Table H.1 Notes:

(1) This table summarizes readily available information about a variety of reservoir characteristics. The following notes illustrate Water Board staff's synthesis of this information to assess potential TMDL allocation and implementation options for the Reservoir Mercury Control Program. Citations for the material summarized in these notes are provided in the table. The notes indicate that particular types of mercury control actions and reservoir water chemistry and fisheries management practices might or might not be possible for a particular 303(d)-listed reservoir. However, these notes are not recommendations for reservoir-specific implementation actions. The Reservoir Mercury Control Program will not specify the actual means of compliance by which responsible entities choose to comply with the proposed TMDL allocations. These notes are intended to inspire additional discussions, monitoring, and cooperative studies and field trials. See sections 7.2–7.4 in Chapter 7 for a review of general assumptions about where different types of actions may be effective. The following notes provide additional information and assumptions specific to particular reservoirs.

(2) Reservoir sediment Hg concentration data are not available for 29 reservoirs on the 2010 303(d) List. Codes for reservoirs with sediment Hg data:

- BG Reservoir average surface sediment mercury concentration within the typical range of natural background soil mercury concentrations.
- MBG Reservoir average surface sediment mercury concentration within the typical range of modern background soil mercury concentrations, which includes storage of atmospheric deposition during the industrial era.
- X Reservoir average sediment mercury concentration exceeds typical modern and natural background soil mercury concentrations.
- X+ Reservoir average sediment mercury concentration more than doubles modern background concentrations.

(3) The USGS's MRDS database indicates that 56 of the 74 reservoirs initially included in this Reservoir Mercury Control Program have at least 1 historical gold and/or mercury mine feature. Codes for reservoirs with MRDS data:

- X+ Indicates a reservoir with a relatively higher density of historical mercury and/or gold mine sites.
- X+++ Indicate extremely high mine site densities.
- [#] Numbers in brackets indicate the number of mine features in watersheds with a very low density of historical productive mine sites or no productive mine sites. See Tables C.1 through C.6 in Appendix C for number of historical mercury, gold, and silver mine features and watershed mine site densities for 303(d)-listed reservoir watersheds.

(4) This section of Table H.1 summarizes readily available information about stocking practices, including CDFW stocking reports and CDFW Private Stocking Permits. Lack of information should not be assumed to equate to no stocking by CDFW or private parties. Generally, if there is a cooperative stocking agreement in place for a public water body, no permit is required for stocking public waters (ICF 2010). For example, East Bay Municipal Utility District (EBMUD) has an MOU with CDFW to match or exceed the numbers of rainbow trout CDFW plants in San Pablo and Lafayette reservoirs; East Bay Regional Parks (EBRP) also has an MOU with CDFW to plant fish in their reservoirs; and these two

agencies also plant channel catfish in summertime when water temperature gets too high to plant trout [Neillands (CDFW) pers. comm. 2014].

In addition, private parties may stock private waters without obtaining a Private Stocking Permit or notifying CDFW if they plant one of CDFW's eight accepted species, which include white, blue, and channel catfish, bluegill, rainbow trout, largemouth bass, redear sunfish, and Sacramento perch (ICF 2010). Parties can stock these fish without a permit in private reservoirs located in: (a) Alameda, Butte, Colusa, Contra Costa, Glenn, Imperial, Kern (except in the Kern River drainage above Democrat Dam), Kings, Lake (except in the Eel River drainage), Merced, Los Angeles, Napa, Orange, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, Santa Barbara, Solano, Stanislaus, Sutter, Tehama, Ventura, Yolo and Yuba counties; (b) Amador, El Dorado, Nevada, Tuolumne, Calaveras, Mariposa, and Placer counties west of Highway 49; and (c) Fresno, Madera, and Tulare counties west of the national park and national forest boundaries. Several of the 303(d)-listed reservoirs may be considered private waters or covered by cooperative agreements and therefore may not require private stocking permits for accepted species.

As a result, it is impossible to determine with certainty based on readily available information that no stocking has taken place at a reservoir unless the reservoir is closed to public fishing or the reservoir operators are contacted directly. Reservoirs closed to public fishing include Beach (Black Crown), Calaveras, Marsh Creek, and Davis Creek reservoirs.

The Central Valley Water Board contracted Moss Landing Marine Laboratories to compile information about fish distributions, creel surveys, fish stocking, and other fisheries management practices for 30 representative reservoirs throughout California. Once the survey report is finalized, Water Board staff will include the additional information in this section. Also, stakeholders may continue to provide additional information that could be included in future drafts.

(5) Almanor. This reservoir was listed per Listing Policy frequency-based thresholds; however, both 350 mm LMB and average TL4 fish MeHg concentrations are below the proposed target. Only one species, Sacramento sucker, a native species that is not predatory like bass, has average MeHg that exceeds the proposed target. Because of its large surface area and high ratio of surface area to watershed area, and because there are few mine sites in its watershed, Almanor fish MeHg likely would be responsive to reductions in atmospheric deposition. However, the USEPA's REMSAD model attributes very little of the atmospheric deposition to local anthropomorphic emissions. Consequently, improvements would rely on reductions in global emissions and reservoir water chemistry and fisheries management activities.

(6) Anderson. Source control is not expected to make substantial improvements, much less timely improvements, because fish MeHg levels are high while there is no record of mining activity in the watershed, sediment Hg is not elevated, and there is relatively low modelled atmospheric deposition with majority of it attributed to global emissions by USEPA's REMSAD model. Consequently, improvements would rely on reductions in global emissions and reservoir water chemistry and fisheries management activities. Staff cannot evaluate the nutrient management option without chlorophyll a (chlorophyll) data. Per preliminary input from Santa Clara Valley Water District (SCVWD) staff, SCVWD reservoirs are highly eutrophic, and due to current eutrophication, ongoing algae issues, and water quality treatment concerns, nutrient addition to reduce fish methylmercury is not possible; SCVWD focus is on oxygenation and aeration applications (Young 2014 pers. comm.).

SCVWD does not stock reservoirs per court order due to effects on federal and California Endangered Species Act (ESA) listed species and habitat including downstream steelhead habitat (Young 2014 pers. comm.).

(7) Beach. Water chemistry and fisheries management activities may be the only effective way to make relatively quick improvements. Attempting to reduce Beach Lake (a.k.a. Black Crown Lake) fish MeHg through source control efforts in the Morrison Creek watershed could be confounded by the complicated hydrology of its water inputs and the variety of sources that contribute to those inputs. Source information in this table reflects sources in the Morrison Creek watershed. However, it may receive water inputs from other sources. Per the Bufferlands master plan (Carollo Engineers. 2000.): “Black Crown Lake is a 28-acre artificial lake created by excavation of material for I-5 roadway fill. The lake is fed in the dry season by a high water table and by a channel located at the northern tip of the lake that connects to the perennial water supply of lower Morrison Creek. In winter, the lake is inundated by backwater flowing in from the Beach Lake dike on Morrison Creek. Diversion of water for agricultural use causes the elevation of the water surface to vary approximately 3–4 feet in summer. During this period, water is added to the lake through the channel connecting the lake to Morrison Creek.” The master plan provides the following description of Morrison Creek: "Morrison Creek is the northernmost of several streams that are tributaries to the Beach/Stone Lakes basin. It originates in portions of south Sacramento, Mather Air Force Base, and eastern Sacramento County. The headwaters of Morrison Creek and its tributaries are below an elevation of 300 feet; therefore, local winter rainfall runoff is the primary source of flow. During the summer months, the principal source of flow is runoff from urban irrigation (i.e., lawn watering and other dry-season runoff)."

Also, as noted in Chapter 6, discharges from groundwater treatment facilities may be an important source of flow in Morrison Creek, but are expected to have very low mercury concentrations. In addition, the USEPA’s REMSAD model attributes very little of the atmospheric deposition to local anthropomorphic emissions. Consequently, reducing mercury in atmospheric deposition and urban runoff would rely primarily on reductions in global industrial emissions. Finally, while historical gold mining activities took place in a relatively localized area of the Morrison Creek watershed, that area is more than 20 km upstream of Beach Lake. Consequently, sediment contaminated by mining waste may be dispersed across a large portion of the Morrison Creek channel and floodplain, which could be time-consuming if not impossible to remediate.

Beach Lake is closed to public fishing. If largemouth bass are the only species with elevated MeHg, intensive fishing and other fisheries management activities may be effective at reducing wildlife exposure to methylmercury. Additional fish, water, and sediment mercury data and hydrologic data are needed for Beach Lake to determine the most effective water chemistry and fisheries management strategies to reduce fish MeHg.

(8) Berryessa. Some reservoir arms have very contaminated sediment (1-7 ppm; CVRWQCB 1987); consequently, remediating mining waste is expected to make substantial fish MeHg reductions. In addition, aeration in these reservoir arms may be effective at reducing water MeHg levels. Such high sediment Hg concentrations indicate reducing atmospheric deposition likely would not make measurable improvements even though the reservoir has an immense surface area. Staff cannot evaluate the nutrient management option without chlorophyll data. The reservoir has been recently stocked with LMB and CHIN; reservoir monitoring data indicates LMB and CHIN have elevated MeHg. Consequently, stocking changes could be effective at reducing fish MeHg. Because of the

size of the reservoir, attempting to change the number of food web trophic levels likely would not be feasible.

(9) Big Bear. Reservoir sediment Hg concentrations are comparable to modern background, which indicates upstream historical mine sites may not be an important source. In addition, the USEPA's REMSAD model attributes <20% of the atmospheric deposition to local anthropomorphic emissions. Big Bear Municipal Water District (BBMWD) has an ongoing aquatic plant and carp harvest program to improve navigation and decrease nutrients, respectively (BBMWD 2010, 2011, 2013). The carp are removed using an electroshocking boat and an annual carp round-up contest to improve the desired trout fishery and reduce eutrophication induced by nutrients released by carp stirring up bottom sediments. Additional fisheries management (e.g., additional carp removals and intensive fishing) could both reduce methylmercury production within the reservoir and reduce bioaccumulation. In addition, BBMWD aerates the reservoir and has proposed to oxygenate the hypolimnion for nutrient management, which could lead to additional fish MeHg reductions (BBLNTTF 2008, 2010; BBMWD 2005, 2010, 2011, 2013). BBMWD also has conducted a variety of other remediation actions to address water quality concerns, such as: lake level stabilization, alum treatments to sequester phosphorous, sediment dredging, and public education and water conservation programs (BBMWD 2013; Hamilton 2007).

(10) Black Butte. Available records indicate only two productive historical mercury mine sites in the watershed. Consequently, mining waste remediation is not expected to make improvements in Black Butte. However, reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. Some fish MeHg reductions may occur if local industrial emissions (e.g., from geothermal power plants) are reduced. However, the USEPA's REMSAD model attributes <20% of the atmospheric deposition to local anthropomorphic emissions, while 55–66% MeHg reductions are needed to achieve the proposed target in predatory fish (Table 1.2). As a result, even if local industrial emissions were reduced to zero, global emissions would need to be substantially reduced, or other reservoir water chemistry or fisheries management activities would need to be implemented, to achieve the proposed fish target. Reservoirs in the Coast Ranges and southern California often have strong anoxia; consequently, reservoir water chemistry management activities such as oxygen and nitrate additions may be effective at reducing fish MeHg. However, water chemistry data (e.g., dissolved oxygen and chlorophyll) and sediment Hg data are needed to evaluate these and other reservoir water chemistry and fisheries management options for Black Butte.

(11) Bon Tempe. Reducing fish MeHg will likely need to rely on aeration or other reservoir management activities. This reservoir has a very small surface area and watershed area and has no record of mine sites or other industrial sources in its watershed; therefore, it should be responsive to reservoir water chemistry and fisheries management activities as well as reductions in atmospheric deposition. However, USEPA's REMSAD model attributes very little of the atmospheric deposition to local industrial emissions. As a result, source control would result in fish Hg reductions only if global emissions are reduced substantially. The reservoir has been stocked with both low-MeHg species (rainbow trout) and species that often have elevated MeHg (catfish), and largemouth bass has elevated MeHg while sunfish do not. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions,

intensive fishing, and stocking changes may be effective at reducing fish MeHg. Additional water chemistry data (e.g., chlorophyll) are needed to assess nutrient management and other potential MeHg management strategies.

(12) Britton. Fisheries management might be the most effective way to make timely improvements, or achieve the proposed fish target. Mine waste remediation is not expected to make improvements because of the very low reservoir sediment Hg (0.03 mg/kg), and because the historical mine sites, although geographically localized, are both far upstream and upstream of dams. Nutrient management is not expected to be effective because chlorophyll is above 3 µg/L. Dissolved oxygen decreases with reservoir depth; hence, depending on the residence time, oxygen or nitrate additions might be an effective method to reduce reservoir fish MeHg. However, the Pit #3 Dam, which forms Lake Britton, is used mainly to divert water into a penstock to generate hydroelectricity and its releases are managed to emulate the natural, unimpaired hydrology of the downstream reach to the extent possible (SWRCB 2007); consequently, water residence time may be short during several months of the year, which could limit the use of oxygen or nitrate additions to reduce reservoir fish MeHg.

(13) Calaveras. Given the small watershed size, we expect Calaveras to be responsive to short-term decreases in atmospheric deposition. Per USEPA's REMSAD model, local industrial emissions account for ~25% of atmospheric deposition to the reservoir. However, a ~60% reduction in TL4 fish MeHg is needed to achieve the proposed fish target. As a result, global emissions would need to be substantially reduced, or other reservoir water or fisheries management activities would need to be implemented, to achieve the proposed fish target. The San Francisco Public Utility Commission (SFPUD) has used hypolimnetic oxygen diffusers in Calaveras since 2005 to improve water quality and summer habitat for resident rainbow trout by increasing dissolved oxygen levels in the hypolimnion (Mobley et al. 2012). Evaluation of effects of oxygenation and related DO increases on reservoir fish methylmercury concentrations is underway. Preliminary input from SFPUD staff indicates the oxygen diffusers have for the most part eliminated anoxic conditions and that this is a mesotrophic reservoir and therefore would not be an appropriate candidate for nutrient addition (Fujita 2014).

(14) Camanche. The reservoir is currently being oxygenated to reduce hydrogen sulfide discharges downstream. This has reduced hydrogen sulfide discharges, reduced chlorophyll from 50 to 10 µg/L, and reduced phosphate concentrations. However, aqueous MeHg and sediment Hg were not measured. In addition, oxygenation began before the fish MeHg data were collected so a before/after oxygenation comparison is not possible. USEPA's REMSAD model predicts a moderate amount of atmospheric deposition to the reservoir surface, but attributes very little of the atmospheric deposition to local industrial emissions; consequently improvements would rely on reductions in global industrial emissions. Camanche has relatively low MeHg in TL4 fish (e.g., 0.33 mg/kg in 350 mm LMB) and is located directly downstream of Pardee Reservoir, which also has relatively low fish MeHg (0.28 mg/kg in 350 mm LMB) when compared to surrounding reservoirs (which are ~0.4 mg/kg), in spite of having a high density of upstream historical gold mines. In addition, the historical mine sites are widely dispersed in the watershed. Consequently, mining waste remediation is expected to make some improvements, but may not make substantial or timely improvements. Reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. Black bass apparently has low growth rates, and the reservoir has been stocked with black bass and catfish, as well as low-MeHg species such as rainbow trout;

therefore, fisheries management activities such as intensive fishing and stocking changes may be effective at reducing fish MeHg levels.

(15) Camp Far West. The reservoir has highly elevated sediment mercury concentrations and a very high watershed density of historical gold mine sites. Therefore, mining waste remediation is expected to make substantial reservoir fish MeHg reductions. However, the mine sites are widely dispersed throughout the watershed. Consequently, sediment contaminated by mining waste may be dispersed across a large portion of the watershed, which could be time-consuming if not impossible to remediate, so reservoir improvements are not expected to occur quickly. Camp Far West has exhibited depressed dissolved oxygen levels, and therefore may be a good candidate for oxygen or nitrate additions for water chemistry management to depress methylation and quickly reduce fish MeHg. Intensive fishing or other fisheries management activities may also quickly reduce fish MeHg. However, a 2-year study spanning extreme water level drawdown indicates that Camp Far West may be oligotrophic in the summer but eutrophic in the fall and winter, and that methylmercury from upstream rather than in-reservoir production may be important to bioaccumulation in Camp Far West (Stewart et al. 2008). Consequently, reservoir-specific studies of methylmercury sources and trophic status (i.e., whether oligotrophic) are needed prior to deploying water chemistry or nutrient addition pilot tests.

(16) Casitas. The reservoir has a relatively large surface area, high surface area to watershed area ratio, and very small watershed, which indicate it would be responsive to reductions in atmospheric deposition. However, USEPA's REMSAD model predicts low atmospheric deposition rates and attributes only 10% of atmospheric deposition to local industrial sources; consequently, global industrial emissions would have to be substantially reduced to cause a measurable decrease in fish MeHg. The reservoir has been stocked with trout and warm-water species, and largemouth bass has elevated MeHg while carp and redear sunfish do not. These traits, along with its southern California location (reservoirs in southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, intensive fishing, and stocking changes may be effective at reducing fish MeHg. However, concerns about stocked rainbow trout (RBT) inbreeding with ESA listed species such as steelhead trout could prevent fisheries management options that involve stocking RBT to provide low-MeHg sport fish opportunities for anglers and low-MeHg prey for predatory fish and other wildlife.

(17) Castaic. Reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, intensive fishing, and stocking changes may be the primary methods to make timely fish MeHg reductions and ultimately achieve the proposed fish target. Dissolved oxygen decreases from about 9 to 5 mg/L at a depth of about 160 feet. Because of its relatively large surface area, the reservoir may also be responsive to reductions in atmospheric deposition; however, USEPA's REMSAD model attributes very little of the atmospheric deposition to local industrial emissions. In addition, the reservoir receives almost all its water from outside its watershed; depending on the THg and MeHg concentration of the imported water, atmospheric deposition reductions to the reservoir surface may not be effective at reducing reservoir fish MeHg. In spite of the historical mine sites in the watershed, the reservoir sediment Hg is within modern background levels. Chlorophyll levels are so high that nutrient additions likely would not be an effective method to reduce fish MeHg. Of four fish species sampled, only largemouth bass has elevated MeHg, which indicates intensive fishing and other fisheries management activities may be effective at decreasing fish MeHg.

(18) Chabot. Given the small watershed size and lack of mine sites, the reservoir may be responsive to short-term decreases in atmospheric deposition. Per USEPA's REMSAD model, local industrial emissions account for ~30% of atmospheric deposition to the reservoir. However, ~50-60% fish MeHg reduction is needed to achieve the proposed fish target. As a result, even if local emissions were reduced to zero, global emissions would need to be substantially reduced, or other reservoir water or fisheries management activities would need to be implemented, to achieve the proposed fish target. The reservoir has been stocked with rainbow trout and channel catfish, and largemouth bass and carp have elevated MeHg while rainbow trout, channel catfish, and sunfish do not. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, intensive fishing, and stocking changes may be effective at reducing fish MeHg. Preliminary input from East Bay Municipal Utilities District (EBMUD) staff indicates all EBMUD reservoirs stratify (Mulchaey 2014b pers. comm.). Additional water chemistry data (e.g., chlorophyll) are needed to assess nutrient management and other potential MeHg management strategies. Nutrient additions may not be a viable option for reducing fish MeHg given Chabot was recently enrolled in the Statewide General NPDES Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (Order 2013-0002-DWQ, NPDES Permit CAG990005).

(19) Chesbro. Because of its small watershed, and the proximity of historical mining activity, Chesbro fish MeHg might have short-term improvements in response to mine waste remediation. However, reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. In addition, because fish MeHg is highly elevated—an ~80% reduction is needed to achieve the proposed fish target—additional reservoir management practices may be needed to make substantial short term improvements and ultimately achieve the proposed fish target. Per preliminary input from Santa Clara Valley Water District (SCVWD) staff, SCVWD reservoirs are highly eutrophic, and due to current eutrophication, ongoing algae issues, and water quality treatment concerns, nutrient addition to reduce fish methylmercury is not possible; SCVWD focus is on oxygenation and aeration applications (Young 2014 pers. comm.). SCVWD does not stock reservoirs per court order due to effects on federal and California ESA listed species and habitat including downstream steelhead habitat (Young 2014 pers. comm.). Predator fish species are undesirable as they move below the dams into steelhead streams and predate on the trout; possible management option is removing non-native fish including carp and bass (Young 2014 pers. comm.).

(20) Combie. Sediment Hg is very high (0.5 mg/kg) compared to other Sierra Nevada reservoirs, indicating that mine sites are the dominant source. However, most of the mine sites are upstream of Rollins Reservoir, which is more than 15 km upstream of Combie. USEPA's REMSAD model predicts moderate atmospheric deposition rates for the reservoir and its watershed and attributes only ~20% of the atmospheric deposition to local industrial sources. Although the watershed is relatively small, the high number of mine sites and their distance upstream may make it difficult to remediate enough sites to result in short-term improvements, unless there are just a couple grossly erosive mine sites in the Combie watershed downstream of Rollins Reservoir. There is no water chemistry or fish stocking to evaluate water chemistry and fisheries management options.

(21) Davis Creek. This very small reservoir was created to supply water for mining operations and is adjacent to the abandoned Reid Mine quicksilver processing facilities (Slotton et al. 2002; Homestake Mining Company 1987). There is no public access. This mesotrophic reservoir can experience pronounced anoxia in its hypolimnion (Slotton et al. 2002). In 1995 sediment mercury concentrations ranged from 0.1 mg/kg to >20 mg/kg in the different arms of the reservoir. Between 1995 and 2002, total mercury deposition in the reservoir decreased from about 230 kg/year to 2.0 kg/year, and mean surface sediment mercury concentration decreased from 2.6 mg/kg to 0.6 mg/kg (Slotton et al. 2002). It may be more cost effective to install aeration than cap or otherwise remediate the mining waste. Mining waste remediation would likely be effective at reducing fish methylmercury levels in a short period because of the small watershed size. In addition, fisheries management may be effective because of the small reservoir and watershed size and because it is not used for public fishing. This reservoir may also have some improvement from reductions in local industrial emissions because it has a high atmospheric deposition rate (compared to much of the state), USEPA's REMSAD model attributes >70% of the deposition to local California industrial sources, and the reservoir has a very small watershed.

(22) Del Valle. Given the small watershed size, Del Valle may be responsive to short-term decreases in atmospheric deposition. USEPA's REMSAD model attributes ~25% of atmospheric deposition to the reservoir surface to local industrial emissions. However, a ~60% fish MeHg reduction is needed to achieve the proposed fish target. As a result, even if local industrial emissions were reduced to zero, global emissions would need to be substantially reduced, or other reservoir water or fisheries management activities would need to be implemented, to achieve the proposed fish target. In addition, this reservoir receives almost all its water from outside its watershed. As a result, local watershed source control activities may not be effective at reducing fish MeHg. The reservoir has been stocked with both low-MeHg species (rainbow trout and Kokanee salmon) and species that often have elevated MeHg (channel catfish and Chinook salmon), and largemouth bass and channel catfish have elevated MeHg. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, intensive fishing, and stocking changes may be effective at reducing fish MeHg. Additional water chemistry data (e.g., chlorophyll) are needed to assess nutrient management and other potential MeHg management strategies. Nutrient additions may not be a viable option for reducing fish MeHg given Del Valle was recently enrolled in the Statewide General NPDES Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (Order 2013-0002-DWQ, NPDES Permit CAG990005). Even so, because this is a small reservoir, other reservoir water chemistry and fisheries management activities may be particularly effective at reducing fish MeHg.

(23) Don Pedro. The reservoir has slightly elevated sediment Hg and a high watershed density of historical gold mine sites. Therefore, mining waste remediation is expected to make at least some reservoir fish MeHg reductions. However, the mine sites are widely dispersed throughout the watershed. Consequently, sediment contaminated by mining waste may occur in many miles of channel, which could be time-consuming if not impossible to remediate, so reservoir improvements are not expected to occur quickly unless there were just a couple grossly erosive mine sites near the reservoir. The reservoir sediment Hg (average=0.13 mg/kg) is not as high as in nearby New Melones (average=0.21 mg/kg), and the reservoir surface area is large; consequently, reservoir fish Hg may be responsive to reductions in atmospheric deposition. However, although USEPA's REMSAD model

predicts a moderately high rate of atmospheric deposition to the reservoir surface, the model attributes very little of the atmospheric deposition to local industrial emissions. Consequently, global industrial emissions would have to be substantially reduced to cause a measurable decrease in fish MeHg. The reservoir may need to rely on fisheries management activities such as nutrient management, intensive fishing, and stocking changes, to make quick improvements. Don Pedro may be oligotrophic and has been stocked with both predatory and low-MeHg fish species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(24) East Park. Available records indicate only one productive historical mercury mine in the watershed. Consequently, mining waste remediation is not expected to make improvements in Black Butte. However, reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. USEPA's REMSAD model attributes ~25% of atmospheric deposition to the reservoir to local industrial emissions. However, 30–60% MeHg reductions are needed to achieve the proposed target in predatory fish (Table 1.2). As a result, even if local industrial emissions were reduced to zero, global emissions would need to be substantially reduced, or other reservoir water chemistry or fisheries management activities (e.g., oxygen or nitrate additions) would need to be implemented, to achieve the proposed fish target. Reservoirs in the Coast Ranges and southern California often have strong anoxia; consequently, reservoir water chemistry management activities such as oxygen and nitrate additions may be effective at reducing fish MeHg. However, water chemistry data (e.g., dissolved oxygen and chlorophyll) and sediment Hg data are needed to evaluate these and other reservoir water chemistry and fisheries management options for East Park.

(25) El Dorado Park Lakes. Quick fish MeHg reductions are not likely unless supplemental ground water source or methylating conditions are changed. The available fish methylmercury data for 1991-2010 did not appear to show a declining time trend during period after substantial Long Beach Southeast Resource Recovery Facility (SERRF) emission reductions, and SERRF emissions were the primary source of atmospheric deposition per USEPA's 2001 REMSAD model. The model did not include vehicle emissions, but the SERRF emissions were so great compared to all other local and global sources, and the reductions so substantial, some type of reduction in fish MeHg would be expected if atmospheric deposition was the driving mechanism for fish MeHg. All the fish MeHg data were collected from Coyote and Alamo Lakes in the northern system, which are hydraulically connected. The USEPA TMDL report for Los Angeles area lakes (USEPA 2012e) states that the northern four lakes receive supplemental water additions from a groundwater well that pumps into Coyote Lake. The purpose of the supplemental water is to maintain water levels in the park lakes system. The USEPA TMDL load analysis estimated that the supplemental groundwater contributed 74% of all mercury loading to the northern system lakes, and atmospheric deposition direct to the water surface contributed 26% (storm runoff and irrigation contributed <1%). The lake is stocked and is a popular fishing lake (it's in Fishing in the City Program); however, information about specific stocking practices (e.g., for bass) is not available. Consequently, stocking practices also could affect fish MeHg. Bluegill MeHg levels are much lower than bass mercury levels, ~0.04 mg/kg in bluegill compared to 0.1 to 0.7 mg/kg in LMB. Fisheries management practices such as intensive fishing and stocking changes may be effective at reducing fish MeHg. In addition, reservoir water chemistry management activities such as oxygen or nitrate additions may be effective.

(26) Englebright. Reservoir sediment Hg is elevated (0.24 mg/kg) compared to other Sierra Nevada reservoirs, indicating that mining waste from historical gold mining is a substantial anthropogenic source. However, because of the broad distribution of mine sites across the watershed and high density of mine sites, mine remediation likely would not result in short term improvements, unless there were just a couple grossly erosive mine sites near the reservoir. USEPA's REMSAD model predicts an elevated atmospheric deposition rate to the reservoir attributes ~30% of the atmospheric deposition to local industrial emissions. However, because of the potential magnitude of mine inputs, the large size of the watershed, and the relatively small reservoir surface area (compared to the watershed area), atmospheric deposition reductions likely would not result in quick improvements. Only a small decrease (~2 mg/L) in dissolved oxygen was observed down to 66 feet during the summer and fall sampling events; however, DO levels may drop at lower depths. Aeration may or may not be effective at reducing water and fish MeHg. Englebright may be oligotrophic and is stocked with both predatory and low-MeHg fish species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(27) Folsom. About half of the 63 sediment samples were analyzed with a high detection limit of ~0.1 mg/kg and were nondetects, resulting in a geomean of 0.073 mg/kg, which is in the upper range of modern background. The average of the 31 samples with detectable Hg is 0.14 mg/kg, which is elevated above modern background and indicates mine waste may be a substantial source. The mine sites are distributed throughout much of the large watershed; however, there are many mine sites near the reservoir. If there are erosive mine sites near the reservoir, mine remediation might result in short-term improvements. The large reservoir surface area and moderately elevated REMSAD atmospheric deposition rate indicate the reservoir may be responsive to atmospheric deposition reductions. However, USEPA's REMSAD model attributes only ~16% of atmospheric deposition to local industrial emissions. Folsom Lake has some decrease in DO at depth, so oxygenation might reduce MeHg production. Folsom may be oligotrophic and has been stocked with both predatory and low-mercury species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(28) Hell Hole. About a 70% reduction is needed in predatory fish MeHg to attain the proposed target. There is no record of any upstream gold, mercury, or silver mine sites. USEPA's REMSAD model attributes very little of the atmospheric deposition to local industrial emissions, so substantial reductions in global industrial emissions are required. Data available to Water Board staff indicates Hell Hole may be oligotrophic and has been stocked with both predatory and low-mercury species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg. Preliminary input from Placer County Water Agency (PCWA) staff indicates that Hell Hole is oligotrophic, stratifies in spring, and can be anoxic at sediment/water interface (Ransom 2014 pers. comm.). PCWA staff noted that rainbow trout, brown trout, and kokanee are stocked annually, and that a possible management action could be to eliminate brown trout stocking.

(29) Hensley. Only one reservoir sediment Hg result is available (0.026 mg/kg), and it is near natural background in spite of the relatively high mine density. The MRDS indicates several mine sites may have been flooded by reservoir construction. However, the majority of mine sites are 10–20 km upstream of the reservoir. This, combined with the low sediment Hg, indicates remediating mine sites likely would not result in substantial or quick

improvements; however, more sediment Hg data are needed to further evaluate the potential for mining waste remediation to achieve substantial fish MeHg reductions. The low reservoir surface area to watershed area ratio indicates reducing atmospheric deposition may not result in quick improvements. In addition, USEPA's REMSAD model attributes very little of the atmospheric deposition to local industrial emissions. It appears that the upstream Fresno River is ephemeral, which may increase the reservoirs chance of thermal stratification and anoxia. Aeration may reduce MeHg production. Also, LMB have elevated MeHg while carp do not, and Hensley has been stocked with low-mercury species; therefore Hensley may be a good candidate for intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg. Additional fish, water, and sediment mercury data are needed for Hensley to determine the most effective strategies to reduce fish MeHg.

(30) Herman. Because Lake Herman is small and has a very small watershed, the reservoir may be responsive to several different control options: aeration, fisheries management, reducing atmospheric deposition, and capping mine-contaminated sediments. USEPA's REMSAD model attributes ~50% of atmospheric deposition to local industrial emissions, many of which are expected to be reduced substantially during the next ten years. Mining waste at historical mine sites and in downstream channels in this small watershed is not visually apparent (it appears that mining waste has already been mostly washed downstream into the reservoir). If areas of reservoir sediment have elevated mercury from mining, capping these areas may be effective in reducing methylation. Also, LMB have elevated MeHg while sunfish do not, which indicates Herman may be a good candidate for intensive fishing or other fisheries management activities to quickly reduce fish MeHg. Because of its small size, aeration could be particularly effective to increase dissolved oxygen and depress methylation.

(31) Hetch Hetchy. Only brown trout, a predatory nonnative species, were sampled for MeHg by the 2007-2008 SWAMP California Lakes Study (Davis et al. 2010) and included in the linkage analysis (Chapter 5 and Appendix Z). A recent San Francisco Public Utilities Commission (SFPUC) analysis of brown trout (33 samples) and rainbow trout (9 samples) confirmed elevated fish MeHg levels in Hetch Hetchy (Horvath 2012). Further, the SFPUC analysis of four reservoir sediment samples (ranging from 0.031 mg/kg at the Tuolumne River input to 0.237 mg/kg near the dam) indicates sediment Hg levels above modern background levels. However, there is no record of historical gold mining in the Tuolumne River watershed upstream of Hetch Hetchy, and there is very little developed land in the watershed.[1] Reservoir sediment Hg levels could be influenced by deposition from historical mining emissions. USEPA's REMSAD model predicts moderately low atmospheric deposition rate and attributes very little of the atmospheric deposition to local industrial emissions. The watershed size and reservoir surface area to watershed area ratio indicate the reservoir may not experience rapid improvements in response to atmospheric deposition decreases. More monitoring is needed to determine if water chemistry and fisheries management would be effective. Studies involving atmospheric, sediment, water, and biota monitoring are underway to evaluate attributing sources of mercury bioaccumulation and the effect of ozone (from local emissions) on mercury deposition and

[1] The USGS's Mineral Resources Data System (MRDS) identifies only one historical mine site in the Hetch Hetchy's watershed (Table C.1 in Appendix C), but that site is likely incorrectly located, given the MRDS record for the mine site states it is located in Fresno County (USGS 2005). Further, no gold mining districts or significant gold deposits have been identified in the watershed (Clark 1998; Long et al. 1998). Less than 0.01% has been developed, and there are no densely populated areas in the watershed associated with NPDES-permitted MS4 service areas (Appendix E).

biota in Hetch Hetchy and other Tuolumne River watershed lakes and reservoirs (Horvath 2012; SFPUC and NPS 2012). Improvements may rely on reductions in global industrial emissions and upwind mitigation of sources of ozone and mercury deposition precursors.

(32) Hodges. Aeration/circulation and fisheries management may be the only effective methods to make relatively quick fish MeHg reductions and ultimately achieve the proposed fish target. Anoxia occurs during the summer. In spite of the historical mine sites in the watershed, the reservoir sediment Hg is within modern background levels. In addition, USEPA's REMSAD model predicts relatively low atmospheric deposition rates and attributes very little of the atmospheric deposition to local industrial emissions. Chlorophyll levels are so high that nutrient management likely would not be an effective method to reduce fish MeHg. Concerns about stocked rainbow trout (RBT) inbreeding with ESA listed species such as steelhead trout could prevent fisheries management options that involve stocking RBT to provide low-MeHg sport fish opportunities for anglers and low-MeHg prey for predatory fish and other wildlife.

(33) Indian Valley. Reservoir sediment Hg in Indian Valley Reservoir is about double that of East Park, Stony and Black Butte reservoirs to the north, which could indicate the importance of the elevated atmospheric deposition. However, given proximity to historical mining activities, watershed and reservoir sediment Hg levels also could be influenced by deposition from historical mining emissions and inputs from naturally mercury-enriched springs. Because the reservoir surface area is relatively large compared to its watershed area, it may be responsive to atmospheric deposition reductions, which may be possible given USEPA's REMSAD model attributes almost 60% of the atmospheric deposition to local industrial emissions that are expected to have substantial reductions. Given the low chlorophyll levels, nutrient management may be another way to quickly reduce fish MeHg. Also, all six of the species sampled have elevated MeHg, and the reservoir has been stocked with low-MeHg species; consequently, intensive fishing and other fisheries management activities may be effective. Due to its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), reservoir water chemistry management activities such as oxygen and nitrate additions may be effective.

(34) Kaweah. USEPA's REMSAD model predicts a moderate atmospheric deposition rate but attributes very little of the atmospheric deposition to local industrial emissions. Mine sites may be geographically localized, which might make remediation more feasible and effective, but the mines are >20 km upstream, which could increase the amount of time needed for improvements to be reflected downstream. Reservoir sediment Hg data are needed to further evaluate the potential for mining remediation to make substantially reduce fish MeHg. Four different bass species were sampled for mercury. In addition, the reservoir has been stocked with low-Hg species. The presence of multiple bass species and ability to stock low-Hg species indicate fisheries management may be effective at reducing fish MeHg. Additional fish, water, and sediment mercury data are needed for Kaweah to determine the most effective strategies to reduce fish MeHg.

(35) Lafayette. The reservoir has been stocked with low-MeHg species and is very small, and therefore may be responsive to stocking and other fisheries management changes. Both 350 mm bass and average TL4 fish MeHg are ~0.3 mg/kg, so only ~30% reduction in fish MeHg is needed to achieve proposed fish target. Because the reservoir watershed is so small (~1 square mile), the reservoir fish MeHg are expected to be very responsive to changes in atmospheric deposition. USEPA's REMSAD model attribute ~20% of atmospheric deposition to local industrial emissions, so even if local emissions were reduced to zero, global emissions would need to be reduced, or other reservoir water or

fisheries management activities would need to be implemented, to achieve the proposed fish target. This is a very small reservoir in the Coast Range, and as a result likely receives little inflow from its watershed during the summer and, depending on how much water it receives from outside its watershed, may become anoxic during the summer. Preliminary input from East Bay Municipal Utilities District (EBMUD) staff indicates all EBMUD reservoirs stratify (Mulchaey 2014b pers. comm.). Because of its small size, it may be particularly responsive to aeration or other reservoir chemistry management methods.

(36) Marsh Creek. Aeration would likely make relatively quick improvements and may be the most feasible short-term option for reducing wildlife exposure to fish MeHg. Slotton and others (1998) observed low dissolved oxygen (<3.5 ppm) throughout the <6-foot water column, without thermal stratification. Upstream mining waste remediation might also result in short-term improvements. The mine sites (particularly Mount Diablo Mine) are more than 10-20 km upstream, but the creek and watershed are small. Because the watershed is small, mining waste remediation would likely result in relatively quick downstream improvements. Slotton and others (1998) observed interannual variability in reservoir surface sediment Hg concentrations that they hypothesized was attributed to different rainfall and runoff patterns, with higher sediment Hg concentrations in the reservoir resulting from high rainfall and runoff "with a substantial amount of sediment material transported down Marsh Creek from upstream source regions, including the mine site." This would indicate a short travel time for waste material between the upstream mine sites and reservoir, and consequently relatively quick improvements at the reservoir if the upstream mining waste were remediated. The reservoir has high sediment Hg concentrations, and Slotton and others (1998) determined that one mine waste area in the upper watershed contributes more than 90% of mercury loading in the watershed; these factors indicate reducing global emissions (and associated atmospheric deposition) alone would likely not make measurable reductions in reservoir fish Hg, in spite of the small watershed size.

(37) McClure. The reservoir has slightly elevated sediment Hg and a high watershed density of historical gold mine sites; therefore, mining waste remediation is expected to make at least some reservoir fish MeHg reductions. However, the mine sites are widely dispersed throughout the watershed. Consequently, sediment contaminated by mining waste may occur in many miles of channel, which could be time-consuming if not impossible to remediate, so reservoir improvements are not expected to occur quickly unless there are just a couple grossly erosive mine sites near the reservoir. Both 350 mm bass and average TL4 fish MeHg are high (~0.7 mg/kg) compared to neighboring reservoirs even though the sediment Hg (0.11 mg/kg) is not particularly elevated. In addition the reservoir surface area is large; consequently, reservoir fish MeHg may be responsive to reductions in atmospheric deposition; however, although USEPA's REMSAD model predicts moderately high atmospheric deposition rates, REMSAD attributes very little of the atmospheric deposition to local industrial emissions. Reductions in atmospheric deposition would rely on reducing global industrial emissions. Dissolved oxygen decreased with depth in the late summer down to 3 mg/L or below, so aeration or nitrate additions may decrease MeHg production. In addition, McClure may be oligotrophic and is stocked with both predatory and low-Hg fish species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(38) Mendocino. Reducing fish MeHg by 60% to achieve the proposed fish target, much less making relatively quick reductions, likely will need to rely on reservoir water chemistry and

fisheries management practices. Reservoir sediment Hg is within natural background levels. In addition, USEPA's REMSAD model predicts relatively low atmospheric deposition rates and attributes very little of the atmospheric deposition to local industrial emissions. Also, there are no known historical mines in the watershed. Mendocino may be oligotrophic, has multiple bass species with elevated MeHg, and has been stocked with low-MeHg fish species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg. Due to its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), reservoir water chemistry management activities such as oxygen and nitrate additions may be effective.

(39) Mile Long Pond. Mile Long Pond and Robinson's Pond are in porous dredge tailings within the floodplain of the Feather River downstream of Lake Oroville and are directly hydrologically connected to the Feather River. The Oroville watershed has a moderate historical gold mine density and widely distributed mine sites. Consequently, the ponds likely receive mining waste from both local and distant sources. Bullhead and sunfish MeHg levels are lower than bass and carp mercury levels in Mile Long Pond, which indicates fisheries management practices such as intensive fishing may be effective at reducing fish MeHg. Additional fish, water, and sediment mercury data and hydrologic data are needed for these ponds to determine the most effective strategies to reduce fish MeHg.

(40) Millerton. Only one reservoir sediment Hg result is available (0.12 mg/kg), and it is at the upper range of modern background, which is unexpectedly low given the watershed has a moderately high density of historical gold mine sites, many of the mine sites are within 1-10 km of the reservoir, and many are classified in the MRDS as past producers. More sediment Hg data are needed to further evaluate the potential for mining waste remediation to achieve substantial fish MeHg reductions. The reservoir has been stocked within the last five years with striped bass and other warm water fish species, as well as low-mercury species (rainbow trout), but stocking recently ceased because disease outbreak could impact the downstream hatchery. Follow-up fish MeHg monitoring might indicate the effects of stocking cessation on reservoir fish MeHg levels. Intensive fishing and other fisheries management practices may be effective at decreasing fish MeHg. Millerton has higher mine density but lower fish MeHg than the neighboring Pine Flat Reservoir. USEPA's REMSAD model predicts moderate atmospheric deposition rates, and reservoir surface area is relatively large, which might make this reservoir responsive to decreases in atmospheric deposition if upstream mine sites are not grossly erosive. However, REMSAD attributes very little of the atmospheric deposition to local industrial emissions; hence, reducing mercury in atmospheric deposition would rely on reductions in global industrial emissions. Additional water and sediment mercury data are needed to determine the most effective strategies to reduce fish MeHg.

(41) Modesto. Modesto Reservoir is an off-channel reservoir that receives almost all its water from outside its proximal watershed. Both Modesto and Turlock reservoirs receive water from La Grange Reservoir, the regulating reservoir for Don Pedro Reservoir. Don Pedro has a high watershed density of historical gold mine sites, with the mine sites broadly dispersed across the watershed. Even so, Don Pedro generally has low mercury discharges—on average <0.8 ng/L THg and <0.02 ng/L MeHg— and Modesto Reservoir has very low sediment THg (5 samples with maximum of 0.01 mg/kg) compared to Don Pedro (1 sample with 0.13 mg/kg). Consequently, Modesto Reservoir may not be impacted by the mine sites in the Don Pedro watershed. In addition, Modesto Reservoir may be particularly responsive to reductions in atmospheric deposition because of its small

proximal watershed size, relatively large reservoir surface area, and lack of industrial sources in its proximal watershed. However, although USEPA's REMSAD model predicts elevated atmospheric deposition, REMSAD attributes very little of the atmospheric deposition to local industrial emissions; hence, reducing mercury in atmospheric deposition would rely on reductions in global industrial emissions. Modesto Reservoir has been stocked with low-MeHg species (rainbow trout), but only smallmouth bass and carp were monitored for MeHg in Modesto Reservoir. Additional fish species and water data (e.g., dissolved oxygen and chlorophyll) are needed to determine effective water chemistry and fisheries management strategies to reduce fish MeHg.

(42) Nacimiento. Both mining waste remediation and nutrient management have the potential to relatively quickly reduce fish MeHg. Many of the historical mercury mine sites are within ~10 km of Lake Nacimiento. In addition, the highly contaminated sediment may be relatively localized to one area of Nacimiento. Further, USEPA's REMSAD model predicts low atmospheric deposition rates for Lake Nacimiento and its watershed and attributes very little of the deposition to local industrial emissions. Consequently, mining waste remediation may result in both substantial and relatively quick fish MeHg reductions in the reservoir. However, Nacimiento may continue to have elevated fish MeHg even after mining waste is remediated if no other management actions take place to control MeHg production and bioaccumulation in the food web because of its high annual water level fluctuations and low chlorophyll levels. See section 7.2.1 in Chapter 7 for additional assessment of Lake Nacimiento conditions. Due to its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), reservoir water chemistry management activities such as oxygen and nitrate additions may be effective. Concerns about stocked rainbow trout (RBT) inbreeding with ESA listed species such as steelhead trout could prevent fisheries management options that involve stocking RBT to provide low-MeHg sport fish opportunities for anglers and low-MeHg prey for predatory fish and other wildlife. Bass and other sportfish populations are self-sustaining.

(43) Natoma. Lake Natoma is the regulating reservoir for upstream Folsom Lake. The fish MeHg in Natoma are not as elevated as in Folsom. There are very few mine sites in the watershed below Folsom. However, extensive dredge tailings comprise more than half the perimeter of Lake Natoma and several creeks pass through dredge tailings before they enter Natoma. There are likely several methylation hotspots in the reservoir that result from in situ MeHg production or upstream production in creeks, particularly where there is fluctuating and shallow water that inundates dredge tailings (e.g., Mississippi Bar). However, there are likely limited options for remediating the dredge tailings. In addition, in areas like Mississippi Bar there are likely too many small channels for aeration/circulation to be effective. In general, Lake Natoma does not have anoxia. Even so, if there are MeHg hotspots in bottom sediments of open-water areas, aeration/circulation may be effective. Communications with locals suggest that elemental Hg pools may be present in the gravel of local creeks. The reservoir has been stocked within the last five years with low-mercury species (rainbow trout), but stocking recently ceased because disease outbreak could impact the downstream hatchery. Follow-up fish MeHg monitoring might indicate the effects of stocking cessation on reservoir fish MeHg levels. Natoma is oligotrophic; therefore nutrient management, intensive fishing, and other fisheries management practices may be effective at reducing fish MeHg.

(44) New Bullards Bar. Although the reservoir has a relatively large reservoir surface area and therefore may be more responsive to atmospheric deposition reductions, the high watershed density of historical gold mine sites suggests the magnitude of mine inputs might

exceed atmospheric deposition inputs. Consequently, reducing atmospheric deposition likely would not result in short term improvements. Because of the broad distribution of mine sites across the watershed and high number of mine sites, mine remediation likely would not result in short term improvements, unless there were just a couple grossly erosive mine sites near the reservoir. Only one sediment sample result with adequate quality control is available, and it is comparable to natural background. Sediment mercury data are available in the CVRWQCB 1987 Regional Mercury Assessment (5 locations, average 0.205 mg/kg); however, per the study author and supplemental project files, samples were analyzed erroneously and are unusable. Nonetheless, they suggest reservoir sediment Hg levels may be elevated well above modern background levels, which is not surprising given the high watershed density of mine sites. More reservoir sediment Hg data are needed to further evaluate the potential for mining waste remediation to achieve substantial fish MeHg reductions. Although USEPA's REMSAD model predicts moderately elevated atmospheric deposition rates, REMSAD attributes very little of the atmospheric deposition to local industrial emissions. Reductions in atmospheric deposition would rely on reducing global industrial emissions. Low-MeHg species (rainbow trout and Kokanee) have been stocked, and nonnative predatory (largemouth and smallmouth bass) and other warm-water species (carp and bluegill) have elevated MeHg, which indicate intensive fishing, stocking changes, and other fisheries management activities may be effective at reducing fish MeHg. Preliminary input from Yuba County Water Agency staff indicates that the California Department of Fish and Wildlife actively manages New Bullards Bar as a black bass fishery, and the reservoir is home to trophy black bass (Rabone 2014 pers. comm.); this should be considered when assessing fisheries management options for reducing bass MeHg (e.g., intensive fishing, supply of low-MeHg prey fish, etc.). Additional water chemistry data are needed to evaluate whether oxygen, nitrate, or nutrient management also may be effective at reducing fish MeHg.

(45) New Hogan. New Hogan's watershed has an extremely high density of historical gold mine sites, but the sites are broadly dispersed across the watershed. Reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. Although USEPA's REMSAD model predicts moderately elevated atmospheric deposition to the reservoir surface, REMSAD attributes very little of the atmospheric deposition to local industrial emissions and consequently deposition reductions would rely on reductions in global industrial emissions. The neighboring Camanche Reservoir had a history of anoxic conditions, and is currently being oxygenated. If New Hogan reservoir also displays strong anoxia in its hypolimnion, then MeHg production may be inhibited by aeration. Black bass apparently has low growth rates, which indicates fisheries management activities such as intensive fishing may be effective at reducing fish MeHg levels. Additional water and sediment data are needed to further evaluate potentially effective water chemistry and fisheries management strategies.

(46) New Melones. The New Melones watershed has a high density of historical gold mine sites and highly contaminated sediment may be relatively localized to one area of the reservoir. However, the mine sites are widely dispersed throughout the New Melones watershed. Consequently, there are almost certainly many mine sites and miles of creek channels that need to be remediated. The reservoir sediment Hg (0.21 mg/kg) is elevated compared to modern background levels and sediment Hg levels in neighboring reservoirs (~0.1 mg/kg), which indicates mine inputs may dwarf inputs from atmospheric deposition. As a result, reductions in atmospheric deposition may not make short-term measurable decreases in fish MeHg. In addition, USEPA's REMSAD model attributes very little of the atmospheric deposition to local industrial sources. Dissolved oxygen decreased with depth in the late

summer down to 3 mg/L or below, so aeration may decrease MeHg production. In addition, New Melones may be oligotrophic and has been stocked with both predatory and low-MeHg fish species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(47) Nicasio. Source control is not expected to make substantial improvements, much less timely improvements, because fish MeHg needs to be reduced by ~50%, available mine site records indicated there were "occurrences" but no prospects or productive mine sites in the watershed, and there is relatively low REMSAD modelled atmospheric deposition with the majority of it attributed to global emissions. Largemouth bass apparently has low growth rates, and largemouth bass and carp have elevated MeHg while bluegill does not. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions and intensive fishing may be effective at reducing fish MeHg. Additional water chemistry data are needed to assess nutrient management and other potential MeHg management strategies.

(48) O'Neill Forebay. This reservoir was listed per Listing Policy frequency-based thresholds; however O'Neill average TL4 fish MeHg is about equal to the proposed fish target. Average channel and white catfish MeHg concentrations are less than 0.20 mg/kg, and both 350 mm LMB and average LMB MeHg concentrations are equal to 0.20 mg/kg. Only one species, striped bass, has average MeHg (0.3.4 mg/kg) that exceeds the proposed target. Implementation of the Delta MeHg TMDL may reduce fish MeHg in O'Neill because the Delta is the source of virtually all water in O'Neill and possibly the fish, too. O'Neill is supplied by the California aqueduct and Delta; water is pumped uphill from O'Neill to the San Luis Reservoir, and stored in San Luis until released back into O'Neill Forebay to continue downstream along the aqueduct. Available temperature data indicates O'Neill does not stratify, and as a result aeration likely would not be effective. O'Neill may be oligotrophic. However, O'Neill likely has short residence time and constant mixing because of its use for water supply/transport, and as a result nutrient management may or may not be technically feasible. Bass may be replenished by water imports from the Delta so nutrient, stocking, and other fisheries management activities may or may not be effective; O'Neill fish MeHg levels are similar to central Delta fish Hg. Further, nutrient additions may not be a viable option for reducing fish MeHg given O'Neill was recently enrolled in the Statewide General NPDES Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (Order 2013-0002-DWQ, NPDES Permit CAG990005). Although the reservoir has a large surface area, it receives much of its water from the Delta and northern California watersheds, and therefore is not expected to be responsive to local reductions in atmospheric deposition. Further, USEPA's REMSAD model predicts low atmospheric deposition rates to O'Neill Reservoir and its local watershed and attributes very little of the atmospheric deposition to local industrial emissions.

(49) Oroville. Although the watershed has a relatively high density of historical gold mine sites, the reservoir sediment Hg is very low (median = 0.017 mg/kg, n=9), and the mine sites are dispersed throughout much of the large watershed with many upstream of dams. As a result, mining waste remediation may not result in timely improvements unless there are erosive mine sites near the reservoir, particularly if they are near the reservoir arm with elevated sediment MeHg. The low sediment Hg, large reservoir surface area and elevated REMSAD atmospheric deposition rate indicate the reservoir may be responsive to

atmospheric deposition reductions. However, USEPA's REMSAD model attributes only ~10% of atmospheric deposition to local industrial emissions. Nutrient management may reduce fish MeHg; however, the chlorophyll data are highly variable. Fish and sediment MeHg concentrations for different reservoir arms had a significant positive correlation. This indicates aeration/circulation or nitrate additions in reservoir arms with elevated sediment MeHg may be effective at reducing MeHg production. Oroville may be oligotrophic and is stocked with predatory species, and therefore may be a good candidate for intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(50) Oxbow. This reservoir was listed per Listing Policy frequency-based thresholds; however, average fish MeHg is lower than the proposed target (Table 1.2 in Chapter 1). Only one species, Sacramento pikeminnow, has MeHg concentrations that slightly exceed the proposed target; results for 12 brown trout and 7 rainbow trout samples are all less than 0.1 mg/kg. Oxbow has upstream historical gold mine sites but not a particularly high watershed mine site density and the mine sites are broadly dispersed in the watershed. Reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. Oxbow may be oligotrophic; therefore, some short-term improvements may be possible from nutrient management and intensive fishing. Aeration probably would not be effective because available dissolved oxygen data indicates the reservoir likely does not become anoxic and the residence time is likely short. Preliminary input from Placer County Water Agency (PCWA) staff indicates that water level fluctuates daily and the reservoir typically does not stratify, although the surface water layer can show warming depending on location, air temperature, and recent operating regime (Ransom 2014 pers. comm.). Per PCWA staff, the reservoir has a very short residence time (hours to days), the sediment/water interface is not anoxic, and fish have not been stocked for decades.

(51) Pardee. Pardee Reservoir has relatively low fish MeHg (e.g., 0.28 mg/kg in 350 mm LMB) when compared to surrounding reservoirs (which are ~0.4 mg/kg), in spite of having a high density of upstream historical gold mines. In addition, the historical mine sites are widely dispersed in the watershed. Consequently, mining waste remediation is expected to make some improvements, but may not make substantial or timely improvements. USEPA's REMSAD model predicts a moderate amount of atmospheric deposition to the reservoir surface, but attributes very little of the atmospheric deposition to local industrial emissions; consequently, improvements related to source control would rely on reductions in global industrial emissions. Reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. Camanche Reservoir, directly downstream, has a history of anoxic conditions and is currently being oxygenated. If Pardee Reservoir also displays strong anoxia in its hypolimnion, then MeHg production might be inhibited by aeration. The reservoir has been stocked within the last five years with largemouth bass and catfish, consequently stocking changes, intensive fishing, and other fisheries management practices may be effective at decreasing fish MeHg.

(52) Pillsbury. Reducing fish Hg by ~80% to achieve the proposed fish target, much less making relatively quick reductions, likely will need to rely on reservoir water chemistry and fisheries management activities rather than source control. Reservoir sediment Hg is within modern background levels and there are no known historical productive mine sites in the watershed. In addition, USEPA's REMSAD model predicts moderate atmospheric deposition rates and attributes only a small portion of the atmospheric deposition to local

industrial emissions (e.g., geothermal power), which are expected to decrease substantially during the next ten years. Because the reservoir surface area is relatively large, the reservoir may be responsive to reductions in atmospheric deposition, but only if substantial reductions in global industrial emissions occur. Pillsbury may be oligotrophic, has multiple species with elevated MeHg, and has been stocked with low-MeHg fish species. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, nutrient management, intensive fishing, stocking changes, or other fisheries management activities may be effective at reducing fish MeHg.

(53) Pine Flat. Only one reservoir sediment Hg result is available (0.08 mg/kg), and it is within the range of modern background levels in spite of the moderately high mine density. The majority of historical gold mine sites are classified in the MRDS as occurrence, prospect, or unknown status. In addition, the mines are localized but some are >20 km upstream. As a result, mining waste remediation may have little effect on fish MeHg. More sediment Hg data are needed to further evaluate the potential for mining waste remediation to achieve substantial fish MeHg reductions. USEPA's REMSAD model predicts relatively moderate atmospheric deposition rates, and reservoir surface area is relatively large, which might make this reservoir responsive to decreases in atmospheric deposition. However, REMSAD attributes very little of the atmospheric deposition to local industrial emissions. The reservoir has been recently stocked with Chinook salmon and "warm-water fish species"; warm-water species stocked elsewhere typically include catfish, bass, and sunfish, but information available for Pine Flat does not specify the particular species stocked. Mercury data are available for largemouth bass, white catfish, and carp in Pine Flat; largemouth bass and white catfish have elevated MeHg. Consequently, stocking changes, intensive fishing, and other fisheries management activities may be effective at decreasing fish Hg. The reservoir likely thermally stratifies, so aeration may reduce MeHg production, but water chemistry data (e.g., dissolved oxygen and chlorophyll) are needed to evaluate this and other reservoir water chemistry and fisheries management options such as nitrate and nutrient additions.

(54) Puddingstone. The USEPA TMDL load analysis indicated that about half of all loading to the reservoir is from atmospheric deposition direct to the reservoir surface, and almost all the rest from NPDES-permitted stormwater, much of which likely comes from atmospheric deposition (USEPA 2012e). Four reservoir sediment Hg results range between 0.12 and 0.15 mg/kg, with an average just slightly above modern background levels. USEPA's REMSAD model predicts very elevated atmospheric deposition rates, and REMSAD attributed about half of the atmospheric deposition to local industrial emissions. About 30% of the watershed is urbanized and about 20% is characterized as developed open space. Consequently, reductions in local anthropogenic emissions are expected to make both substantial and relatively quick reservoir fish MeHg reductions. The reservoir has been stocked with channel catfish, which has elevated MeHg in other California reservoirs, but no MeHg data are available for this fish in Puddingstone. Largemouth bass have elevated MeHg (average=0.38 mg/kg) but carp do not (average=0.05 mg/kg). These traits, along with its southern California location (reservoirs in southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions and intensive fishing may be effective at reducing fish MeHg. Nutrient additions may not be a viable option for reducing fish MeHg given Puddingstone was recently enrolled in the Statewide General NPDES Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control

Applications (Order 2013-0002-DWQ, NPDES Permit CAG990005). Mercury data for additional fish species are needed to evaluate other potential fisheries management methods.

(55) Pyramid. Reservoir water chemistry and fisheries management may be the primary methods to make timely fish MeHg reductions. USEPA's REMSAD model predicts relatively low atmospheric deposition rates and attributes less than 20% of the deposition to local industrial emissions. In addition, the reservoir does not have an overly large surface area and it receives almost all its water from outside its watershed. As a result, reservoir fish MeHg may not be responsive to local atmospheric deposition reductions. Further, although the Pyramid watershed has a moderately high density of historical gold mine sites, the mine sites are broadly dispersed across the watershed. Reservoir sediment Hg data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. The reservoir has been stocked with rainbow trout; largemouth bass, channel catfish, and brown bullhead have elevated MeHg while rainbow trout do not. These traits, along with its southern California location (reservoirs in southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, intensive fishing, and stocking changes may be effective at reducing fish MeHg. Chlorophyll levels are so high that nutrient management likely would not be an effective method to reduce fish MeHg.

(56) Robinsons Pond. Robinson's Pond and Mile Long Pond are in porous dredge tailings within the floodplain of the Feather River downstream of Lake Oroville and are directly hydrologically connected to the Feather River. The Oroville watershed has a moderate historical gold mine density and widely distributed mine sites. Consequently, the ponds likely receive mining waste from both local and distant sources. Only LMB and carp were sampled in Robinson's Pond and both have elevated MeHg. Bullhead and sunfish MeHg levels are lower than bass and carp mercury levels in Mile Long Pond, which indicates fisheries management practices such as intensive fishing may be effective at reducing fish MeHg in both ponds. Additional fish, water, and sediment mercury data and hydrologic data are needed for these ponds to determine the most effective strategies to reduce fish MeHg.

(57) Rollins. The reservoir has highly elevated sediment mercury concentrations and an extremely high watershed density of historical gold mine sites. Therefore, mining waste remediation is expected to make substantial reservoir fish MeHg reductions. However, the mine sites are widely dispersed throughout the watershed. Consequently, sediment contaminated by mining waste may be dispersed across a large portion of the watershed's creek and river channels, which could be time-consuming if not impossible to remediate, so reservoir improvements are not expected to occur quickly unless there are just a couple grossly erosive mine sites. USEPA's REMSAD model predicts moderate atmospheric deposition rates for the reservoir and its watershed but attributes only ~20% of the atmospheric deposition to local industrial emissions. Even so, Rollins may be oligotrophic, is stocked with both predatory and low-MeHg fish species, and may have black bass with low growth rates. Consequently, Rollins may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(58) San Antonio. San Antonio fish MeHg (e.g., 0.23 mg/kg in TL4 fish and 0.24 mg/kg in 350 mm LMB) barely exceeds the proposed fish target. There are no known historical mine sites in the San Antonio watershed, and just one historical gold prospect. Because the reservoir surface area is relatively large, the reservoir may be responsive to reductions in atmospheric deposition, but only if substantial reductions in global industrial emissions

occur. USEPA's REMSAD model predicts low atmospheric deposition rates for San Antonio and its watershed and attributes very little of the deposition to local industrial emissions. Nutrient management is not expected to be effective because chlorophyll is above 3 µg/L. See section 7.2.1 in Chapter 7 for additional assessment of San Antonio conditions. Largemouth bass and carp have elevated MeHg, while brown bullhead, smallmouth bass, and white catfish do not. These traits, along with its southern California location (reservoirs in southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions and intensive fishing may be effective at reducing fish MeHg. Concerns about stocked rainbow trout (RBT) inbreeding with ESA listed species such as steelhead trout could prevent fisheries management options that involve stocking RBT to provide low-MeHg sport fish opportunities for anglers and low-MeHg prey for predatory fish and other wildlife. Bass and other sportfish populations are self-sustaining.

(59) San Luis. Most of the water in San Luis is pumped uphill from O'Neill Forebay, which is supplied by the California aqueduct and Delta, and ultimately released back into O'Neill Forebay to continue downstream along the aqueduct. San Luis is a large and likely well-mixed reservoir because of power generation and water supply/transport activities; as a result, aeration may not be an effective tool in spite of its Coast Ranges location. There is a hypothesis that bass may be replenished by water imports from the Delta and O'Neill, in which case nutrient, stocking, and other fisheries management activities may not be effective. However, San Luis has three times higher fish MeHg than O'Neill. This indicates fish are affected by conditions in San Luis and that pilot tests of nutrient, stocking, and other fisheries management activities may be warranted. Reservoir operations are very unique. This reservoir warrants its own study, especially given aquatic plant removal activities are already being considered for water supply reasons. USEPA's REMSAD model predicts low atmospheric deposition rates to San Luis Reservoir and its local watershed and attributes very little of the atmospheric deposition to local industrial emissions.

(60) San Pablo. There are no known mine sites in the watershed. Given its small watershed size, the reservoir may be responsive to decreases in atmospheric deposition. However, USEPA's REMSAD model predicts moderately low atmospheric deposition rates to the reservoir and its watershed, and attributes only ~20% of atmospheric deposition to local industrial emissions. In addition, about ~60% reduction in 350 mm LMB MeHg, and ~20% reduction in average TL4 fish MeHg, are needed to achieve the proposed fish target. Consequently, either global emissions need to be substantially reduced, or other reservoir water or fisheries management activities need to be implemented, to achieve the proposed fish target. The reservoir has been stocked with crappie, catfish, and rainbow trout. Largemouth bass have elevated MeHg, while carp, black crappie, and channel catfish do not. No MeHg data are available for rainbow trout in San Pablo, but rainbow trout in other California reservoirs typically have low MeHg levels. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, intensive fishing, and stocking changes may be effective at reducing fish MeHg. Preliminary input from East Bay Municipal Utilities District (EBMUD) staff indicates all EBMUD reservoirs stratify (Mulchaey 2014b pers. comm.). Additional water chemistry data are needed to assess nutrient management and other potential MeHg management strategies.

(61) Scotts Flat. The watershed has a high density of historical gold mine sites, but the MRDS classifies most of the sites as occurrence or unknown status, and the fish MeHg

concentrations (e.g., 0.32 mg/kg in LMB) are relatively low given the high mine density, which indicate that mining waste may not be a dominant source. Reservoir sediment mercury data are not available to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation. The very small watershed size and moderately elevated REMSAD atmospheric deposition rate indicate the reservoir may be responsive to atmospheric deposition reductions if mining waste is not a dominant source. However, REMSAD attributes only ~15% of atmospheric deposition to local industrial emissions; consequently, improvements would rely on substantial reductions in global industrial emissions. No dissolved oxygen or chlorophyll data are available, so reservoir water chemistry and fisheries management activities such as oxygen, nitrate, and nutrient additions cannot be assessed at this time. However, low-MeHg species such as rainbow trout and Kokanee salmon have been stocked. In addition, largemouth bass has elevated MeHg but brown trout, rainbow trout, and green sunfish do not. Consequently, fisheries management activities such as intensive fishing and stocking changes might be effective at reducing fish MeHg.

(62) Shadow Cliffs. There are no known mine sites in the watershed. Even so, Shadow Cliffs Reservoir has a very high reservoir surface area to watershed ratio, a tiny watershed, and small surface area. As a result, multiple methods may make relatively quick reductions in fish MeHg. USEPA's REMSAD model attributes only about 21% of atmospheric deposition to local industrial emissions, but 15% is attributed to cement plants, which will likely experience substantial (~90%) reductions as the new USEPA air rule for cement plant emissions is implemented. However, ~50% reduction is needed in high trophic level fish to achieve the proposed target; hence, source control alone would not fix the mercury impairment if global industrial emissions are not reduced substantially. Catfish and rainbow trout have been stocked. Largemouth bass has elevated MeHg, while bluegill, carp, rainbow trout, and channel catfish do not. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, intensive fishing, and stocking changes may be effective at reducing fish MeHg. Additional water chemistry data (e.g., chlorophyll data) are needed to assess nutrient management and other potential MeHg management strategies. Nutrient additions may not be a viable option for reducing fish MeHg given Shadow Cliffs was recently enrolled in the Statewide General NPDES Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (Order 2013-0002-DWQ, NPDES Permit CAG990005).

(63) Shasta. Shasta had a moderate watershed density of widely distributed historical gold and silver mine sites. Mercury results for only three sediment Hg samples (0.090, 0.121, and 0.123 mg/kg), one each collected at different locations, are available Shasta; none are elevated compared to the others. More sediment Hg data are needed to further evaluate the potential for mining waste remediation to achieve substantial fish MeHg reductions. If some reservoir arms have contaminated sediment, sediment removal/capping and other reservoir water chemistry management practices in these areas may be effective at reducing fish MeHg. Shasta sediment Hg is more than three times higher than sediment Hg in upstream Lake Britton, which indicates historical mine sites and atmospheric deposition may be important sources to Shasta; however, the three sediment Hg results are only slightly elevated above modern background levels. USEPA's REMSAD modelled atmospheric deposition rate is higher at Shasta than at Britton but is still relatively low compared to elsewhere in the state. In addition, REMSAD attributes more of the atmospheric deposition at Shasta to local industrial emissions (e.g., cement plants and

geothermal power plants) than at Britton, but attributes less than 20% of atmospheric deposition at Shasta to local industrial emissions. Also, even though the large reservoir surface area may make the reservoir more responsive to atmospheric deposition reductions, the slightly elevated sediment Hg indicates the mine inputs may be great enough that substantial reductions in atmospheric deposition from local and global industrial would be needed to cause substantial fish MeHg reductions. A combination of mining waste remediation and industrial emission reductions likely will be needed to achieve the 10–30% reductions in high trophic level fish needed to achieve the proposed fish target.

Shasta may be oligotrophic and is stocked with both predatory and low-MeHg fish species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg. Shasta has been stocked with Chinook salmon and rainbow trout. Chinook salmon, carp, channel catfish, and largemouth bass have elevated MeHg, spotted bass average MeHg equals the proposed target, and rainbow trout and bluegill have low MeHg. Chlorophyll levels in Shasta are among the lowest observed in any of the reservoirs, which indicate nutrient management could be particularly effective. However, the size of the reservoir could make widespread implementation of this method, as well as other water chemistry and fisheries management practices, difficult.

(64) Shastina. Fish MeHg data are available only for largemouth bass and indicate LMB are only moderately elevated (0.23 mg/kg in 350 mm bass, 0.27 mg/kg in average TL4). MRDS has no record of any historical mine sites in watershed. There are no NPDES facility discharges in the watershed. The watershed is relatively small, and USEPA's REMSAD-modelled atmospheric deposition rate is moderate, so reservoir fish MeHg may be responsive to reductions in atmospheric deposition. However, REMSAD attributes very little of the atmospheric deposition to local industrial emissions. So improvements would rely on reductions in global industrial emissions. The reservoir has been recently stocked with brown trout and rainbow trout, but MeHg monitoring data are available only for largemouth bass. Largemouth bass has relatively low growth rates, which indicates fisheries management activities such as intensive fishing may reduce fish MeHg. Reservoir monitoring data (e.g., dissolved oxygen and chlorophyll and MeHg in additional fish species) are needed to evaluate the potential for other reservoir water chemistry and fisheries management practices such as oxygen, nitrogen, and nutrient additions, to effectively reduce fish MeHg.

(65) Sherwood. Sherwood needs >60% reduction in high trophic level fish MeHg to attain the proposed fish target. There are no known mine sites or industrial discharges in the watershed. Water Board staff's land use evaluation indicates only about 2% of the watershed has been urbanized, and about 12% of the watershed is developed open space. This reservoir has a small watershed, which likely makes it responsive to reductions in atmospheric deposition. However, USEPA's REMSAD modelled atmospheric deposition rate is relatively low, and REMSAD attributes less than 20% of the atmospheric deposition to local industrial emissions. Per USEPA's 2010 TMDL report, algae, ammonia, eutrophication, and low dissolved oxygen impairments are subject to a previous TMDL. In addition, USEPA's 2010 TMDL report states, "the lake is primarily fed by watershed runoff but also contains natural springs." Improvements may rely on reservoir water chemistry and fisheries management activities. Oxygen or nitrate additions and intensive fishing could be effective at decreasing fish MeHg. Collection of chlorophyll, dissolved oxygen, and fish MeHg data before and after TMDL implementation actions taken to address the algae,

ammonia, eutrophication, and low dissolved oxygen impairments would be useful for determining the most effective strategies for reducing fish MeHg.

(66) Slab Creek. Slab Creek watershed has a relatively high density of localized mine sites, but the reservoir has very low sediment Hg levels (16 samples ranging between 0.004 and 0.06 mg/kg) that are within the range of natural background levels. Consequently, mining waste remediation may or may not substantially reduce reservoir fish MeHg. USEPA's REMSAD modelled atmospheric deposition rate is moderately low and REMSAD attributes very little of the atmospheric deposition to local industrial emissions. During May, September and August 2011 Water Board sampling the dissolved oxygen down to 66 feet did not measure below 9 mg/L; the dam is >100 feet, so DO may be lower close to the bottom, but additional DO data are needed to evaluate water chemistry management strategies. Slab Creek may be oligotrophic. In addition, brown trout, Sacramento sucker, and Sacramento pikeminnow have elevated MeHg, while rainbow trout does not. Consequently, Slab Creek may be a good candidate for nutrient management, intensive fishing, or other fisheries management activities to quickly reduce fish MeHg.

(67) Solano. Solano is immediately downstream of Lake Berryessa, which has a moderate watershed density of widely distributed historical mercury, gold and silver mine sites. MRDS records indicate all of the historical mine sites are upstream of Berryessa. Sediment Hg data for Berryessa indicates mining waste remediation could enable substantial reductions in Berryessa fish MeHg; however, reservoir sediment mercury data are not available for Solano to enable further analysis of the potential effectiveness and timing of benefits from mining waste remediation for Solano fish MeHg. Solano has a small surface area and small capacity. Consequently, Solano is expected to be responsive to reductions in MeHg and THg concentrations in Berryessa discharges that result from upstream mining waste remediation and other in-reservoir MeHg management activities. However, Solano may not have short-term improvements resulting from atmospheric deposition reductions. USEPA's REMSAD model attributes ~20% of atmospheric deposition to Solano's water surface to local industrial emissions, and ~50% of atmospheric deposition to its watershed to local industrial emissions. However, atmospheric deposition reductions likely will not result in timely improvements for Solano because of its small surface area to watershed area ratio, the abundance of upstream mines, and the majority of its watershed is upstream of Lake Berryessa. Depending on the reservoir residence time, oxygen or nitrate additions may be effective at reducing water and fish MeHg in Solano. Solano has been stocked with rainbow trout, but reservoir monitoring MeHg data are available only for Sacramento sucker and small hitch. Sacramento sucker MeHg are elevated (average = 0.4 mg/kg), but hitch are not. Concerns about stocked rainbow trout (RBT) impacting ESA listed species could prevent fisheries management options that involve stocking RBT to provide low-MeHg sport fish opportunities for anglers and low-MeHg prey for predatory fish and other wildlife. Additional water chemistry data (e.g., chlorophyll) and MeHg data for additional fish species present in the reservoir are needed to assess fisheries management options such as intensive fishing and nutrient additions.

(68) Sonoma. Reducing fish Hg by ~70% to achieve the proposed fish target, much less making relatively quick reductions, likely will need to rely on reservoir water chemistry and fisheries management activities rather than source control. Reservoir sediment Hg is within modern background levels for the Coast Ranges. Available records indicate only one historical productive mercury mine site in the watershed. In addition, USEPA's REMSAD model attributes only a small portion of the atmospheric deposition to local industrial emissions (e.g., geothermal power), which are expected to decrease substantially during the next ten

years. Because the reservoir surface area is relatively large, the reservoir may be responsive to reductions in atmospheric deposition, but only if substantial reductions in global industrial emissions occur. Sonoma may be oligotrophic and has multiple species with elevated MeHg. These traits, along with its Coast Ranges location (reservoirs in the Coast Ranges and southern California often have strong anoxia), indicate reservoir water chemistry and fisheries management activities such as oxygen and nitrate additions, nutrient management, intensive fishing, or other fisheries management activities could be effective at reducing fish MeHg.

(69) Stevens Creek. There are no known mine sites or industrial discharges in the watershed. Given the small watershed size, the reservoir may be responsive to short-term decreases in atmospheric deposition. Per REMSAD, local industrial emissions account for ~30% of atmospheric deposition to the reservoir, and cement plants are the primary Hg emissions in the region. Cement plant emissions will likely experience substantial (~90%) reductions as the new USEPA air rule for cement plant emissions is implemented. However, a ~70% fish Hg reduction is needed to achieve the proposed fish target. As a result, global emissions would need to be substantially reduced, or other reservoir water or fisheries management activities would need to be implemented, to achieve the proposed fish target. Because this is a small reservoir, oxygen or nitrate additions could be particularly effective. The Santa Clara Valley Water District (SCVWD) will soon oxygenate this reservoir, as a reference site to compare to SCVWD reservoirs with upstream mine sites. Staff cannot evaluate the nutrient management option or other fisheries management practices without chlorophyll data. Per preliminary input from Santa Clara Valley Water District (SCVWD) staff, SCVWD reservoirs are highly eutrophic, and due to current eutrophication, ongoing algae issues, and water quality treatment concerns, nutrient addition to reduce fish methylmercury is not possible; SCVWD focus is on oxygenation and aeration applications (Young 2014 pers. comm.). SCVWD does not stock reservoirs per court order due to effects on federal and California ESAlisted species and habitat including downstream steelhead habitat (Young 2014 pers. comm.). Predator fish species are undesirable as they move below the dams into steelhead streams and predate on the trout; possible management option is removing non-native fish including carp and bass (Young 2014 pers. comm.).

(70) Stony Gorge. Available records indicate only one productive historical mercury mine in the watershed. In addition, there is one available reservoir sediment Hg result (0.11 mg/kg) that is within the upper range of natural background levels for the Coast Ranges, indicating mining waste is not a substantial source to the reservoir. Per USEPA's REMSAD model, local industrial emissions account for ~20% of atmospheric deposition to the reservoir. However, 30–40% MeHg reductions are needed to achieve the proposed target in predatory fish (Table 1.2). As a result, even if local industrial emissions were reduced to zero, global emissions would need to be substantially reduced, or other reservoir water chemistry or fisheries management activities would need to be implemented, to achieve the proposed fish target. Reservoirs in the Coast Ranges and southern California often have strong anoxia; consequently, reservoir water chemistry management activities such as oxygen and nitrate additions may be effective at reducing fish MeHg. However, water chemistry data (e.g., dissolved oxygen and chlorophyll) and additional sediment Hg data are needed to evaluate these and other reservoir water chemistry and fisheries management options.

(71) Thermalito. This reservoir was listed per Listing Policy frequency-based thresholds; however, both 350 mm LMB and average TL4 Hg concentrations are below the proposed fish target. There are no known historical gold, silver or mercury mine sites in its local

watershed. Thermalito receives almost all its water from outside its local watershed. Although its supply watershed, the Feather River watershed upstream of Lake Oroville, has a high density of historical gold mine sites, Thermalito has very low sediment mercury concentrations (3 samples with a maximum of 0.01 mg/kg) within the range of natural background levels. This indicates the reservoir may not receive contaminated sediment from its supply watershed. Because of its large surface area, Thermalito could be responsive to reductions in atmospheric deposition if the reservoir does not receive water with elevated MeHg or THg from its supply watershed. However, REMSAD attributes little of the atmospheric deposition to local industrial emissions so reductions in global emissions would be required. Thermalito may be oligotrophic and has been stocked with low-MeHg fish species (rainbow trout), and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to reduce fish MeHg.

(72) Trinity. Reservoir sediment Hg is in the upper range of modern background, and is surprising low given the relatively high mine site density, many of the MRDS mine sites are classified as past producers, and there are many mine sites within 1-10 km of the reservoir. The reservoir surface area is large, and REMSAD atmospheric deposition rate is moderate, so reservoir fish MeHg may be responsive to reductions in atmospheric deposition if mine inputs are not substantial. However, REMSAD attributes very little of the atmospheric deposition to local industrial emissions. Dissolved oxygen did not decrease with depth down to 100 feet on 8/30/11, but the reservoir may be ~450 feet deep. Also the DO did not decrease at the bottom in one of the arms of the reservoir. This indicates that aeration/circulation might not be effective. Trinity may be oligotrophic and is stocked with both predatory and low-MeHg fish species, and therefore may be a good candidate for nutrient management, intensive fishing, stocking changes, or other fisheries management activities to quickly reduce fish MeHg.

(73) Tulloch. Tulloch Reservoir is the regulating reservoir for upstream New Melones Reservoir. Tulloch and New Melones have similar 350 mm largemouth bass MeHg concentrations (0.37 and 0.39 mg/kg, respectively). Most of the historical gold mines in the Tulloch watershed are upstream of New Melones. However, no sediment Hg data are available for Tulloch to evaluate the extent of contamination from mining waste. Tulloch is likely heavily influenced by New Melones discharges. Tulloch has been stocked with low-MeHg species (rainbow trout). Stocking changes and intensive fishing may be effective. However, only one fish species (largemouth bass) has been monitored for MeHg, and no water chemistry data (e.g., chlorophyll) are available to enable evaluation of the potential effectiveness of reservoir water chemistry and fisheries management methods to reduce fish MeHg. Reductions in Tulloch fish MeHg may need to rely on reductions in New Melones water MeHg concentrations rather than local source controls or in-reservoir management practices, unless there are grossly erosive mine sites in the Tulloch watershed downstream of New Melones.

(74) Turlock. Both 350 mm largemouth bass and average TL4 fish MeHg concentrations in Turlock are about equal to the proposed target. Turlock is an off-channel reservoir that receives almost all its water from outside its proximal watershed. Both Modesto and Turlock reservoirs receive water from La Grange Reservoir, the regulating reservoir for Don Pedro Reservoir. Don Pedro has a high watershed density of historical gold mine sites, with the mine sites broadly dispersed across the watershed. In addition, Don Pedro has one reservoir sediment sample result of 0.13 mg/kg, which is lightly elevated above modern background levels, indicating contributions from mining waste. Even so, Don Pedro

generally has low mercury discharges, on average <0.8 ng/L THg and <0.02 ng/L MeHg. Turlock has only one sediment THg result with 0.06 mg/kg, which is within modern background levels but higher than sediment Hg levels in Modesto Reservoir. Consequently, Turlock may be affected by mining waste from the Don Pedro watershed, though it is not possible to evaluate the potential effectiveness and timing of benefits from mining waste remediation without additional sediment Hg data for Turlock. Turlock may be particularly responsive to reductions in atmospheric deposition because of its small proximal watershed size, relatively large reservoir surface area, and lack of industrial sources in its proximal watershed. However, although USEPA's REMSAD model predicts elevated atmospheric deposition for the Turlock area, REMSAD attributes very little of the atmospheric deposition to local industrial emissions; hence, reducing mercury in atmospheric deposition would rely on reductions in global industrial emissions. Turlock has been stocked with low-MeHg species (rainbow trout), but only largemouth bass and carp were monitored for MeHg in Turlock. Additional fish species and water data (e.g., dissolved oxygen and chlorophyll) are needed to determine whether the reservoir can be de-listed and, if not, to determine effective water chemistry and fisheries management strategies to reduce fish MeHg.

(75) Uvas. Reducing fish MeHg will likely need to rely on aeration or other reservoir MeHg management activities. This reservoir has a very small surface area and watershed area and has no record of historical mercury, gold or silver mine sites or other industrial sources in its watershed; therefore, it should be responsive to reservoir and fisheries management activities as well as reductions in atmospheric deposition. However, USEPA's REMSAD model attributes very little of the atmospheric deposition to local industrial emissions. As a result, source control would result in fish MeHg reductions only if global emissions are reduced substantially. Reservoirs in the Coast Ranges and southern California often have strong anoxia; consequently, reservoir water chemistry management activities such as oxygen and nitrate additions may be effective at reducing fish MeHg. However, water chemistry data (e.g., dissolved oxygen and chlorophyll) are needed to evaluate these and other reservoir water chemistry and fisheries management options. Per preliminary input from Santa Clara Valley Water District (SCVWD) staff, SCVWD reservoirs are highly eutrophic, and due to current eutrophication, ongoing algae issues, and water quality treatment concerns, nutrient addition to reduce fish methylmercury is not possible; SCVWD focus is on oxygenation and aeration applications (Young 2014 pers. comm.). SCVWD does not stock reservoirs per court order due to effects on federal and California ESA listed species and habitat including downstream steelhead habitat (Young 2014 pers. comm.). Predator fish species are undesirable as they move below the dams into steelhead streams and predate on the trout; possible management option is removing non-native fish including carp and bass (Young 2014 pers. comm.).

(76) Whiskeytown. This reservoir was listed under the listing policy; however, both 350 mm LMB MeHg and average MeHg in 150-500 mm TL4 fish are below the proposed fish target. Even so, several largemouth and smallmouth bass samples have MeHg that exceed the proposed target. In addition, there are many large (>500 mm) Sacramento sucker and Sacramento pikeminnow with MeHg that exceed the proposed target. The reservoir has a moderately high watershed density of historical gold mine sites. Therefore, mining waste remediation is expected to make at least some reservoir fish MeHg reductions. However, the mine sites are widely dispersed throughout the watershed. Reservoir sediment Hg data are needed to further evaluate the potential for mining remediation to make substantially reduce fish MeHg. USEPA's REMSAD model attributes little of the atmospheric deposition to local industrial emissions. Whiskeytown is stocked with both predatory and low-MeHg fish species, and therefore may be a good candidate for intensive fishing, stocking

changes, or other fisheries management activities to quickly reduce fish MeHg. However, water chemistry data (e.g., dissolved oxygen and chlorophyll) are needed to evaluate reservoir water chemistry and fisheries management options such as nitrate and nutrient additions.

(77) Wildwood. Reservoir sediment Hg is extremely high (1.09 mg/kg) compared to other Sierra Nevada reservoirs, indicating that mine sites are the dominant source. In addition, its relatively small watershed has an extremely high density of historical gold mine sites. However, the mine sites are widely dispersed in the watershed. Consequently, mining waste remediation is expected to make substantial fish MeHg reductions, but may not make quick improvements, unless there were just a couple grossly erosive mine sites near the watershed. USEPA's REMSAD model predicts elevated atmospheric deposition rate to the reservoir surface and attributes 30% of the atmospheric deposition to local industrial emissions that have almost entirely ceased since the 2001 model was developed. There is no information available to evaluate water chemistry and fisheries management options.

(78) Woodward. Woodward is an off-channel reservoir that receives almost all its water from outside its proximal watershed. Woodward receives water from Tulloch Reservoir, the regulating reservoir for New Melones Reservoir. Woodward has lower fish MeHg (0.25 mg/kg in 350 mm LMB) compared to Tulloch and New Melones (0.37 and 0.39 mg/kg, respectively, in 350 mm LMB). New Melones has a high watershed density of historical gold mine sites, with the mine sites broadly dispersed across the watershed. In addition, New Melones has average reservoir sediment Hg well above modern background levels. Woodward has only one sediment THg result with 0.10 mg/kg, which is at the upper range of modern background levels and is higher than sediment Hg levels in similar off-channel reservoirs, Modesto and Turlock reservoirs. Consequently, Woodward may be affected by mining waste from the New Melones watershed, though it is not possible to evaluate the potential effectiveness and timing of benefits from mining waste remediation without additional sediment Hg data for Woodward. Woodward may be particularly responsive to reductions in atmospheric deposition because of its small proximal watershed size, relatively large reservoir surface area, and lack of industrial sources in its proximal watershed. However, although USEPA's REMSAD model predicts elevated atmospheric deposition for the Woodward area, REMSAD attributes very little of the atmospheric deposition to local industrial emissions; hence, reducing mercury in atmospheric deposition would rely on reductions in global industrial emissions. Woodward has been stocked with low-MeHg species (rainbow trout), but only largemouth bass and carp were monitored for MeHg in Woodward. Additional fish species and water data (e.g., dissolved oxygen and chlorophyll) are needed to determine effective water chemistry and fisheries management strategies to reduce fish MeHg.