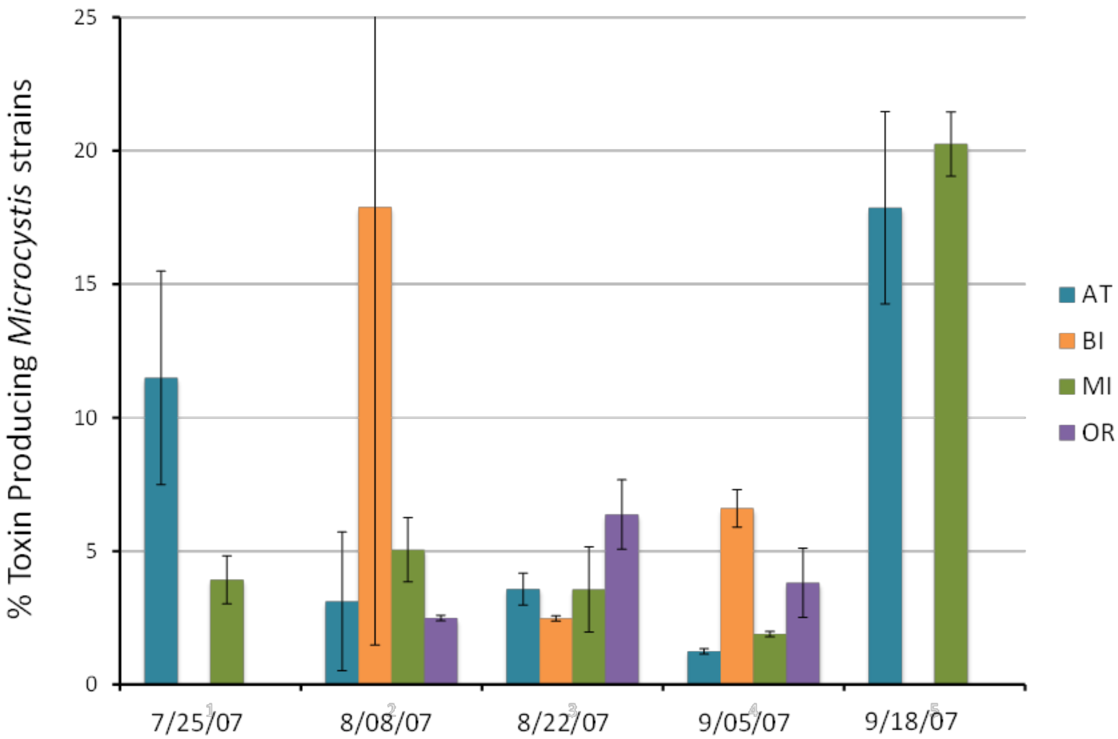

Figure 4.4. Percent toxin-producing strains in Microcystis assemblage at stations AT, Antioch (D12); BI, Brannan Island (D23); MI, Mildred Island; and OR, Old River at Rancho del Rio (D28). Data from Baxa *et al.* 2010.

Microcystis produces approximately 100-400 ng microcystin per µg Chl *a* in toxin producing strains (Sivonen and Jones 1999). Just as with other regions where *Microcystis* occurs, the strains that occur in the Delta are a mix of toxigenic and non-toxigenic strains (Baxa *et al*. 2010). Toxigenic strains generally comprise 2-20% of the total number of *Microcystis* strains present. This variation in the proportion of toxigenic strains is observed everywhere (i.e. at every station) and at all times (Figure 4.4). No single station stands out as consistently producing a greater proportion of toxigenic strains compared with other stations (Figure 4.4). Accordingly, total microcystin concentrations reflect total *Microcystis* cell abundance, typically varying from 10-50 ng L^{-1} (Lehman *et al*. 2008). However, in 2012 concentrations approaching 2000 ng L^{-1} were detected in the Stockton shipping channel during a *Microcystis* event (Spier *et al*. 2013).

In the Sacramento River, intermediate concentrations of total microcystins have been detected at a station close to Rio Vista (Brannon Island) where *Microcystis* cell abundance is low to non-detectable (Lehman *et al*. 2008, 2010). This station is connected via a channel to the San Joaquin River and the Frank's Tract area. Physical mixing of water directly from the San Joaquin River with brackish water at this station situated at the entrance to the Sacramento River may bring toxins but establishment of *Microcystis* populations may be prevented by the conditions in the Sacramento River including colder water, greater flow rates, mixing down to the bottom, and lower water clarity (Lehman *et al*. 2008).

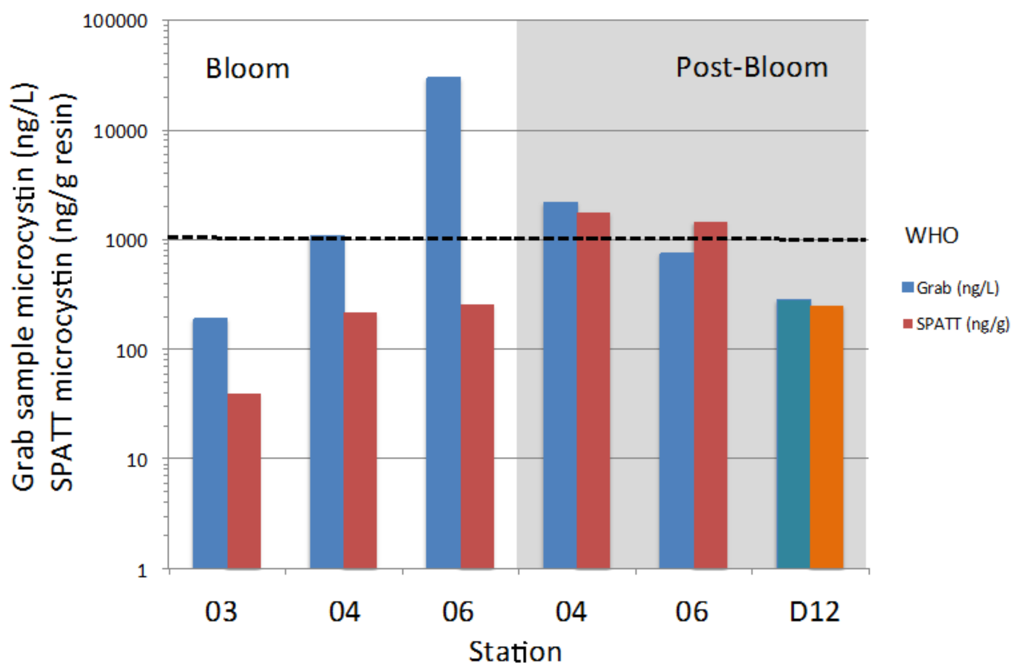

Figure 4.5. Microcystin toxin concentrations determined with grab samples (blue/cyan) and with SPATT resin (red/orange) at three stations in Clear Lake, during and after a Microcystis bloom, and at one station (D12, Antioch) in the Delta. Data from Mioni *et al.* 2012.

Microcystin toxin has also been detected at low concentrations throughout the Delta and the San Francisco Estuary using the novel Solid Phase Adsorption Toxin Tracking (SPATT) technique which integrates exposure of dissolved toxins over longer time spans (Kudela 2011). While valuable to indicate a potential for exposure to cyanotoxins, the comparison of SPATT to existing guidelines for human and aquatic health is problematic because SPATT detected concentrations are not directly comparable to traditional, instantaneous grab samples. For example, in Clear Lake microcystin detected with SPATT (ng/g resin) was 5-115 times lower than grab samples (ng/L) taken the last day of the SPATT deployment during the height of a *Microcystis* bloom (Figure 4.5). Post bloom, microcystin detected with SPATT was either comparable to, or double, levels measured in grab samples (Figure 4.5). While microcystin was detectable both with SPATT and with grab samples in Clear Lake, microcystin was detectable with SPATT in the Delta, at similar levels as in Clear Lake, but not with grab samples. In the former system *Microcystis* was very abundant and in the latter it was not. The above example illustrates that given longer equilibration times, SPATT becomes more senstitive than grab samples at lower concentrations of toxins. Although difficult to "translate" directly into effects on aquatic life (i.e. Echols *et al*. 2000), SPATT detection may be a very useful system for identifying regions at risk for harm to aquatic life from toxin exposure (Gibble and Kudela 2014).

4.2.4 Potential for CyanoHAB Risk to Delta Beneficial Uses

Characterization of the risk of cyanoHABs to Delta beneficial uses is generally poor. While no guidelines for toxicity of cyanotoxins to aquatic life have been established for California, total microcystin levels found in the Delta are within the range of potential impacts to aquatic health, as recently reviewed by the California Office of Environmental Health Hazards (OEHHA 2009). For example, microcystins are acutely toxic to fish at concentrations as low as a fraction of a microgram per liter (OEHHA 2009). Chronic exposures can also be problematic; embryos and larval fish appear to be very sensitive to chronic exposures to microcystins, resulting in oxidative stress, reduced growth, developmental defects, and lethality; exposures as low as 0.25 µg/L resulted in oxidative stress to zebrafish embryos (OEHHA 2009).

Consumption of prey items with body burdens of cyanotoxins can also be a potential pathway of impact. Lehman *et al*. (2010) traced increasing concentrations of microcystins from the water (25-50 ng L^{-1}) to zooplankton (0.4-1.5 µg g dry wt^{-1}) to striped bass muscle tissue (1-3.5 µg g dry wt^{-1}) at Central Delta Stations. These values are within the range of sublethal microcystin doses to fish (2.5 µg g dry wt^{-1}; OEHHA 2009). The striped bass caught at stations where *Microcystis* cells comprised 100% of the surface Chl *a* had tumor lesions in their liver tissue, consistent with the sublethal effects caused by microcystin-LR toxin (OEHHA 2009, Lehman *et al*. 2010). This is consistent with fish feeding studies which demonstrate that microcystin-LR spiked diets result in lesions of the liver (Deng *et al*. 2010; Acuna *et al*. 2012a,b). Zooplankton are also acutely sensitive to *Microcystis aeruginosa* cells; diets consisting of 50% toxigenic and non-toxigenic *Microcystis* strains result in 100% mortality in the copepods *Eurytemora affinis* and *Pseudodiaptomus forbesi* (Ger *et al*. 2010). Interestingly, when fed diets containing only 10-25% *Microcystis* cells, both copepods demonstrate significantly greater survival on the toxigenic strain than the non-toxigenic strain, suggesting that bioactive compounds other than the microcystin toxin exert a greater adverse impact on the zooplankton (Ger *et al*. 2010). This is consistent with a number of the studies of the effect of cyanoHABs on zooplankton mentioned in Section 2.2.6.

Determination of risk to human health in the Delta is problematic because cyanoHABs monitoring has been focused on aquatic health (depth-integrated sampling) rather than human health (via surface-scum sampling). With this caveat, toxin concentrations of 10-50 ng L^{-1} (Lehman *et al*. 2008) are 16-80 times lower than the Office of Environmental Health Hazard Assessment (OEHHA) Action Level for human health (Table 4.1), but the 2012 concentrations approaching 2000 ng L^{-1} in the Stockton shipping channel (Spier *et al*. 2013) exceed both the OEHHA Action level and the WHO guideline of 1000 ng L^{-1} (Table 4.1).

Table 4.1. Action levels developed by OEHHA (2009) for human health exposure to cyanotoxins compared with the WHO guidance level for microcystins and the EPA 10-day average exposure threshold.

Toxin	OEHHA Recreational Use (µg/L water)	OEHHA Consumption Level (ng/g fish)	WHO recreational Use (µg/L water)	EPA 10-day average (µg/L)
Microcystins	0.8	10	1.0	0.3
Cylindrospermopsin	4	70		
Anatoxin-a	90	5000		

4.2.5 Summary of Potential for Adverse Effects on Delta Beneficial Uses

A thorough characterization of the risks for adverse effects on Delta beneficial uses is hindered by the fact that cyanoHAB prevalence and toxin concentrations are currently not routinely monitored in the Delta; moreover, sampling has been focused on aquatic health and does not include sampling for human health risks. Determination of risk to human health is not possible at this time because surface scums are not currently being monitored. The current risk to Delta aquatic health is of concern and merits a more thorough investigation. This observation is based on total microcystin levels found in Delta fish tissues that are within the range of sublethal effects to fish as recently reviewed by the California Office of Environmental Health Hazards (OEHHA 2009). In addition, dissolved toxin concentrations (10- 50 ng L^{-1}) that are generally 16-80 times below the OEHHA action level, occasionally exceed both the OEHHA action level and the WHO guideline of 1000 ng L^{-1} in certain "hotspots" of the Delta. Whether or not these hotspots are expanding is currently not known and merits further investigation and monitoring.

5.0 SYNTHESIS OF FACTORS INFLUENCING CYANOHABS PRESENCE AND TOXIN PRODUCTION IN THE DELTA

The charge of the cyanobacterial workgroup, as outlined in the Delta Nutrient Management Charter, is to "assess whether observed increases in the magnitude and frequency of cyanobacterial blooms in the Delta is the result of long-term changes in nutrient concentrations and whether management of nutrient loads can remedy the problems associated with cyanobacteria." The best way to characterize the relationship between the extent and frequency of bloom occurrence and nutrient concentrations is by regression analysis. Ideally, this type of analysis ought to be performed in multiple locations for longer time scales. Given that temperature, irradiance and water column clarity are such powerful triggers of blooms, stepwise multiple regression analysis to test the influence of several environmental indicators simultaneously on cyanoHAB cell densities would be even more useful in order to ascertain key triggers of the blooms in the Delta region.

While environmental indicators such as salinity, turbidity, temperature, total phytoplankton biomass (as Chl *a*), and phytoplankton species composition are monitored on a monthly basis by DWR, surface concentrations of phytoplankton, which requires special sampling, are not routinely monitored in this program. Therefore, the statistical analyses needed to answer the charge of the cyanobacterial working group cannot be performed at this time. Instead, this section focuses on summarizing factors known to favor cyanobacterial prevalence (from Section 2) and synthesizing available literature on the extent to which those factors may also be at play in the Delta.

5.1 Present and Future Factors associated with cyanoHAB prevalence in the Delta

5.1.1 Flow and mixing

Environmental and population drivers that promote growth of cyanoHABs in freshwater bodies around the world also play key roles in regulating growth of cyanoHABs in the Delta (Table 5.1). Chief among these is low flow. For example, Lehman *et al*. (2013) noted that increased abundance of *Microcystis* is associated with up to a 50% reduction in flow of water in the San Joaquin River. In 2004, *Microcystis* only appeared in the Central Delta when stream flow was 1-35 $m^3\ s^{-1}$ (Lehman *et al*. 2008). In addition to direct effects of decreased flow such as increased stratification of the water column, changes in flow and mixing also impart indirect effects that may influence cyanobacterial growth. These include changes in turbulence, sediment resuspension (therefore turbidity), chemical consitutents, and water temperature to mention a few. Changes in these parameters typically cannot be separated from that of flow to determine their relative importance. For example, in the Delta, reduction in flow is accompanied by a 50% reduction in turbidity and volatile suspended solids. Decreased flow also leads to increased water temperatures. Conditions of decreased flow occur more predictably in dry years (Lehman *et al*.

2013). Within the summer season, reduced flows typically occur in the July-August time frame (Figure 5.1) and set the stage for the two factors necessary for bloom initiation, including increased water column temperature and water column clarity (decreased turbidity).
While decreased flow may increase the abundance of *Microcystis*, increasing rates of flow decrease its abundance because of the negative effects of water column mixing, such as light limitation, on its growth. Artificial mixing is even used as a strategy to mitigate blooms of harmful cyanobacteria in lakes and reservoirs (Reynolds *et al*. 1983, Burford and O'Donohue 2006). In the Delta, natural mixing rates may be sufficient to restrict the abundance of *Microcystis* to 10-15% of the total phytoplankton community.

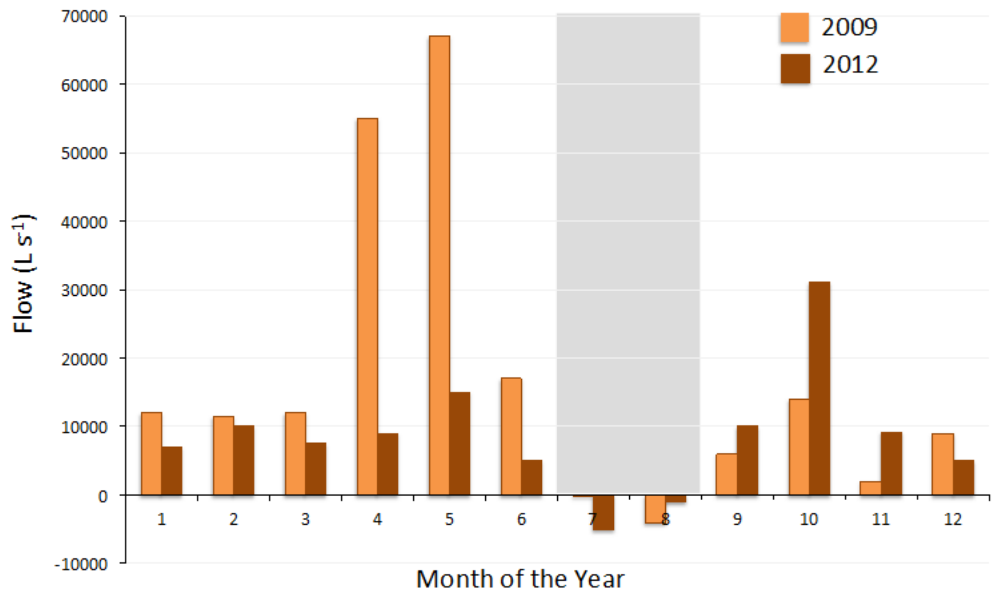

Figure 5.1. Variation in flow at Brandt Bridge in the Delta (years 2009 and 2012) illustrating the low- and reverse-flow window in July-August (shaded grey). Data and plot from Spier *et al.* 2013.

5.1.2 Temperature

Aside from the rate of water flow, water temperatures have increased globally over the last few decades as a result of global warming (Gille 2002, Hansen *et al*. 2005). In the Central Delta, a change from mainly negative deviations in the water temperature from the long-term mean to positive deviations occurred in 1999 (Figure 5.2). This local change in the water temperature may be part of the larger-scale global patterns and/or the Pacific Decadal Oscillation weather pattern which also changed sign in the same year (Cloern *et al*. 2007).

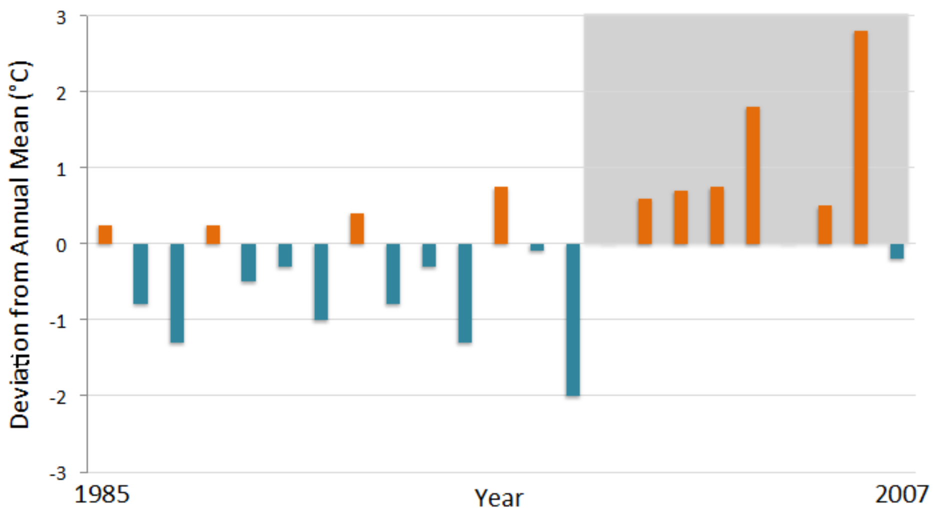

Figure 5.2. Deviation from the annual mean of maximum water temperatures at Stockton in the Central Delta. Grey shaded area indicates period from 1999 onwards with increased positive temperature deviations. Data from Brooks *et al.* 2011.

The interesting question with respect to changes in water temperatures is whether they are great enough to affect competition between cyanobacteria and other members of the phytoplankton community in the Central Delta. Presently, 40-75% of the phytoplankton community in the Delta is comprised of diatoms, followed by chlorophytes (15-30%), cyanobacteria (15-40%), cryptophytes (5-10%) and flagellates (0-10%), including dinoflagellates (Lehman 2007). In order for cyanoHAB species to to grow faster than diatoms and displace diatoms as the dominant member of the phytoplankton community, they would have to be able to accelerate their growth rates upto 2-3 fold. Alternatively, a scenario where the growth rate of diatoms would decrease and cyanobacteria would increase is necessary. Examining variation in growth rates with changes in environmental data, temperature appears the most likely candidate for bringing about such a change. Data from Figure 3.6 indicates that a doubling in cyanobacterial growth rates occurs with an increase in temperature from 20-27°C, whereas diatom growth rates decrease over the same temperature range. Therefore, a rise in temperature is a scenario under which cyanobacteria are able to outcompete diatoms.

This scenario is consistent with differences in temperature between a system, such as Clear Lake, where cyanoHABs dominate community composition, and the Delta. Comparing the 2011 environmental variables from Clear Lake and the Central Delta, two pre-bloom (June) differences become immediately clear. One is that the water temperature in Clear Lake is 7°C degrees warmer than the Delta (Figure 4.3). The other is that the Secchi disk depth is 2.6-fold greater in Clear Lake compared with the Delta (Figure 4.3). This difference in water clarity disappears in July when the *Microcystis* bloom takes off in Clear Lake, increasing Chl *a* 35-fold and decreasing the water clarity (Figure 4.3). Lehman *et al*. (2013) also predicted that the two factors that potentially would make the greatest impact on accelerating the growth of *Microcystis*, and increase the frequency and duration of blooms in the Delta, would be increased water temperatures and increased water column clarity. The earlier in the growth season that these increases would occur the greater the window of opportunity for growth would become (see also Peeters *et al*. 2007).

5.1.3 Water Clarity

The Central Delta is highly turbid due to large amounts of sediments transported into the upper estuary via the Sacramento River as well as due to sediment resuspension. However, as more and more of the sediment load is being caught behind dams, sediment transport is on the decline and the upper estuary is becoming less turbid (Schoellhamer *et al*. 2012). Since 1975, turbidity at Stations D26 and D28 has declined by on average 2 and 4% per year, respectively (Jassby 2008). These average declines are accentuated by declines in turbidity of up to 50% during the low flow months (Lehman *et al*. 2013). If these present declines in turbidity in the Central Delta continue into the future, they may substantially promote growth of cyanoHAB species.

5.1.4 Nutrient Concentrations

If water temperatures did not increase above the summer-time average of 18-20°C, could there be a 2-fold acceleration in cyanobacterial growth rates with changes in N source, or with N:P ratio, at non-limiting nutrient concentrations that would enable them to outcompete diatoms and become dominant? To answer this question, we can 1) look to growth results from culture investigations and 2) investigate how nutrient ratios differ between a system that is overwhelmed by *Microcystis* (such as Clear Lake) compared with the Delta.

1) Culture investigations demonstrate that there is no significant, or consistent, change in growth rates with change in N source, or N:P ratios, at nutrient concentrations in excess of demand (Tilman *et al*. 1982, Tett *et al*. 1985, Reynolds 1999, Saker and Neilan 2001, Roelke *et al*. 2003, Sunda and Hardison 2007).
2) Comparing the ratios of dissolved N:P between the Delta and Clear Lake, 3.6±0.6 and 2.9±0.8, respectively, it's clear that these are essentially the same (Mioni *et al*. 2012). Nutrient ratios also do not vary from pre-bloom to bloom in the Delta, indicating that nutrients are in excess of phytoplankton demand for the entire summer season (Lehman *et al*. 2008, Mioni *et al*. 2012). Moreover, nutrient concentrations, or ratios, do not change sufficiently from year–to–year in order to explain year–to–year variation *Microcystis* biomass or occurrence. For example, since 1994 there has been no change in concentrations or ratios of nutrients in the Cental Delta (Appendix A).

Therefore, the initiation of *Microcystis* blooms around 1999 in the Delta was probably not associated with changes in nutrient concentrations or their ratios. However, as with all phytoplankton blooms, once initiated, cyanoHABs cannot persist without an ample supply of nutrients. It is important to keep in mind that while nutrient reduction may not limit the onset or frequency of bloom occurrence, it will limit bloom duration, intensity and possibly also geographical extent. If, in the future, nutrient concentrations were to decrease to the point where they start to limit phytoplankton biomass, then the magnitude of the nutrient pool, as well as seasonal changes in the magnitude, would impact cyanoHAB concentration, distribution and bloom duration.

Interestingly, the long-term record for station D26 demonstrates that a decline in Chl *a* and corresponding increases in nitrogen concentrations (NH_4^+ and NO_3^-) and N:P ratios occurred in the period from 1985-1994 (Appendix A). Jassby (2008) reported similar changes in Chl *a* (decrease) and nitrogen (increase) at Central Delta Stations D16 and D28 between the years 1985 and 1994. Van Nieuwenhuyse (2007) hypothesized that the changes in N:P ratios and Chl *a* were driven by a decrease in phosphorus loadings to the Sacramento River that occurred in 1994; however the step change in P loading that year does not explain the gradual decrease in Chl *a* that started prior to 1994 (Appendix A).

Gradual decreases in Chl *a* concentrations may have been brought about by relative changes in flow and benthic grazing, leading to a new and lower Chl *a* equlibrium by the mid-1990's (Lucas and Thompson 2012). According to Lucas and Thompson (2012) the areas of the Delta where benthic grazing typically overwhelms phytoplankton growth rates are the same as those where *Microcystis* tends to bloom (Figure 4.1; Lehman *et al*. 2005). Because *Microcystis* floats at the very surface, it may avoid being grazed by clams in contrast with other phytoplankton that are distributed throughout the water column. It's important to bear in mind that large-scale (temporal and spatial) variation in environmental factors such as flow and grazing by clams may have a more profound impact on phytoplankton standing stocks, and competition among different phytoplankton taxa, compared with many of the autecological adaptations discussed in this review.

5.2 Summary

In the review of the global literature on factors influencing cyanobacterial blooms and toxin production, five principal drivers emerged as important determinants:

1) Water temperatures above 19°C
2) High irradiance and water clarity
3) Availability of N and P in non-limiting amounts; scientific consensus is lacking on the importance of N:P ratios and nutrient forms (e.g. ammonium) as a driver for cyanoHABs
4) Long residence times and stratified water column
5) Low salinity (<10 ppt) waters

Comprehensive understanding of the role of nutrients vis-à-vis other environmental factors in influencing cyanoHAB presence in the Delta is severely hampered by the lack of a routine monitoring program. The DWR monitoring program currently measures many of the environmental factors of interest, except cyanobacterial abundance and toxin concentration, which require a different approach than that used in standard phytoplankton monitoring. Drawing on the five factors influencing cyanoHABs, we can conclude the following:

- Because of the large effects of temperature and irradiance on accelerating, and decelerating, the growth rates of cyanoHABs, these two factors appear to exert key roles in the regulation of the onset of blooms. Cyanobacteria require temperatures above 20°C for growth rates to be competitive with eukaryotic phytoplankton taxa, and above 25°C for growth rates to be competitive with diatoms (Table 5.1). In addition, they require relatively high irradiance to grow at maximal growth rates. This is in contrast with diatoms that are able to keep near-maximal growth rates at irradiances limiting to cyanoHABs in the Delta, e.g., 50 µmol phot m^{-2} s^{-1} (Table 5.1).
- It appears that N and P are available in non-limiting amounts in the Delta; moreover concentrations, or ratios, do not change sufficiently from year-to-year to explain year-to-year variation in Microcystis biomass or occurrence. Therefore, the initiation of *Microcystis* blooms and other cyanoHABs are probably not associated with changes in nutrient concentrations or their ratios in the Delta. However, as with all phytoplankton blooms, once initiated, cyanoHABs cannot persist without an ample supply of nutrients. As long as temperatures, flow rates and irradiance remain favorable for growth, the size of the nutrient pool will determine the magnitude and extent of cyanoHAB blooms.
- Salinity is controlling the oceanward extent of cyanobacterial blooms in the Delta, but salinity gradients do not explain the spatial distribution of cyanoHABs in the Delta (Table 5.1). Notably, salinity regime is not a barrier to toxin transport, as cyanotoxins have been detected in San Francisco Bay.
- Higher flows, turbidity and lower temperatures during most of the year are likely restricting cyanobacterial blooms to the July-August time period.

Climate change and anthropogenic activity associated with land use changes have the potential to alter cyanoHAB prevalence in the future. Climate change will likely result in warmer temperatures and increased drought, the latter of which could result in reduced flows, increased residence time and water column stability leading to higher light availability in the Delta. Both higher temperatures and reduced flows would presumably result in a greater prevalence of cyanoHABs. It's noteworthy that phytoplankton biomass and primary productivity are depressed relative to available nutrients in the Delta, so it's unclear what the effect of modifying nutrient loads will have on frequency and intensity of cyanoHAB occurrence in the future.

Table 5.1. Summary of general physiological drivers of cyanobacterial growth, how they are manifested in population growth and competition with diatoms, and how they compare with environmental drivers observed to be operating in the Delta.

Physiological Driver	Population Driver	Observations in the Delta
Growth significantly slower below 20°C, and greater above 25°C, compared with eukaryotic phytoplankton taxa	Requires temperatures above 25°C for growth rates to be competitive with diatoms	Not observed at temperatures <19°C
Cyanobacteria have greater cellular N:P ratios than diatoms due to two light harvesting systems and peptide toxin production	At non-limiting nutrient concentrations, changes in ratios of nitrogen substrates or N:P does not affect competition among species or taxa	Nutrient concentrations, nitrogen speciation, and dissolved N:P ratios have not changed in the Delta over the last 25 years
Production of bioactive peptide compounds (toxic and non-toxic) results in high N demand of cells	Toxin production per cell is greatest at maximal growth rates; linked with external N concentrations and decrease at N limiting conditions; cyanoHABs do not secrete toxin	Inorganic N and P concentrations are at non-limiting concentrations for growth and toxin production; Variation in toxin produced per cell or in number of toxigenic vs non-toxigenic strains is not related to any specific environmental condition
Inefficient photosynthesis, low alpha; efficient at dissipating excess light energy via high concentration of carotenoid pigments in photosystems (*Microcystis*, *Anabaena* and *Aphanizomenon*)	CyanoHABs (*Microcystis*, *Anabaena* and *Aphanizomenon*) require high irradiance to grow; diatoms able to keep near-maximal growth rates at irradiances limiting to cyanoHABs (e.g. 50 μmol phot m^{-2} s^{-1})	High rate of water flow and mixing most of the growing season restricting blooms to low-flow periods (July-August), when turbidity is < 50 NTU, flow is <30 m^3 s^{-1} and irradiance > 50 μmol phot m^{-2} s^{-1} (Central Delta 2004-2008)
Growth optimal at salinities <10 ppt for most cyanoHAB species	CyanoHABs generally restricted to freshwater habitats and estuaries with salinities <10 ppt (Baltic Sea, San Francisco Delta, North Carolina)	Does not proliferate outside the Delta in the Sacramento River (freshwater) or Suisun Bay (mesohaline) suggesting that the primary agent restricting its spread is not salinity

6.0 RECOMMENDATIONS

The goal of this review is to synthesize available information to provide insight into cyanobacterial bloom occurrence in the Delta. The review has three major objectives:

1) Provide a basic review of biological and ecological factors that influence the prevalence of cyanobacteria and the production of cyanotoxins;
2) Summarize observations of cyanobacterial blooms and associated toxins in the Delta;
3) Synthesize literature to provide an understanding of what ecological factors, including nutrients, may be at play in promoting cyanobacterial blooms in the Delta.

This review found that the lack of a routine monitoring of cyanoHAB occurrence in the Delta greatly hindered our ability to summarize, with confidence, the status and trends of cyanoHABs in the Delta (Objective 2), and to what extent nutrients versus other factors were controlling their occurrence (Objective 3). Given this finding, our recommendations are focused on two principal actions:

1) Strengthening routine monitoring; and
2) Development and use of an ecosystem model, coupled with routine monitoring and special studies, to 1) understand controls on primary productivity and phytoplankton assemblage in the Delta and 2) test hypotheses regarding factors promoting or curtailing growth of cyanobacteria.

R1: Implement Routine Monitoring of CyanoHABs

DWR is currently conducting a monitoring program that routinely samples many of the variables of interest known to influence cyanoHABs. Comprehensive cyanoHAB monitoring should be added as a component to this program to fully evaluate risk to human and aquatic health as well as better understand linkages to factors that may be promoting or maintainting blooms.
To begin, a work plan should be developed which specifically scopes the needed changes in the program to comprehensively monitor cyanoHABs. Monitoring should include enumeration of major cyanobacterial species (e.g. *Microcystis*, *Aphanizomenon* and *Anabaena*). Sampling of toxins should include water column concentrations as well as mussel tissue concentrations or other important taxa that represent sentinels for bioaccumulation in the food web. Analyses of toxin concentrations should be expanded to include the six major cyanotoxins of concern identified in the OEHHA guidance in year 1 then adjusted based on the most commonly encountered toxins thereafter. In addition, selective sampling for analysis of concentrations of herbicides and fungicides commonly encountered in the Delta should be considered. The workplan should also consider monitoring needed to develop and calibrate an ecosystem model to further investigate controls on primary productivity and phytoplankton assemblage (see R2 below).

After an initial period of 3-5 years, the monitoring data should be used to comprehensively report on the status and trends of cyanoHABs and the factors that favor bloom occurrence in the Delta.

R2: Develop an Ecosystem Model of Phytoplankton Primary Productivity and HAB Occurrences to further Inform Future Risk and Hypotheses on Factors Controlling CyanoHABs

The Delta is at an advantage with respect to management of cyanoHABs in that naturally occurring high rates of flow and turbulence act to keep cyanobacteria in check. Despite this, future increases in temperature and residence time associated with climate change, increasing the degree and duration of stratification events, may substantially degrade the effectiveness of the Delta's breaking mechanism and increase the risk of cyanoHAB occurrences. Because nutrients are not currently limiting cyanobacterial blooms, it is critical that an improved understanding is gained of the factors that are controlling phytoplankton primary productivity in the Delta, since a relaxation of those factors followed by increased growth of phytoplankton could lead to increased risk of cyanoHABs.

To inform management actions moving into the future, an ecosystem model of phytoplankton primary productivity and HAB occurrences should be developed. This model should have the capability to provide information on primary productivity and biomass as well as planktonic food quality and transfer of carbon to higher trophic levels. Moreover, such a model could be used to assess the relative importance of environmental factors such as benthic grazing, flow, water column stability, temperature, to mention a few, at various times and locations in the Delta, on cyanobacterial growth. To step into model development, four steps should be taken: 1) examine existing models already available to determine suitability for this task, 2) utilize existing data from the Central Delta to explore, to the extent possible, the relationships between Chl *a*, phytoplankton composition, climate variables and other factors at stations where cyanoHABs are known to occur (e.g. D26, D28 and turning basin in the Stockton Shipping Channel). 3) Develop hypotheses regarding the environmental conditions in those areas that promote cyanoHABs. In addition, develop hypotheses regarding conditions needed to curtail cyanoHABs; including the effect of reducing nutrient loads on the entire phytoplankton community (including cyanobacteria) and on the transfer of carbon to higher trophic levels. These hypotheses can subsequently be tested through model development as well as potential future scenarios, and 4) a work plan should be developed that lays out the modeling strategy, model data requirements, and implementation strategy.

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APPENDIX A

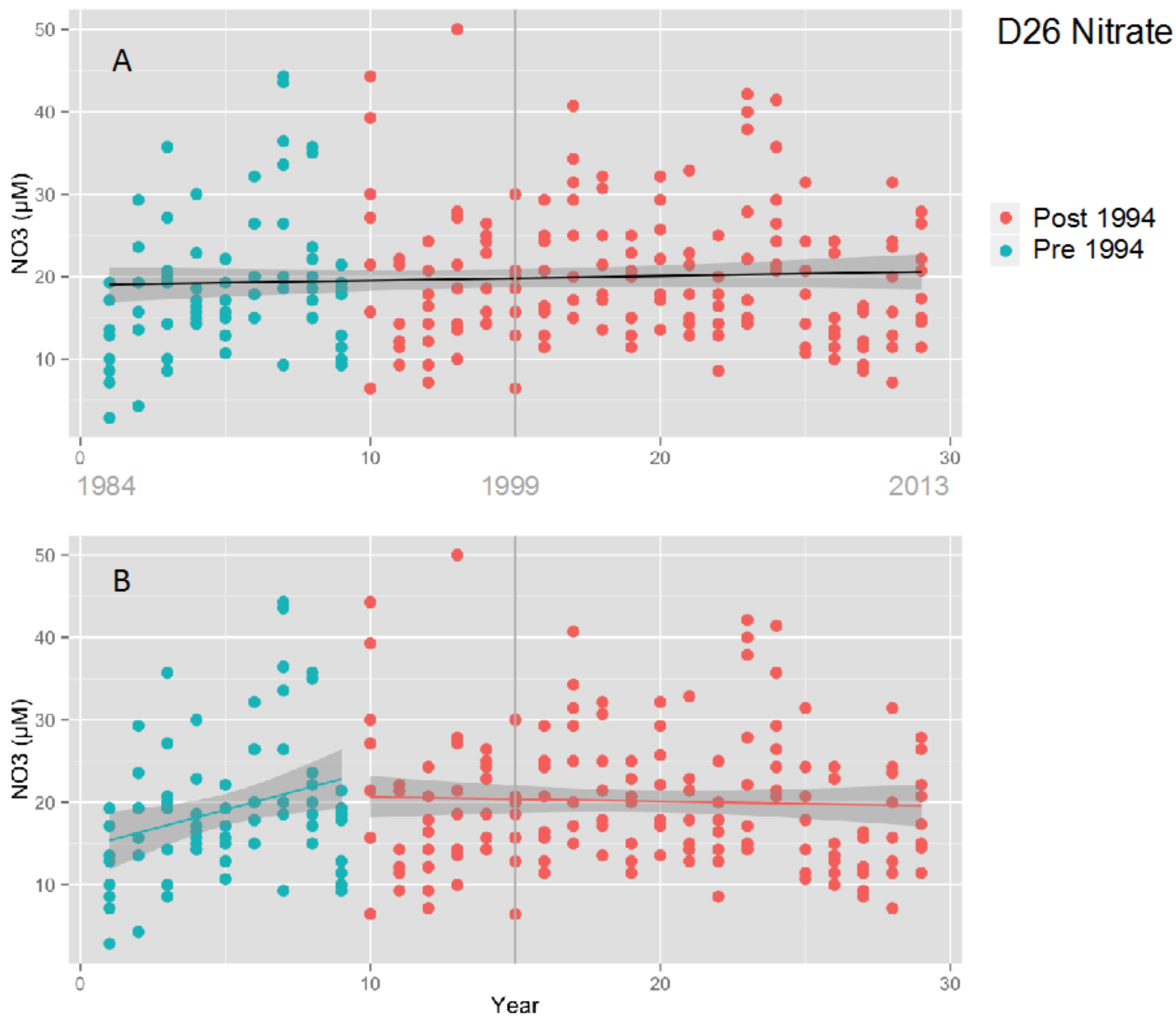

Figure A-1. Changes in the concentration of nitrate (NO_3^-) over time (1985-2013) at station D26 in the Delta. Green filled circles denote period before 1994 and red filed circles denote the period after 1994. Vertical grey line denotes the year 1999 when Microcystis started occurring. A) Regression of NO_3^- versus time for the period 1985-2013 (black line) with 95% confidence interval in grey. B) Regression of NO_3^- versus time for the period 1985-1994 (green line) and the period 1994-2013 (red line). Slopes significantly different from zero in bold in regression table:

Nitrate	1985-2013	1985-1994	1994-2013
Slope	0.09066	**1.374**	-0.02962
Probability	0.226	0.00149	0.832
multi- R^2	0.00424	0.09127	0.0001988

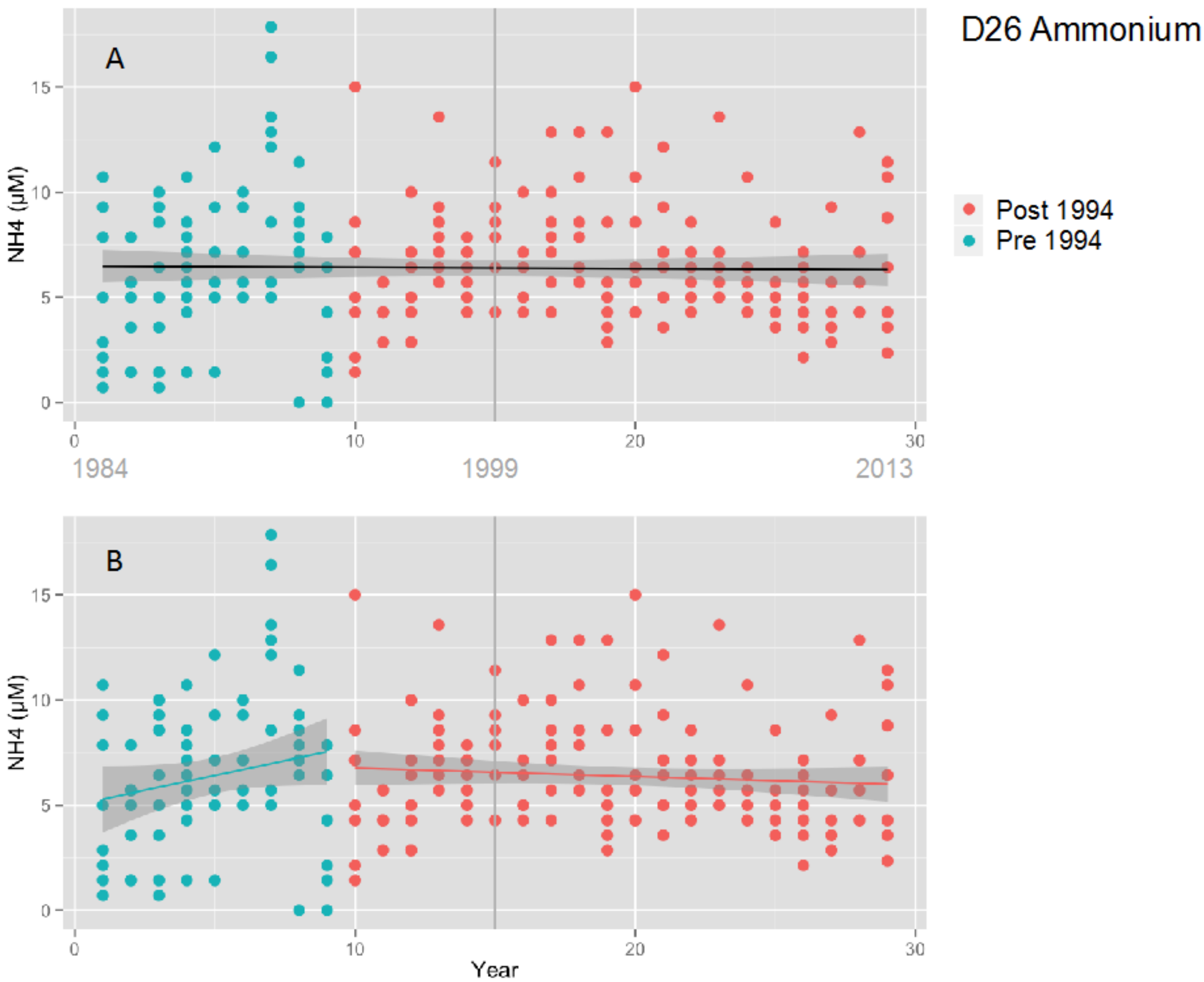

Figure A-2. Changes in the concentration of ammonium (NH_4^{+-}) over time (1985-2013) at station D26 in the Delta. Green filled circles denote period before 1994 and red filed circles denote the period after 1994. Vertical grey line denotes the year 1999 when Microcystis started occurring. A) Regression of NH_4^+ versus time for the period 1985-2013 (black line) with 95% confidence interval in grey. B) Regression of NH_4^+ versus time for the period 1985-1994 (green line) and the period 1994-2013 (red line). Slopes significantly different from zero in bold in regression table:

Ammonium	1985-2013	1985-1994	1994-2013
Slope	-0.038	**0.3801**	-0.03525
Probability	0.108	0.023	0.358
multi- R^2	0.007448	0.04779	0.00374

Figure A-3. Changes in the concentration of phosphate (PO_4^{3-}) over time (1985-2013) at station D26 in the Delta. Green filled circles denote period before 1994 and red filed circles denote the period after 1994. Vertical grey line denotes the year 1999 when Microcystis started occurring. A) Regression of PO_4^{3-} versus time for the period 1985-2013 (black line) with 95% confidence interval in grey. B) Regression of PO_4^{3-} versus time for the period 1985-1994 (green line) and the period 1994-2013 (red line). Slopes significantly different from zero in bold in regression table:

Phosphate	1985-2013	1985-1994	1994-2013
Slope	**-0.048906**	0.03673	-0.008772
Probability	2.00E-16	0.263	0.157
multi- R^2	0.2594	0.01183	0.008855

Figure A-4. Changes in the N:P ratio (mol:mol) over time (1985-2013) at station D26 in the Delta. Green filled circles denote period before 1994 and red filed circles denote the period after 1994. Vertical grey line denotes the year 1999 when Microcystis started occurring. A) Regression of N:P ratio versus time for the period 1985-2013 (black line) with 95% confidence interval in grey. B) Regression of N:P ratio versus time for the period 1985-1994 (green line) and the period 1994-2013 (red line). Slopes significantly different from zero in bold in regression table:

N:P Ratio	1985-2013	1985-1994	1994-2013
Slope	**0.3726**	**0.6236**	0.02932
Probability	3.79E-16	0.000572	0.736
multi- R^2	0.1747	0.1064	0.0005047

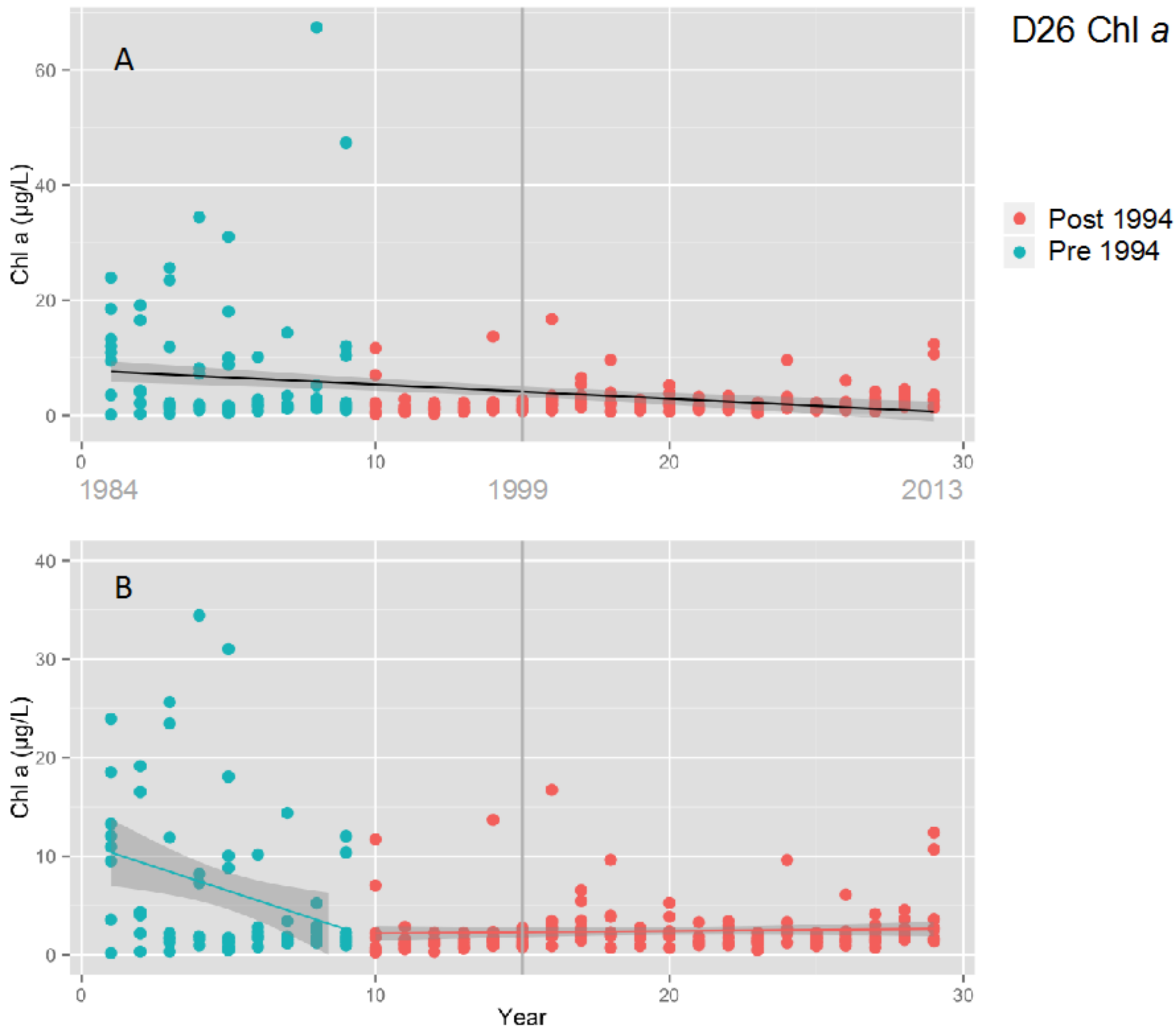

Figure A-5. Changes in the concentration of Chlorophyll a (Chl a) over time (1985-2013) at station D26 in the Delta. Green filled circles denote period before 1994 and red filed circles denote the period after 1994. Vertical grey line denotes the year 1999 when Microcystis started occurring. A) Regression of Chl a versus time for the period 1985-2013 (black line) with 95% confidence interval in grey. B) Regression of Chl a versus time for the period 1985-1994 (green line) with two of the high values from 1994 removed, and the period 1994-2013 (red line). Slopes significantly different from zero in bold in regression table:

Chl *a*	1985-2013	1985-1994	1994-2013
Slope	**-0.1676**	-0.7386	0.03936
Probability	2.87E-05	0.00759	0.1148
multi- R^2	0.05143	0.07266	0.01116

APPENDIX B

Comments from the Scientific Working Group and responses from the authors.

Author	Page	Comment	Response
Anonymous	iii	Under Finding #3, second bullet, regarding ratios of Nand P in Delta: I'm reading this to mean ratios of total N and total P (including various forms of each). I don't know that enough research has been done to determine if the ratios of the different forms can be an important driver.	Ratios of N:P are important drivers when one nutrient is in limiting supply and slows the growth rate down. Ratios of different forms of the same nutrient are important if a certain form produces a lower growth rate than the other; research on this topic is discussed under section 3.2.3 p24.
Foe	11	Under section 2.2.5, first paragraph, last sentence: Add something like this to last sentence on page 11, "it was deduced that *under nutrient limiting conditions*phytoplankton would become …"	Done
Foe	19	On pages 19, 22, and 38 you note that nutrient concentrations are one factor constraining the accumulation of cyanoHAB biomass. Can you estimate either from information from the delta or other waterbodies what range of N and P concentrations would be needed to limit cyanoHAB biomass and toxin levels below a low or moderate probability of human and wildlife health effects? Presumably there are a number of complicating factors including the fact that cyanoHABs co occur with blooms of other algal species which would also pull down nutrient levels. I understand that your estimate is likely to be fairly gross. Would it be possible to refine the range through a series of laboratory and/or field experiments? Could this be considered an information gap? Maybe discuss this somewhere around page 37?	I tried to do this in the original version where based on measurements of microcystin toxin that was harmful to aquatic life (0.8 µg/L) I calculated the amount of Microcystis-associated surface Chl a needed to produce that amount (7 µg/L). Because the science group did not like this estimation I've removed it from the paper. However, using 7 µg/L surface Chl a as a rough estimate, you would need greater or equal to 7 moles N/L to sustain such a level; this is not discussed in the current version
Foe	29	Second paragraph: You might note that Ger *et al.*, 2010 found that both toxin producing and non-toxin producing strains of Microcystis reduced the survival of both Eurytemora affinis and Pseudodiaptomus forbesi in 10 day lab bioassays. This suggests that the presence of other microcystis metabolites also contribute to overall toxicity.	A new section (4.2.4) on p39 entitled "Potential for CyanoHAB Risk to Delta Beneficial Uses" has been where the Ger (2010) paper and additional papers mentioned by Peggy Lehman are discussed
Foe	32	Under section 4.2.3, second paragraph: Brannan Island is located inside the legal boundary of the delta.	This sentence has been changed to read "Sacramento River" instead
Foe	35	Under section 4.2.4 under potential adverse effects on Delta beneficial uses: What can be concluded about the potential toxicity of cyanoHABs to aquatic organisms including zooplankton and larval fish in the Delta? Presumably there is the possibility of both direct and indirect effects. See Ger et al 2010 for an example of direct toxicity and Acuna et al (2012) and Deng et al (2010) for examples of bioaccumulation related effects. Peggy gave citations for all these papers. If uncertainty exists about the extent of	These effects and papers are discussed in a new section (4.2.4) on p39 entitled "Potential for CyanoHAB Risk to Delta Beneficial Uses". I think uncertainty exists regarding 1) whether the organisms reflect concentrations that are in the water column or 2) they bioaccumulate the toxin 3) what affects the zooplankton - toxic or non-toxic cells

		potential toxicity, then should this be listed as an information gap? What information is most important to collect first?	
Foe	38	Figure 5.2 shows nutrient trends at station D26 in the delta between 1994 and 2014. The conclusion is that nutrients concentrations are not changing. Longer term nutrient analysis suggest otherwise. Nutrient concentrations, N speciation, and dissolved N:P ratios have changed in the delta over the last 40 years. More DIN, more NH4, less SRP and an increase in the N:P ratio (Jassby 2008; Glibert, 2010[3] ; Van Nieuwenhuyse, 2007[4]) [3] Reviews in Fishery Science, 18:211-232 [4] Canadian journal of fisheries and aquatic science 64:1529-1542	I reanalyzed the nutrient data going back to 1985. My new interpretation is in section 5.1.4 on p43. I included the Van Nieuwenhuyse and Jassby citations. Appendix A provides plots of NO3, NH4, PO4, N:P, and Chl a from station D26. I demonstrate that one can draw different conclusions from these data depending on whether they are broken into separate time periods or analyzed as one long time course.
Foe	39	Around page 39. You note that cyanoHAB growth rates are a positive function of water clarity. The Delta has become clearer. The delivery of suspended sediment from the Sacramento River to the Delta has decreased by about half during the period between 1957 and 2001 (Wright and Schoellhamer (2004)[1] and this has resulted in a statistically significant -2 to -6 percent decrease per year in SPM between 1975 and 2005 (Jassby, 2008)[2]. Of course, it is uncertain whether the trend will continue. Might this increase in clarity also increase the frequency and magnitude of cyano blooms in Delta and make other factors like nutrients more important? [1] San Francisco Estuary and Watershed Science, 2004 volume 2, issue 2 [2] San Francisco Estuary and Watershed Science, 2006 volume 6, issue 1	This is true and I've added a new section (5.1.3) entitled Water Clarity (p 43) where this additional information is discussed.
Joab	ii	Second paragraph, second sentence. Add "the" between "by" and "Water Board".	Done
Joab	ii	Under Finding #2, item 1), change "e,g." to e.g.,"	Removed
Joab	1	Under section 1.1, first sentence. Add "in" between "found" and "Northern California".	Done
Joab	1	Last paragraph, first sentence regarding the commissioning of literature reviews: Actually we only commissioned two white papers (to date) on cyano	Changed to "two"

		and macrophytes. We are working on commissioning the third.	
Joab	4	Under section 2.1, first paragraph, fourth sentence. In sentence, "Cyanobacteria also produce and array…" Change "and" to "an".	Done
Joab	5	In Table 2.1, under the Nostocales (Group 4), is Cylindrospermum the correct name?	It is the correct name; however, I could just as easily have mentioned Cylindrospermopsin which is a more recognizable species.
Joab	6	Second paragraph, second sentence. You identify Group 5 as having toxic cyanoHAB-forming cyanobacteria: Don't you mean Group 4 based on the species identified in Table 2.1? Also, which group is Planktothrix in? I did not see them identified in the table - can they be added?	I did mean Group 4; it's been changed. I've also indicated in the text which subgroup Planktothrix belongs to
Joab	8	Under Ammonium transport section, third paragraph. Change "alterate" to "alternate".	Done
Joab	8	Under Nitrate transport and reduction section, last sentence regarding nitrate uptake: What concentrations of ammonia are relevant? Are these concentrations in the cells or the water column?	External; sentence changed to reflect this
Joab	9	First paragraph, first sentence: Carbon fixation seems to be very important in the nutrient uptake process. What controls carbon fixation? Is there someway to reduce their carbon fixation?	Irradiance controls CO2 fixation; this has been mentioned
Joab	9	Fourth paragraph, last sentence. Remove "have" between "their genomes" and "demonstrates".	Done
Joab	10	Under Nitrogen fixation, second paragraph, last sentence relating to n2 fixation under iron-limiting conditions: What is the iron-limiting condition? Do we know?	Where iron is not enough to support cell division
Joab	10	Under nitrogen fixation, last paragraph, seventh sentence. Correct the spelling of "heterocyst".	Done
Joab	11	First paragraph: What are the conditions for N starvation?	When N concentration is not enough to support cell division of available biomass
Joab	19	In Figure 3.1, step 6 states to add grazers: Are their cyanobacteria grazing fish and zooplankton?	This figure was very busy and included many processes not discussed in the White Paper; I've substituted a new and simpler figure
Joab	38	Under section 5.2, first paragraph, first sentence: This citation is now 8 years old. Is there any recent information to suggest if these percentages have changed significantly?	Not that I'm aware
Joab	39	First paragraph: Correct the spelling of "cyanHABs" to "cyanoHABs". Do global search in document to check spelling of cyanoHAB.	Done
Joab	39	Second full paragraph: In sentence, "In Clear Lake, Both N and P…" delete capital B and make lowercase.	Sentence changed

Joab	41	In Table 5.1, Observations in the Delta "temperatures above 25° C rarely occur." - Temperatures in the San Joaquin River near Stockton have over the past 3 years (2012-2014) reached over 25°C from June through October, most likely due to this persistent drought and overall increase in temperature.	Sentence has been removed
Kudela	31	Figure 4.2. I think this is an issue with Peggy's original figure, because I remember seeing it before, but the chlorophyll units don't make much sense. 0.1 ng/L is barely detectable under the best of circumstances.	Y-axis corrected to µg/L
Kudela	N/A	The toxin table is very thorough, but it might be worth pointing out that, based on available information, Central California seems to be dominated by microcystins. We have all of those genera present but we don't very often see saxitoxins or anatoxin-a. Admittedly we don't look that often either, but we have tested some samples from Clear Lake, SF Bay, and Pinto Lake. We very rarely get low levels of STX, and one low hit for anatoxin-a in Clear Lake. We did see low levels of anatoxin-a in Lake Chabot also, and if you go further north, anatoxin-a becomes dominant in the Eel River basin. This supports Mine's decision to focus on microcystins in the report, but the implication of that section is that we could see a wide variety of toxins, and we usually don't.	This has been pointed out in the first paragraph of section 4.2.3
Kudela	N/A	Temperature. While I completely agree with Mine's summary, bear in mind that we do see toxin at low temperatures (this is documented in Kudela 2012 and Gibble and Kudela 2014). We were not tracking species, but it seems likely that it's related to a shift in composition to more cold-tolerant species such as Planktothrix. We tend to get two peaks of toxicity—one at lower biomass and cooler temperatures, and the second (larger) when Microcystis is dominant.	I was not aware of the Gibble Kudela paper; would like to add appropriate discussion
Kudela	N/A	Marine toxins. I'm not sure I completely believe it but there is a recent article (which I can't find right now—looking for it) that documents presence of microcystins in marine waters, from marine cyanobacteria.	Noted

Kudela	N/A	I'd be very supportive of developing an ecosystem model, but for CHABs in particular you probably need a fairly complex model that can parameterize both end-members (riverine and marine). A good hydrodynamic model would be a great place to start. I'm not sure how easy or difficult it would be to add a biological model on top of that, or whether you'd need two models, etc. It's probably my own bias but I would start with assembling all the available data and run statistical analyses on that (Peggy's done quite a bit of this already) to see what variables emerge as most important. Cecile Mioni has been attempting that with the Bay/Delta data and it's been interesting, in that there are no clear physical drivers related to cell abundance or toxicity. She looked at all the usual ones, temperature, salinity, nutrients, etc. suggesting that either there's not enough data (a real possibility) or that it's not a simple relationship. That of course leads back to the need for more monitoring and modeling.	Noted
Mussen	iii	Under Finding #4, third sentence regarding increased nutrient loading: With continued regluatory controls on nutrient loads into the system, we should not necessarily expect nutrient loading to increase substantially in the future.	This has been removed
Mussen	1	Under section 1.1, in fourth sentence "The Delta is widely recognized as in "crisis" because of competing demands…" Add "human effects on the environment and" between "because of" and "competing".	Done
Mussen	4	Last paragraph, second sentence. Add "in local communities" between "irrigation of farms" and "as well as". Plus, remove the words "drinking water to" after the words "as well as".	Sentence has been revised
Mussen	7	Under Carbon Fixation, fifth sentence. Add "near" between "concentrate CO2" and "its vicinity".	Sentence has been revised
Mussen	28	Under section 4.1 Ecosystem Services, second paragraph, third sentence: Change "Striped Bass" to "juvenile-Striped Bass".	Done
Mussen	29	First paragraph, fourth sentence: "At high densities…(Paerl 2004, Paerl and Fulton 2006)" is a repeat from text in the paragraph above on page 28.	Noted; the repeat text has been removed
Mussen	29	First paragraph, sixth sentence "At dense concentrations…" - If low nutrient concentrations can be used to limit the magnitude of future cyanoHAB blooms, the effects of lower nutrient concentrations must also be considered for all other plant and algae species growing in the system (this is especially important for the period followin onset of a future cyanoHAB blooms where nutrients in the area would be fully depleted).	Noted; this point has been brought up in the recommendations section (6.0) in conjunction with hypotheses development

Mussen	38	Under section 5.2, second paragraph, first sentence refering to growth of cyanoHABs versus diatoms: Without nutrient limitation, growth rates may not determine which phytoplanktong species is dominant in the system. Other factors such as light availability, buoyancy, temperature, salinity and grazing pressure may determine the dominant species.	This sentence, presently in section (5.1.4) has been revised to clarify point
Mussen	40	Under second bullet, third sentence concerning blooms not persisting without ample supply of nutrients: Once a bloom consumes the available nutrients, would nutrient remineralization be able to sustain some lower concentration of cyanoHABs presence throughout the remainder of the growth season? Could cyanoHABs persist at harmful levels in this manner?	I think typically not; harmful levels require a certain level of biomass to be sustained
Mussen	40	Under second bullet, third sentence: Add "flow rates," between "temperatures," and "and irridiance".	Done
Mussen	40	Under second bullet, third sentence: Remove "s" from word "remains".	Done
Mussen	40	Last paragraph, fourth sentence starting with "Increase nutrient loading…": Please see my comment above on increased nutrient loading.	This has been removed
Mussen	42	Under R1, second paragraph discussing enumeration of cell counts: What about the inclusion of "and average biomass?"	Controversy regarding how it is to be measured; could be discussed under recommendations
Mussen	43	Under R2, first paragraph, second sentence: Replace "higher chlorophyll a" with "increased phytoplankton growth in the Delta".	Done
Mussen	43	Last paragraph, first sentence concerning informing management actions: It is also important to model expected nutrient levels with levels of reduced loading. The time required for a reduction and the amount of nutrient regeneration in a system can be highly variable.	Section expanded in order to note this point
Mussen	43	Last paragraph, first sentence. Add "s" to "action" making it "actions".	Done
Mussen	43	Last paragraph, second sentence regarding modeling primary productivity and biomass: CyanoHAB growth rates under ideal conditions (which may be used as the basis for a model design) can be quite different from their growth rates at near-limiting nutrient conditions. Do we know what low nutrient concentrations (thresholds) would be necessary to prevent the overgrowth of different cyanoHABs? How would other plants and algae in the system be affected by low nutrient concentrations? With limited nutrients, can we predict which phytoplankton species would be dominant in the system, and how the dominant species may change with climatic factors such as temperature, flow, and turbidity, or with differing grazing rates?	Section expanded in order to note this point

Orr	iii	Under #3, first bullet - During the last meeting lower temperatures (18°C) were discussed. Are there references for the blooms at lower temperatures in the delta?	None that I'm aware of
Orr	28	For the last sentence on page 28 under section 4.1. Ecosystem Services, "CyanoHABs also can cause night-time dissolved oxygen depletion via bacterial decomposition and respiration of dense blooms which results in fish kills and loss of benthic fauna (Paerl 2004, Paerl and Fulton 2006) - Does this occur in the Delta or is flow mixing sufficient to prevent the issue?	This is an example of an adverse effect noted in other systems
Orr	29	In the second paragraph, the sentences starting with "At low concentrations…(Lehman *et al.* 2010)" are already in the preceding paragraph. Consider removing.	This has been removed
Orr	29	Regarding the thrid sentence at the top of the page, "However, even at low concentrations, toxins released (upon death and cell lysis, or by grazing) can bioaccumulate in higher trophic levels (Lehman *et al.* 2010) - There is some disagreement on this topic in the literature. Based on the Lehman paper alone it seems unclear whether the toxins bioaccumulate or simply occur in tissue at concentrations that are not greater than the surrounding environment. In other systems it depends on the particular toxin and species in question. I recommend removing the "even at low concentrations" to make a more conservative statement. Another option would be to state they have been observed in higher trophic levels in the delta and leave the bioaccumulation to be addressed in recommendations or further research.	This sentence has been modified
Orr	32	Under section 4.2.3, last sentence in first paragraph "Using the relationship 115 ng microcystin µg surface Chl a^{-1} (Figure 4.4), *Microcystis*-associated surface Chl a concentration of 7 µg L^{-1} (sampled using a horizontal net tow) would produce enough microcystin (800 ng L^{-1}) to reach the OEHHA Action Level, and constitute an action level for the Delta." I am concerned with the concept of using Chl a to determine actions levels. While Chl a and microcystin levels are related the correltation is not linear and does not take other cyanotoxins into account. Whether or not chl a correlates with other toxins would be an interesting question.	This can be discussed further; to be on the safe side I removed Figure 4.4 and the calculation of a surface Chl a level that could potentially constitute an action level

Orr	36	Under section 5.1, last half of paragraph relating to flow and turbidity - Is there data to suggest that increased turbidity reduces risk of HABs in the delta that is independent of flow rate or temperature? HABs are common in other water bodies with high turbidity. The observation the HABs are controlled by turbidity may be an artifact of higher flows and lower temps. In low flows and turbid water could buoyancy regulating species stay near the surface to receive the necessary light intensity?	Yes, I do think that the effect of turbidity cannot be separated from the effect of flows in the Delta; whether turbidity alone has the same effect is not clear. I have revised this statement to reflect that the two covary
Orr	42	Under R1, second paragraph discussing monitoring - Consider not listing species. If the plan is long term the species of concern may change or expand.	Adaptive management strategies should take care of that; the species are listed as an example
Orr	42	Under R1, last sentence in first paragraph, correct the misspelling of "calibrate".	Done
Orr	N/A	The introductory sections have a broad perspective regarding toxigenic algal species. However, the discussion of factors influencing cyanobacterial blooms appears to focus on microcystins as a model for all blooms. I think the dicussion of other species should be increased.	The literature is heavily tilted towards microcystins therefore the white paper as well. However, Kudela noted in his comments that cyanobacterial toxins other than microcystins are almost not detected in the Delta; a statement to this effect has been added in the first paragraph of section 4.2.3
Orr	N/A	I am concerned about how tubidity is discussed. If data is available I recommend discussing it separately from flow and temperature. If turbidity related data is not available avoid general assumptions regarding its influence on blooms.	I have repeated previously published statements regarding turbidity and Microcystis in the Delta; the assumptions in the published work are stated. A new section (5.1.3) on water clarity in the Delta has been added.
Orr	N/A	It was unclear to me what the end goal of the monitoring program is. If a clearer question(s) can be developed I encourage adding a more specific monitoring plan.	To be discussed at the next meeting
Orr	N/A	I heard some monitoring questions from the group and am interested in how common these questions are among the group. I suspect there will be some disagreement about the hypothesized answers but the questions seemed shared. (See 4 questions below)	Noted
Orr	N/A	1. When and where do we reach the required surface temperatures for a bloom? (microcystis exclusively?) a. What is the appropriate depth to measure temperature?	Noted
Orr	N/A	2. Do nutrient limited conditions occur during blooms in the delta? Presumed not to. a. Does this occur in some areas but not others? b. Are we close enough for this to occur in near future? c. Is this question species or nitrogen source dependent in a non-limited system?	Noted
Orr	N/A	3. Spatially where are both temperature and nutrients high and do we need more spatial resolution?	Noted

Orr	N/A	4. Is chlorophyll a the right parameter to be measuring? a. Does it correlate with microcystin concentrations?	Noted
Taberski	iii	Delete "already exists" under the section R1, first sentence.	Done
Taberski	1	Add "of" under section 1.1, 4th sentence "…Delta is widely recognized as in "crisis" because *of* competing demands…"	Done
Taberksi	1	Delete "d" in word "declined" under section 1.1, last sentence "…including the continued decline~~d~~ of …"	Done
Taberski	22	The paragraph under sub-section "Confounding factors:" is not clear, particularly the last sentence is confusing.	This sentence has been revised
Taberski	29	In the 5th sentence at the top of the page, insert a space in the word "watercolumn".	Done
Taberski	32	In table 4.1, I think you should also include the OEHHA thresholds.	Table below has OEHHA thresholds
Taberski	39	Under the last paragraph for section 5.2, the last sentence "…nutrients are unlikely to play a role in the onset or frequency of bloom occurrence in the Delta." - I agree. Nutrient concentrations would play a role, though, in the magnitude (concentration) and duration of a bloom. If nutrients were lower, they would be depleted more quickly and the bloom would crash. This was stated in the Summary bullet #2. That clarification should be added to this paragraph.	This has been added
Taberski	40	Under the second bullet, in the third sentence, correct the misspelling of "initiated".	Done
Taberski	40	In the last paragraph, in the second sentence, put a space in the word "watercolumn".	Done
Taberksi	40	In the last paragraph, in the third sentence, change the sentence to read as "Both *higher* temperature*s* and reduced …"	Changed
Taberksi	42	Under R1, first sentence, delete the wording "already exists".	Done
Taberski	N/A	A section should be added on risk to aquatic life.	Done
Taberski	N/A	Historical data should be analyzed based on driving factors to evaluate risk (areas with high temperatures/low turbidity/long residence time)	Example analysis of nutrient concentrations at station D26 performed; included in Appendix A
Taberski	N/A	Recommended monitoring should be based on specific management questions related to status and trends, hotspots, risks to humans, animals and aquatic life, and directing management actions.	Noted
Taberski	N/A	Monitoring information should be collected on processes and projections needed for modeling cyanoHABs and directing management actions. The SF Bay RMP's management questions could be used as a model for developig management questions for cyanoHABs. The RMP's management questions are:	Noted

Taberski	N/A	1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely? a. Which chemicals have the potential to impact humans and aquatic life and should be monitored? b. What potential for impacts on humand and aquatic life exists due to contaminants in the Estuary ecosystem? c. What are appropriate guidelines for protection of beneficial uses? d. What contaminants are responsible for observed toxic responses?	Noted
Taberski	N/A	2. What are the concentrations and masses of contaminants in the Estuary and its segments? a. Do spatial patterns and long-terms trends indicate particular regions of concern?	Noted
Taberski	N/A	3. What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary? a. Which sources, pathways, and processes contribute most to impacts? b. What are the best opportunities for management intervention for the most important contaminant sources, pathways, and processes? c. What are the effects of management actions on loads from the most important sources, pathways, and processes?	Noted
Taberski	N/A	4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased? A. What are the effects of management actions on the concentrations and mass of contaminants in the Estuary? B. What are the effects of management actions on the potential for adverse impacts of humans and aquatic life due to Bay contamination?	Noted
Taberski	N/A	5. What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary? A. What patterns of exposire are forecast for major segments of the Estuary under various management scenarios? B. Which contaminants are predicted to increase and potentially cause impacts in the Estuary?	Noted
Thompson	ii	You only have four, not five, major findings identified in the Executive Summary section	Corrected
Thompson	iii	Under Finding #3, first bullet, second sentence relating to temperature for growth: Should we specifiy the time frame over which the temperature is measured? e.g., instantaneous, daily average, daily max or min. This will matter more when we get to modeling phytoplankton dynamics.	Save for the modeling

Thompson	19	Under section 3, first sentence: Correct spelling of word "prompted" by adding a "p" between "m" and "t".	Done
Thompson	20	Under section 3.1, in sentence "Indeed, recent decades has witnessed…" Replace word "has" with "have".	Done
Thompson	20	Under section 3.2.1, first paragraph, reference Edmondson and Lehman 1981 was not included in the reference section.	Done
Thompson	21	Under Cellular N:P compostion section: Reference Mills *et al.* was not included in the reference section and date missing in citation.	Corrected; citation added
Thompson	22	Under Confounding Factors, third sentence: Should we introduce the concept that there may be time lags between nutrient uptake and increased biomass, such that a correlation between two variables at a given point in time may not imply causality?	Good idea; sentence added under confounding factors on page 23 of revised manuscript.
Thompson	22	Under Confounding Factors, third sentence discussing parameters: Is there a diagram from a paper or textbook that we could borrow and reference, that shows the patterns of these variables over time before, during and after a bloom? (e.g., temperature, nutrient concentration, nutrient uptake rate, phytoplankton biomass). Something to show phytoplankton biomass peaking as nutrients draw down.	I found one diagram that showed a dinoflagellate peaking as nutrients were drawn down but nothing for cyanobacteria; after looking for the same pattern for cyanobacteria for half day I gave up
Thompson	27	Last paragraph under section 3.6 on stratification and residence time: Suggest adding a brief discussion of the potential role of ferrous iron. See Molot *et al.* 2014. A novel model for cyanobacteria bloom formation: the critical role of anoxia and ferrous iron. Freshwater Biology 59:1323-1340. The article mainly deals with lakes but there is a section on page 1330 that mentions shallow, nearshore regions of lakes, including harbors, inshore areas of Lake Erie, and embayments of Georgian Bay (Lake Huron). [**Text from Introduction shown on next line**.]	The potential role of toxins acting as siderophores and aiding cyanobacteria with iron uptake providing an advantage in competition with eukaryotes is discussed in a new expanded paragraph on p. 19 and the Molot *et al.* citation has been added to this section.

Thompson	27	**Here's some text from the Introduction**: "We cannot predict with any certainty when a cyanobacteria bloom will begin once temperatures are warm enough to support growth or the duration of a bloom except through empirical observations from previous years. Nor do we know why the problem is worsening in some mesotrophic systems." "Clearly, the predictive state of cyanobacteria science is unsatisfactory. This dissatisfaction may have contributed to the recent debate challenging he supremacy of the P paradigm in eutrophication management. Wurtsbaugh, Lewis, Paerl, and their colleagues argue that N plays a major role alongside P in promoting cyanobacteria blooms and that both N and P should be controlled (refs). This argument has been vigorously challenged in return by Schindler and his colleagues who claim that controlling N to control cyanobacteria will not work because N-fixation by cyanobacteria will compensate to a large extent for induced N shortages (refs). The outcome of this on-going debate can be expected to influence the direction of billions of dollars in public expenditures to remedy nutrient loading." "Our purpose here is to present a novel model that does not supplant the important roles of P and N as major macronutrients, but instead weaves additional ideas into older ones to create a novel and more comprehensive conceptual framework with much more explanatory power that spans the range of conditions where cyanobacteria blooms have been observed."	Noted
Thompson	28	Under section 4.1 Ecosystem Services, second paragraph, Reference Sommer *et al.* 1997 not included in reference section.	Citation added
Thompson	30	Figure 4.1 - Can we get a higher resolution version of this map? It was blurry in the original Word version, prior to becoming a Google doc.	Will investigate
Thompson	36	Under section 5.0, first paragraph, last sentence: Should we specify that the variables may need to be time-lagged in order for the correlations to be apparent?	I actually prefer to be vague in case entirely different statistics are needed
Thompson	38	Under section 5.2, first paragraph, second sentence referring to Microcystis and Aphanizomenon becoming more common: Is the reference for this statement the Lehman 2007 paper? I think it would be worth referencing it again at the end of this sentence, or adding an additional reference as necessary.	This is based on Lehman's 2008 paper and the Mioni *et al.* 2012 report; thesecitations have been added
Thompson	38	Under section 5.2, second paragraph, second and fourth sentence refering to Figure 2: I think this is now [Figure] 3.3. Check Figure number.	Corrected: now figure 3.6

Thompson	39	Second full paragraph, reference to Figure 4.5: This information is not shown in this figure. Check your Figure number.	Correct, the reference to this figure has been deleted
Thompson	39	Second full paragraph, last sentence related to culture investigations: It would strengthen the point to reference (re-reference) some key papers here.	Done
Thompson	41	In Table 5.1, Observations in the Delta "when turbidity is <50 NTU, flow is <30 m^3s^{-1} and irradiance >50 μmol phot $m^{-2}s^{-1}$": Please briefly state where in the Delta this was measured, and over what spatial and temporal scale.	Done
Ward	N/A	**Comment 1:** Of the five questions the Work Group is tasked with answering, the first is to determine whether the principal physical and biological factors promoting cyanobacteria blooms and toxin production in the Delta have been identified. My reading of the current work in this area leads me to conclude that these factors have not yet been adequately characterized. More importantly, the critical task of accurately gauging the relative weight of various factors that are known to influence/control the formation of toxigenic (or other) blooms still seems beyond our capability at present, whether in the Delta or in other waterbodies for which some relevant data is available. These deficiencies are particularly problematic for the development of a model that has practical utility. The field work and laboratory studies on Delta water quality and Delta species involved with the Pelagic Organism Decline that were cited in the draft white paper and/or distributed to the Work Group are largely "Microcystis-centric" and "microcystin-centric". There is, in my view, a very large risk in attributing (1) all significant microcystin production to Microcystis in the Delta, and; (2) focusing on microcystin(s) to the exclusion of the effects of other possible toxigenic genera and other cyanotoxins. Dr. Berg's draft white paper duly notes the existence of many other toxigenic genera and other cyanotoxins, but it seems the Delta-specific research on these possibilities may not yet be available for review.	Noted; Please see new comment under section 4.2.3 on toxin data available from Central California demonstrating that very few detections of toxins other than microcystins have been made in the Delta

Ward	N/A	**Comment 1 continued:** This is not a trivial point: for example, various Aphanizomenon strains can produce saxitoxin, microcystin(s), cylindrospermopsin, BMAA, and anatoxin-a (Paerl & Otten, 2013), and Lehman *et al.* have noted the presence of this genus in the estuary, bay and/or Delta. Though it is quite possible that I have overlooked Delta-specific studies on Aphanizomenon strains which examined the possibility that one or more of these toxins is present, if it is true that these studies have not been conducted yet, it would be ill-advised to presume that microcystin(s) are some sort of "model" toxin that can be regarded as a generic equivalent of all of the others in a subsequent modeling exercise, especially given their chemical and toxicological heterogeneity. Similarly, the diazotrophic cyanobacteria such as Aphanizomenon may respond rather differently to "nutrient limitation" (of nitrogen) than the non-diazotrophic genera such as Microcystis. If both genera produce microcystins, then microcystin production per se may continue in a water body as nitrogen becomes more limiting for Microcystis. Comparisons of diazotrophic cyanobacteria with non-nitrogen fixing cyanobacteria to nitrogen-limited conditions tend to show the following pattern: diazotrophs (e.g., Aphanizomenon) tend to produce toxins such as microcystin under nitrogen-limited conditions, whereas non-nitrogen fixers such as Microcystis and Planktothrix increase toxin production under non-limiting conditions.	Not necessarily; please see Dolman 2012 citation for patterns of abundance of various species and toxin production in over 100 lakes in Germany under different N:P scenarios described in "Meta analyses of Lake Studies" on page 24.
Ward	N/A	**Comment 1 continued (references):** Holland, A., Kinnear, S. Interpreting the possible ecological role(s) of cyanotoxins: compounds for competitive advantage and/or physiological aide? Marine Drugs 2013, 11(7), 2239-2258 http://www.mdpi.com/1660-3397/11/7/2239 Paerl, H. Otten, T. Harmful Cyanobacterial Blooms: Causes, Consequences, and Controls. Microbial Ecology 2013 May;65(4):995-1010 http://www.unc.edu/ims/paerllab/research/cyanohabs/me2013.pdf Leao, P. *et al.* The chemical ecology of cyanobacteria. Natural Products Reports, 2012 Mar;29(3):372-91 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4161925/pdf/nihms-599340.pdf	
Ward	N/A	**Comment 2:** Given my time limitations for reviewing more recent work on how/whether nutrient management can reduce the magnitude and frequency of cyanobacteria blooms and toxin formation, I was unable to conduct the review I had originally anticipated on this question.	Noted

Ward	N/A	**Comment 3:** I believe the draft white paper correctly examines and compares the relative significance of various factors in controlling the growth and development of toxigenic blooms based on the limited data now available on this subject that is “Delta-specific”. However, as stated in answer to Question 1 (above), I also believe the factors considered, while appropriate, are nevertheless an incomplete list. At our meeting I mentioned the apparent role of competition for iron as a factor in bloom formation and dominance in freshwater ecosystems, and provided a citation for this. Other factors which should be considered include the differences in sensitivity to herbicides between cyanobacteria and other phytoplankton that are being reported in studies conducted elsewhere, and the role of allelopathy in bloom formation, dominance, and senescence. Allelopathy is also discussed in references provided in answer to Question 1. For pesticides – in this case, I focused on herbicides – please refer to references provided below.	Allelopathy was dicussed in the original version of the White paper under "Potential Functions of toxin production" on page 18. Two new references have been added to the previous references on allelophathy in this section.
Ward	N/A	**Comment 3 continued (references):** The USGS maintains an online geo-referenced database which charts the most commonly-used pesticides in CA as they have continued to change in recent years that is current through 2012: http://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php Lurling, M., Roessink, I.On the way to cyanobacterial blooms: Impact of the herbicide metribuzin on the competition between a green alga (Scenedesmus) and a cyanobacterium (Microcystis). Chemosphere, 2006, 65:4, 618-626. Peterson, H. *et al.* Toxicity of hexazinone and diquat to green algae, diatoms, cyanobacteria and duckweed. Aquatic Toxicology, 1997, 39(2), 111-134. Arunakumara, K. *et al.* Metabolism and degradation of glyphosate in aquatic cyanobacteria: a review African Journal of Microbiology Research, 2013 Vol. 7(32), pp. 4084-4090. http://www.academicjournals.org/article/article1380269900_Arunakumara%20et%20al.pdf	The potentially important influence of herbicides and fungicides on the prevalence of cyanobacteria vis-à-vis other phytoplankton is discussed in a new Section 3.7 on p. 31 and again under Section 4.2.1 p 33. Because concentrations of herbicides in the Delta have been demonstrated to be quite high, a recommendation has been added that selective sampling for herbicides and pesticides be instituted in the Delta.
Ward		**Comment 4**: In answer to this question, please see the additional references supplied in answer to Questions (1) and (3).	A citation by Holland and Kinnear (2013) has been added on the benefits of toxin production under iron limiting conditions as mentioned in previous comments.

Ward	N/A	**Comment 5:** Overall, I agree with the draft recommendation put forward regarding monitoring of CyanoHABs (Recommendation 1), but would place more emphasis on monitoring for more immediate threats to public health e.g., intakes for drinking water treatment plants either within the bloom-prone areas of the Delta. The waterboard's drinking water program staff has informed me that some public water supply systems are struggling to successfully contend with this issue elsewhere in California, and this may also be a recurrent problem for smaller communities in the Delta. With perennially limited resources, public health protection should be given the highest priority, followed closely by protection of beneficial uses such as threatened/endangered species already impacted by the Pelagic Organism Decline, and a (seasonal?) surveillance program for areas of the Bay/Delta which experience periods of frequent and prolonged recreational uses water-contact uses, fishing, etc. With respect to Recommendation 2, I am unclear as to what the model being described is intended to accomplish: will it, if properly deployed, facilitate successful toxigenic bloom "forecasting"? Will use of whatever model results from this development process be of assistance, say, to managers of local public water supplies whose intakes are situated in the Delta? Having worked on this issue for ten years, I am concerned that our scarce resources are not being directed at immediate (& often seasonally recurrent) cyanotoxin hazards, and that local public health officials and water system managers have too few resources to respond effectively, and in a timely manner, when these episodes occur.	Noted

Ward	N/A	**Comment 5 continued:** As an example, last year the public water supply system for 400,000 people in the greater Toledo area were shut down, causing a public emergency and immediate potable water shortage for the entire population, when a microcystin-producing Microcystis bloom swamped the treatment plant's capacity to remove it in the "finished" drinking water. The National Guard was called-up to help deliver potable to this large urban population, and the problem did not abate for several days. Prior to this episode, NOAA had been doing quite a bit of modeling, bloom-forecasting, and other scientific investigations on these recurrent toxigenic blooms on western portion of Lake Erie where Toledo area residents obtain their public water supplies. The NOAA investigations remain on-going, and no doubt have provided much useful information on the role of various environmental factors in bloom formation: their "mission", however, is not to protect specific public water supplies from catastrophic events such as this episode. http://www.washingtonpost.com/news/post-nation/wp/2014/08/04/toledos-water-ban-and-the-sensitivity-of-our-drinking-systems/	Noted

APPENDIX C

Comments from the Stakeholder and Technical Advisory Group (STAG) members and responses from the authors.

Author	Page	Comment	Response
Lee	N/A	Overall Comment: The findings expressed in the draft white papers are consistent with our many years of experience investigating nutrient-related water quality, our findings in investigating Delta nutrient impacts and control of excessive aquatic plants, as well as with the findings expressed in presentations made at the CWEMF Delta Nutrient Modeling Workhop discussed below.	Noted
Lee	N/A	There remains little ability to quantitatively and comparatively describe the role of nutrients (N and P) in controlling the excess fertilization of the Delta waters.	Noted
Lee	N/A	There is considerable misinformation in the professional arena on the relative roles of N and P concentrations and loads, and the ratios of N to P in affecting water quality in the Delta; some of the information presented on nutrient/water quality issues is biased toward preconceived positions.	Noted
Lee	N/A	Based on the results of the US and international OECD eutrophication study and our follow on studies of more than 600 waterbodies worldwide (lakes, reservoirs, estuarine systems) the planktonic chlorophyll levels in the Central Delta are well-below those that would be expected based on the phosphorus loads to the Delta.	Noted
Lee	N/A	There is a lack of understanding of the quantitative relationship between nutrient loads and fish production in the Delta.	Noted
Lee	N/A	The Delta Stewardship Council's timetable for developing Delta nutrient water quality objectives by January 1, 2016, and to adopt and begin implementation of nutrient objectives, either narrative or numeric as appropriate, in the Delta by January 1, 2018 is unrealistically short.	Noted
Lee	N/A	There is need for substantial well-funded, focused, and intelligently guided research on Delta nutrient water quality issues over at least a 10-yr period in order to develop the information needed to generate a technically sound and cost-effective nutrient management strategy for the Delta.	Noted
Lee	N/A	As discussed in our writings, some of which are noted below, it will be especially dfficult to develop technically valid and cost-effective nutrient control programs for excessive growths of macrophytes in the Delta.	Noted

Mioni	3	#2: pH may also be important (I see some correlations and I think Raphe mentioned a report). I believe some cyanobacteria can be more competitive when pH increases due to CO2 concentrating mechanism. I think Alex Parker did some research on the Delta pH... Also, the residence time may be affected by the pumping station located near the EMP Old River D28 station (a station with typically high Microcystis abundance).	Noted
Mioni	13	last paragraph: Please talk to Anke Mueller-Solger. I believe Microcystis was there before 2000 but was simply not monitored as closely or did not cause such bloom.	Noted
Mioni	16	Carbon fixation: I would include a few reference to the cyanobacteria carbon concentrating mechanism.	Noted
Mioni	16	Table 2.3: Microcystin LD50 varies depending on the variant	Noted
Mioni	20	typo "preceding"	Noted
Mioni	21	N:P ratio: I would cite Hans Paerl as well. I believe he has shown (in Lake Taihu?) that the N:P ratios were not so fixed for cyanobacteria.	Noted
Mioni	29	Salinity: I think Pia Moissander did phylogenetic studies in the SFBD and has shown that there were two types of Microcystis, one of those was associated with higher salinity.	Noted
Mioni	31	I agree that absolute concentrations of nutrients is more relevant than N:P ratios with regards to cyanobacteria. I believe Hans Paerl also demonstrated this (Nature paper? I can't recall the exact source).	Noted
Mioni	37	last paragraph: typo "water column"	Noted
Mioni	39	Old River stn (D28) usually has the highest abundance based on my monitoring. Antioch also has a high abundance of Microcystis. Pia Moisander's paper show that there may be two different strains (different requirements?) between antioch and other stations. It varies between years at other stations (see attached examples but please do not use as this is for the paper I am writing...)	Noted

Mioni	40	It really depends on the year. Aphanizomenon was very sporadic before 2011 and I focused on enumerating Microcystis which was the dominant cyanoHAB. But in 2011, Aphanizomenon was pretty significant. The tricky part here is that the Aphanizomenon cells are much larger than Microcystis so even if Aphanizomenon doesn't reach the cell density of Microcystis, it doesn't mean they are not dominating the bloom (e.g. 2011, it would clog my filters pretty quickly at some stations)... In 2012, Microcystis abundance was higher than in 2011 but Apha was still pretty abundant. I think that the "bloom" classification based on cell density should be revised to take into account the biovolume... Cell counts can be misleading.	Noted
Mioni	44	There is definitely variations explained by the method but there are also variations due to heterogeneity, patchiness and temporal variation. In Clear lake, while on station (within maybe 30min or less), we could see the scum moving very quickly with the wind. Also, the two net samples mostly applies to colonial forms of Microcystis although it occurs also as single cells and microcolonies. Another bias is the cell count. Prior to do my cell counts, I was homogenizing the samples by dislocating the colonies physically (based on prior research and comparison). I suspect that not dislocating the colonies prior to do the cell count may result in bias as the person enumerating the cells may not be able to count accurately as colonies can be more 3D than 2D (I hope it makes sense)... Although there is a bias in all methods, I do not think I ever collected samples in the same time than Peggy and at the same location. Thus, the comparison is a little puzzling to me. We never did intercomparison of the cell enumeration from the same samples. It would be more relevant to compare methods for the toxicology work since we did intercomparison of methods for the same samples.	Noted
Mioni	48	"colonial Microcystis have been more common", see my comments regarding the bias of tow net sampling versus grad raw water samples...	Noted

Mioni	4 & 35	#3 and page 35, temperature: Lenny Grimaldo generated a logistic model based on my CALFED data (see attached) which shows that Microcystis bloom probability raises to 50% when surface water temperature reaches 25C. Also, I suspect there is a minimum temperature that would need to be sustained for several days if not week for a bloom to initiate.	Noted
Mioni	42-43	I think the SWAMP report could be cited, especially for the SPATT results.	Noted
Mioni	Fig 4.5	Figure 4.5: the axis are not labelled and I have trouble understanding this figure.	Noted
Mioni	48	I could not find the figure 2 mentioned here…	Noted