2 PROBLEM STATEMENT

The Central Valley Water Board determined that the Delta is impaired by mercury. Fish-tissue data collected since 1969 in the Delta indicate that mercury levels exceed numeric criteria established for the protection of human and wildlife health. This Problem Statement presents information in four sections:

1. Regulatory Background and TMDL Schedule
2. Delta Characteristics and TMDL Scope
3. Mercury Effects & Sources
4. Beneficial Uses, Applicable Standards & Extent of Impairment

2.1 Regulatory Background

2.1.1 Clean Water Act 303(d) Listing and Total Maximum Daily Load Development

Section 303(d) of the federal Clean Water Act requires States to:

- Identify waters not attaining water quality standards (referred to as the "303(d) list").
- Set priorities for addressing the identified pollution problems.
- Establish a "Total Maximum Daily Load" for each identified water body and pollutant to attain water quality standards.

In 1990 the State Water Resources Control Board (State Board) adopted the 303(d) List that identified Delta waterways as impaired for mercury because of the presence of a fish consumption advisory (SWRCB-DWQ, 1990). The 1998 303(d) List identified the TMDL control program for mercury in the Delta as a high priority (SWRCB-DWQ, 2003).

A TMDL represents the maximum load (usually expressed as a rate, such as kilograms per day [kg/day] or other appropriate measure) of a pollutant that a water body can receive and still meet water quality objectives. A TMDL describes the reductions needed to meet water quality objectives and allocates those reductions among the sources in the watershed. Water bodies on the 303(d) List are not expected to meet water quality objectives even if point source dischargers comply with their current discharge permit requirements. TMDLs must include the following elements: description of the problem (Chapter 2), numerical water quality target (Chapter 4), analysis of current loads (Chapters 6 and 7), and load reductions needed to eliminate impairments (Chapter 8).

2.1.2 Porter-Cologne Basin Plan Amendment Process

The State of California Porter-Cologne Water Quality Control Act (Section 13240) requires the Central Valley Water Board to develop a water quality control plan for each water body in the Central Valley that does not meet its designated beneficial uses. The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (the Basin Plan) is the legal document that describes the beneficial uses of all water bodies in these basins, water quality objectives to protect them, and, if the objectives are not being met, an implementation program to correct the impairment (CVRWQCB, 1998). The water quality management strategy for mercury in the Delta will include:

- TMDL Development: involves the technical analysis of methyl and total mercury sources, fate and transport of each, development of a proposed mercury fish tissue water quality objective and an aqueous methylmercury goal, and a description of the amount of reduction necessary to attain the proposed objective.
- Basin Planning: focuses on the development of Basin Plan amendments and a staff report for Central Valley Water Board consideration. The draft Basin Plan amendments propose site-specific water quality objectives for the Delta and an implementation plan to achieve the objectives. The Proposed Basin Plan Amendment draft staff report includes information and analyses required to comply with the California Environmental Quality Act (CEQA). The Basin Planning process satisfies State Board regulations for the implementation of CEQA.[2]
- Implementation: focuses on the establishment of a framework that ensures that appropriate practices or technologies are implemented (§13241 and §13242 of the Porter-Cologne Water Quality Act), including those elements necessary to meet federal TMDL requirements (CWA Section 303(d)).

The proposed Basin Plan amendments are legally enforceable once it has been adopted by the Regional and State Boards and approved by the Office of Administrative Law and the USEPA. Central Valley Water Board staff intends to seek public input by holding several workshops during the TMDL development and implementation planning phases. Also, the Basin Plan amendments will be adopted and approved in a public forum.

2.1.3 Timeline and Process for the Delta Mercury Management Strategy

The TMDL development, Phase I implementation planning, and preliminary Basin Planning phases of the Delta mercury management strategy should be complete in 2006 with the release of the Proposed Basin Plan Amendment draft staff report, which includes this revised TMDL report. The 2006 reports incorporate additional information from ongoing sampling and analyses and public input received on the August 2005 draft TMDL report. Additional public input will be sought during the Basin Planning phases through public workshops and formal hearings.

The Proposed Basin Plan Amendment draft staff report will be presented to the Central Valley Water Board for their consideration in 2006. Should an evaluation of implementation options developed during Phase I of the implementation program indicate that water quality objectives protective of the Delta's beneficial uses cannot be reasonably attained given control technologies and management practices developed between 2006 and 2012, staff may prepare a Use Attainability Analysis in 2013 as part of the Basin Plan amendments for the Board's consideration in 2014 (40 CFR § 131.10 (j)(2)).

[2] The Secretary of Resources has certified the planning process for Basin Plans as a regulatory program pursuant to PRC § 21080.5 and CEQA Guidelines § 15251(g). This certification means basin planning is exempt from CEQA provisions that relate to preparing Environmental Impact Reports and Negative Declarations. The Basin Plan Staff Report satisfies the requirements of State Board Regulations for Implementation of CEQA, Exempt Regulatory Programs, which are found in the California Code of Regulations, Title 23, Division 3, Chapter 27, Article 6, beginning with Section 3775.

2.1.4 Units and Terms Used in this Report

This report uses the term "total mercury" (TotHg) to indicate the sum of all forms of mercury (Hg) in water: physical states (e.g., dissolved, colloidal or particulate bound), chemical states (e.g., elemental, mercurous ion, or mercuric ion), organic compounds (e.g., monomethylmercury), and inorganic compounds (e.g., cinnabar). Monomethylmercury is the predominant form of organic mercury present in biological systems and will be noted in this report as "methylmercury" (MeHg). Because methylmercury typically composes only a small portion of total mercury in ambient water,[3] the phrases "inorganic mercury" and "total mercury" are sometimes used synonymously.

Aqueous concentrations of methyl and total mercury are reported in units of nanograms per liter (ng/l). Aqueous methylmercury concentrations are rounded to three decimal places and total mercury concentrations are rounded to two decimal places. Concentrations of suspended sediment are analyzed as total suspended solids (TSS) and use units of milligrams per liter (mg/l) rounded to one decimal place. In Chapter 7 (Source Assessment – Total Mercury & Suspended Sediment), the concentration of total mercury in suspended sediment is calculated as the ratio of concentrations of mercury to suspended sediments (TotHg:TSS). Units for the concentration of mercury in suspended sediment are part per million (ppm; equivalent to ng/mg or mg/kg), dry weight. Mercury levels in sediment and soil are also presented as part per million, dry weight. The units for loads of methylmercury and total mercury are grams per year (g/yr) and kilograms per year (kg/yr), respectively. Sediment loads are given in terms of millions of kilograms per year (kg/yr x 10^6 or Mkg/yr). Water flow is presented in units of acre-feet per year or million acre-feet per year (M acre-ft) for annual rates, cubic feet per second (cfs) for instantaneous flow measurements, and million gallons per day (mgd) for treatment plants. All loads calculations were typically rounded to two significant figures with calculations completed prior to rounding. For this draft report, additional significant figures occasionally were included to improve the reader's ease in verifying calculations.

Concentrations of mercury in fish tissue are reported as milligrams per kilogram (mg/kg), wet weight basis, rounded to two decimal places. Mercury is typically analyzed as "total mercury" in fish because of the additional cost required for methylmercury analysis. However, mercury exists almost entirely in the methylated form in small and top trophic level[4] fish (Nichols et al., 1999; Becker, 1995; Slotton *et al.*, 2002). Therefore, even though all the fish mercury data presented in the report were generated by laboratory analyses for total mercury, the data are described as "methylmercury concentrations in fish".

Rates of consumption of fish are given as grams of fish eaten per day (g/day) or meals per week. One adult human meal is assumed to be eight uncooked ounces (227 grams). Humans and wildlife species consume fish and other aquatic organisms from various size ranges and trophic levels. Safe fish tissue

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[3] For example, a comparison of average annual methylmercury and total mercury loads from tributary watersheds to the Delta (Tables 6.2 and 7.1) indicates that methylmercury loading comprises only about 2% of all total mercury loading from the tributaries.

[4] Trophic levels are numerical descriptions of an aquatic food web. The USEPA's 1997 Mercury Study Report to Congress used the following criteria to designate trophic levels based on an organism's feeding habits:

Trophic level 1:	Phytoplankton and bacteria.
Trophic level 2:	Zooplankton, benthic invertebrates and some small fish.
Trophic level 3:	Organisms that consume zooplankton, benthic invertebrates, and other TL2 organisms.
Trophic level 4:	Organisms that consume TL3 organisms.

levels are identified in Chapter 4 for different trophic level and size classifications. These classifications are termed "trophic level food groups".

For this report, methylmercury fish tissue concentrations in trophic level food groups are recommended as the TMDL water quality **targets**. The tissue targets will be proposed as options for the Central Valley Water Board to consider when adopting the Basin Plan water quality objective(s). The term **implementation goal** in this report refers to methylmercury concentrations in standard 350-mm largemouth bass and unfiltered water, which are correlated to the targets. The implementation goal for methylmercury in unfiltered water is Central Valley Water Board staff's best estimate of the annual average methylmercury concentration needed to achieve the fish tissue targets. The aqueous goal is used to determine the methylmercury load reductions necessary to meet the targets. The methylmercury water goal is not being proposed as a water quality objective.

2.2 Delta Characteristics and TMDL Scope

2.2.1 Delta Geography

The Sacramento-San Joaquin Delta, along with the San Francisco Bay, forms the largest estuary on the west coast of North America. The Delta encompasses a maze of over 1,100 miles of river channels surrounding about 738,000 acres (1,153 square miles) of dyked islands and tracts in Alameda, Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties (Figure 1.1 and Figure A.1 in Appendix A). Many of the Delta waterways follow natural courses while others have been constructed to provide deep-water navigation channels, to improve water circulation, or to obtain material for levee construction (DWR, 1995). The legal boundary of the Delta is defined in California Water Code Section 12220. Appendix A illustrates the more than 100 named waterways included in this TMDL.

The Delta and its source watersheds comprise nearly 40% of the landmass of the State of California (Table 2.1 and Figure 2.1). The Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers all flow into the Delta, carrying approximately 47% of the State's total runoff (DWR, 2005). The Sacramento River contributes an average annual water volume of 18.3 million acre-feet and the Yolo Bypass and the San Joaquin River contribute an average of 5.8 million acre-feet. Diversions in the Delta include the State Water Project (Banks Pumping Plant and the North Bay Aqueduct), Central Valley Project (Tracy Pumping Plant), and Contra Costa Water District, which withdraw average annual water volumes of about 3.7 million, 2.5 million, and 126 thousand acre-feet, respectively (DWR, 2005). During a typical water year,[5] the Delta receives runoff only from the Sacramento and San Joaquin Basins in the Central Valley (Figure 2.1). During infrequent flood events, the Tulare Basin in the southern Central Valley is connected to the San Joaquin River system.

The mean annual precipitation in the City of Stockton in the eastern Delta is approximately 14 inches, with the majority of rain falling between November and March. Temperatures at Stockton typically

[5] A "water year" (WY) is defined as the period between 1 October and 30 September of the following year; for example, WY2001 is the period between 1 October 2000 and 30 September 2001. Water year types in California are classified according to the natural water production of the major basins. See Appendix E for more information about water year classifications.

average 62 degrees Fahrenheit (^{o}F), with summer highs exceeding 90 ^{o}F and winter lows dropping below 40 ^{o}F.

The Delta had a population of 410,000 people in 1990 (DWR, 1995). As of the 2000 Census, about 462,000 people resided in the Delta Region (DWR, 2005). Rapid growth is occurring in urban areas in and surrounding the Delta, especially in Elk Grove (27% growth per year – the highest growth rate in California), Tracy (5.9% per year), Brentwood (12.3% per year), and Rio Vista (11.1% per year).

Agriculture and recreation are the two primary businesses in the Delta. The Delta also provides habitat for over five hundred species of wildlife (DWR, 1995; Herbold *et al.*, 1992). The Delta is the major source of fresh water to San Francisco Bay and supplies drinking water for over two-thirds of the State's population (over 23 million people) and irrigation water for more than seven million acres of farmland statewide (DWR, 2005). Table 2.2 lists additional features of the Delta.

Table 2.1: Spatial Perspective of the Delta and Its Source Regions

Region	Acreage	Square Miles	% of California	% of Central Valley
California	101,445,246	158,508	---	---
Central Valley	37,982,554	59,348	37%	---
Delta (statutory boundary)	737,630	1,153	1%	1.9%
Delta TMDL Source Area (Statutory Delta & all watersheds that drain directly to the Delta)	27,226,796	42,542	27%	72%
Sacramento River Watershed	17,410,314	27,204	17%	46%
San Joaquin River Watershed	9,801,103	15,314	10%	26%

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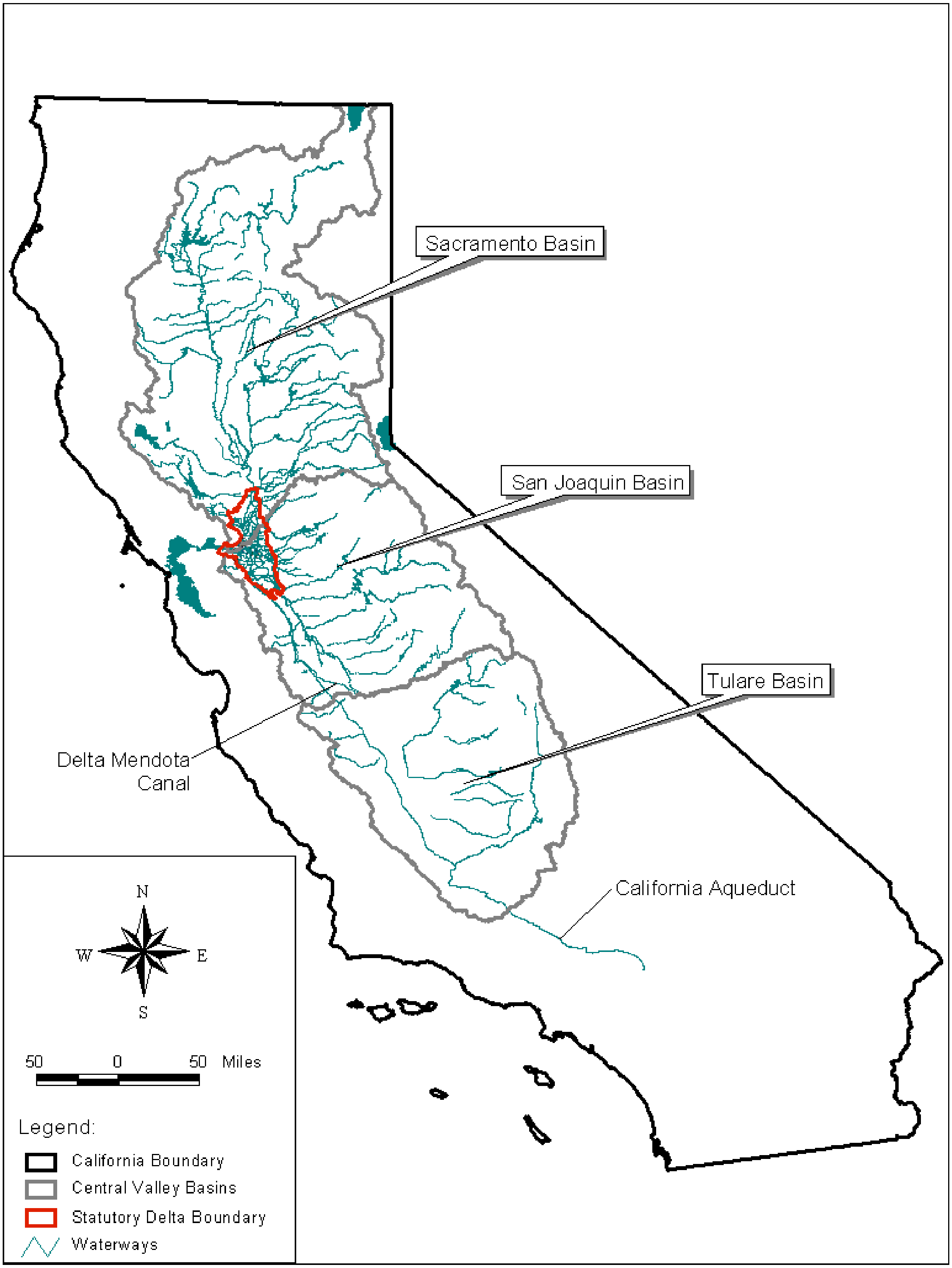

Figure 2.1: The Central Valley

Table 2.2: Key Delta Features (DWR, 1995 & 2005)

Population:	410,000 (1990), 462,000 (2000)	Area (acres):	Agriculture: 538,000 Cities & towns: 64,000 Water surface: 61,000 Undeveloped: 75,000 *Total: 738,000*
Incorporated cities entirely within the Delta:	Antioch, Brentwood, Isleton, Pittsburg, Tracy		
Major cities partly within the Delta:	Sacramento, Stockton, West Sacramento		
# of unincorporated towns and villages:	14	Total length of all leveed channels:	1,100 miles (1987)
Main crops:	Alfalfa asparagus corn fruit grain & hay grapes pasture safflower sugar beets tomatoes	Diversions from the Delta:	Central Valley Project State Water Project Contra Costa Canal City of Vallejo Western Delta Industry 1,800+ Agricultural diversions
		Rivers flowing into the Delta:	Calaveras, San Joaquin Cosumnes, Mokelumne Sacramento

Fish and wildlife:	# of Species	# of Federal & State Species of Concern [a]	# of Non-Native Species [b]
Birds:	230	10	3
Mammals:	45	9	7
Fish:	52	8	30
Reptiles & amphibians:	25	6	1
Flowering plants:	150	54	70
Invertebrates:	na	21	13
Major anadromous fish: American shad, salmon, steelhead trout, striped bass, sturgeon			

(a) Endangered, threatened, rare, and candidate species per the federal listing effective January 31, 1992, and the State listing effective April 9, 1992.
(b) Introduced species in the Sacramento – San Joaquin Delta.

2.2.2 TMDL Scope & Delta Subareas

The scope of this mercury TMDL includes all waterways with fish within the legal Delta (Figure 1.1 and Figure A.1 in Appendix A). This TMDL focuses on fish impairment and methyl and total mercury sources identified in the Delta. Tributaries are considered to be nonpoint sources to the Delta and are evaluated at or near the locations where they cross the statutory Delta boundary. Assessment of point and nonpoint sources that contribute to tributary discharges to the Delta is ongoing and will be described in reports for future mercury TMDL programs for those watersheds and implementation activities for the Delta methylmercury TMDL.

The methylmercury source analysis and linkage analysis for the Delta TMDL divide the Delta into eight regions based on the hydrologic characteristics and mixing of the source waters (Figure 2.2). A hydrology-based methylmercury TMDL is proposed in this report as it more accurately reflects the concentrations and sources of methylmercury and the extent of fish impairment. As described in Chapter 8 (Allocations), essentially a separate methylmercury allocation scheme is developed for each

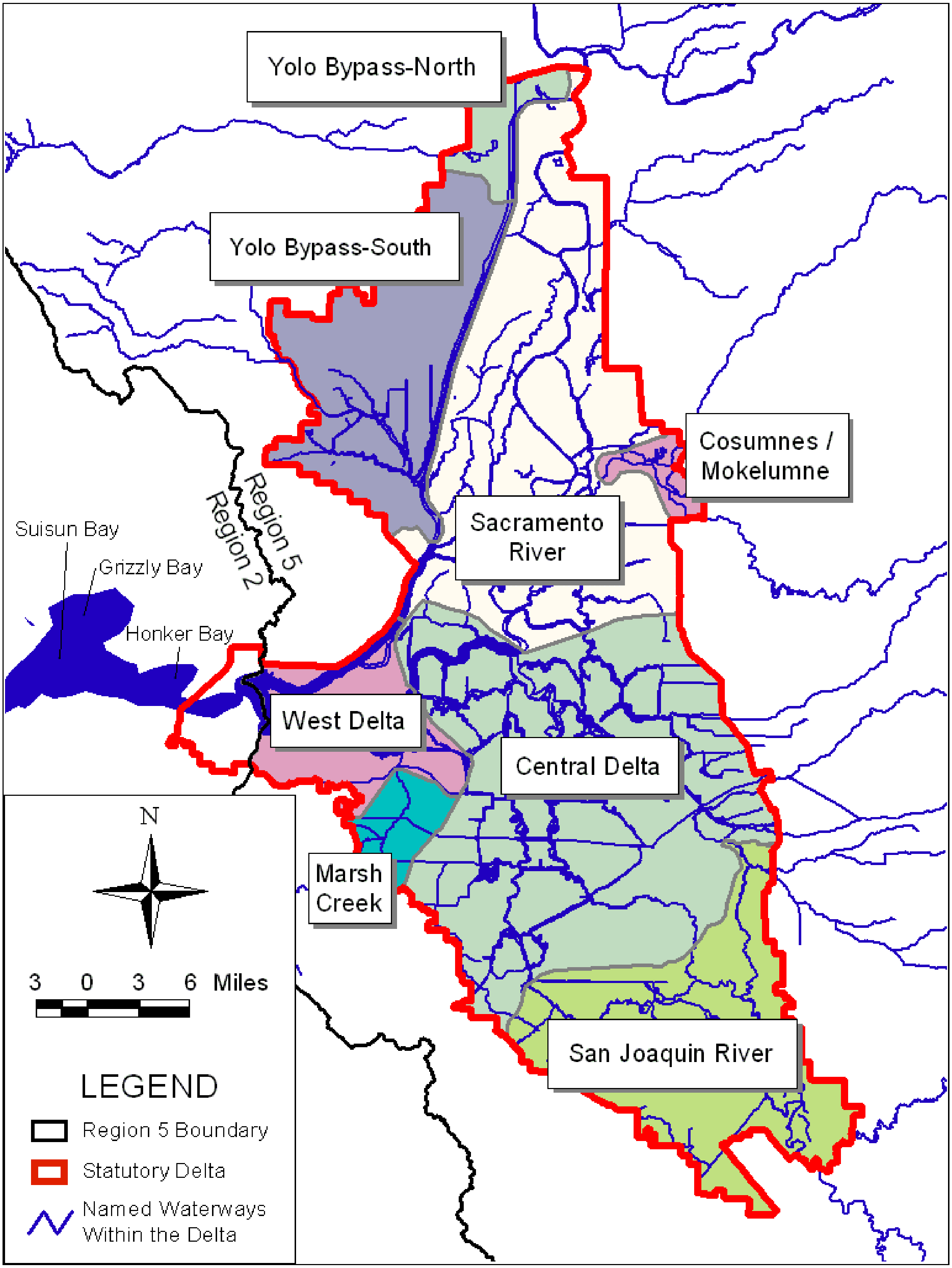

Figure 2.2: Hydrology-Based Delineation of Subareas within the Legal Delta.

subarea because the methylmercury sources and level of fish impairment in each subarea are different. The following paragraphs describe the delineation of the hydrologic subareas.

Sacramento River: This subarea is dominated by Sacramento River flows. It is bound to the east by the legal Delta boundary and to the west by the eastern levee of the Sacramento Deep Water Ship Channel. Sacramento River flows influence the Upper and Lower Mokelumne River in the Delta because of diversions by the Delta Cross Channel near Walnut Grove (Figure A.1 in Appendix A). The Delta Cross Channel controls diversions of fresh water from the Sacramento River to Snodgrass Slough and the Mokelumne River to combat salt-water intrusion in the Delta, to dilute local pollution, and to more efficiently supply the federal Central Valley Project and State Water Project pumps in the southern Delta.

Although drawn as a defined line, the Sacramento River subarea's boundary with the South Yolo Bypass, Central Delta, and West Delta subareas is defined by a gradient in water quality characteristics that varies depending on the tidal cycle, magnitude of wet weather flows, diversions by within-Delta control structures, and releases from reservoirs in the upstream watersheds. The boundary shown in Figure 2.2 is based on available information and may shift as results from ongoing and future studies become available.

Yolo Bypass - North & South: The Yolo Bypass is a floodplain on the west side of the lower Sacramento River (Section E.2.2 and Figure E.1 in Appendix E). The Fremont and Sacramento Weirs route floodwaters to the Yolo Bypass from the Sacramento and Feather Rivers and their associated tributary watersheds. Cache and Putah Creeks, Willow Slough, and the Knights Landing Ridge Cut from the Colusa Basin all drain directly to the Yolo Bypass. The legal Delta encompasses only the southern two thirds of the Yolo Bypass. The "Yolo Bypass – North" subarea is defined by the legal Delta boundary to the north and Lisbon Weir to the south. The "Yolo Bypass – South" subarea is defined by Lisbon Weir to the north and the southern end of Cache Slough to the south. Lisbon Weir (Figure E.1) limits the range of tidal fluctuation upstream in the Yolo Bypass.

Cosumnes/Mokelumne Rivers: This subarea includes the lower Cosumnes and Mokelumne Rivers and is defined by the legal Delta boundary to the east and the Delta Cross Channel confluence with the Mokelumne to the west.

San Joaquin River: The subarea is defined by the legal Delta boundary to the east and south, and Grantline Canal and the beginning of the Stockton Deep Water Channel to the north. At present, the San Joaquin River is almost entirely diverted out of the Delta by way of Old River and Grantline Canal for export south of the Delta via the State and federal pumping facilities near Tracy.

Marsh Creek: This subarea is defined by the portion of the Marsh Creek watershed within the legal Delta boundary that is upstream of tidal effects.

West Delta: The West Delta subarea encompasses the confluence of the Sacramento and San Joaquin Rivers, which transport water from the Central Valley to the San Francisco Bay. The western border of the West Delta subarea is defined by the jurisdictional boundary between the Central Valley Regional Water Quality Control Board (Region 5) and the San Francisco Water Board (a.k.a. Region 2) (Figure 2.2). Water quality characteristics are determined by the tidal cycle, magnitude of wet weather flows, controlled flow diversions by within-Delta structures, and releases from reservoirs in the upstream watersheds.

Central Delta: The Central Delta includes a myriad of natural and constructed channels that transport water from the upper watersheds to San Francisco Bay to the west and the State and federal pumps to the southwest. The Central Delta tends to be most influenced by waters from the Sacramento River.

2.3 Mercury Effects & Sources

2.3.1 Mercury Chemistry and Accumulation in Biota

Mercury (Hg) can exist in various forms in the environment. Physically, mercury can exist in water in a dissolved, colloidal or particulate bound state. Chemically, mercury can exist in three oxidation states: elemental (Hg^o), mercurous ion (monovalent, Hg^+), or mercuric ion (divalent, Hg^{+2}). Ionic mercury can react with other chemicals to form both organic and inorganic compounds, such as cinnabar (HgS), and can be converted by sulfate reducing bacteria to more toxic organic compounds, such as monomethylmercury (CH_3Hg) or dimethylmercury ($(CH_3)_2Hg$). Important factors controlling the conversion rate of inorganic to organic mercury include temperature, percent organic matter, redox potential, salinity, pH, and mercury concentration. Monomethylmercury is the predominant form of organic mercury present in biological systems and will be noted in this report as methylmercury or "MeHg". Because dimethylmercury is an unstable compound that dissociates to monomethylmercury at neutral or acid pH, it is not a concern in freshwater systems (USEPA, 1997a).

Both inorganic and organic mercury can be taken up by aquatic organisms from water, sediments and food. Low trophic level species such as phytoplankton obtain all their mercury directly from the water. *Bioconcentration* describes the net accumulation of mercury directly from water. The *bioconcentration factor* is the ratio of mercury concentration in an organism to mercury concentration in water. Mercury may also accumulate in aquatic organisms from consumption of mercury-contaminated prey (USEPA, 1997b). Mercury *bioaccumulates* in organisms when rates of uptake are greater than rates of elimination.

Repeated consumption and accumulation of mercury from contaminated food sources results in tissue concentrations of mercury that are higher in each successive level of the food chain. This process is termed *biomagnification*. Methylmercury accumulates within organisms more than inorganic mercury because inorganic mercury is less well absorbed and/or more readily eliminated than methylmercury. The proportion of mercury that exists as the methylated form generally increases with the level of the food chain, typically greater than 90% in top trophic level fish (Nichols *et al.*, 1999; Becker, 1995).

Consumption of contaminated, high trophic level fish is the primary route of methylmercury exposure. For example, the aquatic food web provides more than 95% of humans' intake of methylmercury (USEPA, 1997a). Wildlife species of potential concern that consume fish and other aquatic organisms from the Delta include piscivorous fish, herons, egrets, mergansers, grebes, bald eagle, kingfisher, peregrine falcon, osprey, mink, raccoon and river otter.

2.3.2 Toxicity of Mercury

Mercury is a potent neurotoxicant. Methylmercury is the most toxic form of this metal. Methylmercury exposure causes multiple effects, including tingling or loss of tactile sensation, loss of muscle control, blindness, paralysis, birth defects and death. Adverse neurological effects in children appear at dose levels five to ten times lower than associated with toxicity in adults (NRC, 2000). Children may be exposed to methylmercury during fetal development, by eating fish, or through both modes. Effects of methylmercury are dose dependent.

Wildlife species may also experience neurological, reproductive or other detrimental effects from mercury exposure. Behavioral effects such as impaired learning, reduced social behavior and impaired physical abilities have been observed in mice, otter, mink and macaques exposed to methylmercury (Wolfe *et al.*, 1998). Reproductive impairment following mercury exposure has been observed in multiple species, including common loons and western grebe (Wolfe *et al.*, 1998), walleye (Whitney, 1991 in Huber, 1997), mink (Dansereau *et al.*, 1999) and fish (Huber, 1997; Wiener and Spry, 1996).

2.3.3 Mercury Sources & Historic Mining Activities

Identified sources of methyl and total mercury in the Delta and in tributary watersheds include geothermal springs, sediment flux from wetlands and open water habitat, municipal and industrial dischargers, agricultural drainage, urban runoff, atmospheric deposition, and erosion of naturally mercury-enriched soils and excavated overburden and tailings from historic mining operations. Although none are present within the legal Delta, historic mercury and gold mining sites – along with their associated contaminated waterways – may contribute a substantial portion of the mercury in the tributary discharges to the Delta. Chapters 6 and 7 provide a detailed assessment of the within-Delta sources of mercury.

As noted in source analyses in Chapters 6 and 7, tributary inputs to the Delta are the largest sources of methyl and total mercury. These tributaries drain many of the major mercury mining districts in the Coast Range and the placer gold mining fields in the Sierra Nevada Mountains. The Coast Range is a region naturally enriched in mercury. Active geothermal vents and hot springs deposit mercury, sulfur, and other minerals at or near the earth's surface. Most of the mercury deposits in California occur within a portion of the Coast Range geomorphic province extending from Clear Lake in Lake County in the north to Santa Barbara County in the south. Approximately 90% of the mercury (roughly 104 million kilograms) used in the United States between 1846 and 1980 was mined in the Coast Range of California (Churchill, 1999). Much of the mining and extraction occurred prior to 1890 when mercury processing was crude and inefficient. The ore was processed at the mine sites, with about 35 million kilograms of mercury lost at the mine sites. As a result, high levels of mercury are present in sediment and fish tissue in Coast Range water bodies. Fish advisories have been posted for Clear Lake, Cache Creek, Lake Berryessa and Black Butte Reservoir (Stratton *et al.*, 1987; Brodberg & Klasing, 2003; Gassel *et al.*, 2005). Mercury mine waste enters the Delta from mine-impacted Coast Range creeks such as Cache, Putah and Marsh Creeks.

Approximately 10 million kilograms of Coast Range mercury were transported across the valley and used as an amalgam in placer and lode gold mining in the Sierra Nevada's between 1850 and 1890 (Churchill, 1999). Approximately six million kilograms of mercury were lost in Sierra Nevada rivers and streams during gold mining operations. Principal gold mining areas were in the Yuba River and Bear River (tributaries to the Sacramento River via the Feather River), the Cosumnes River (a tributary to the Mokelumne River), and the Stanislaus, Tuolumne and Merced Rivers (tributaries to the San Joaquin

River). Elevated mercury concentrations are present in fish from all these Sierra Nevada waterways. Floured[6] elemental mercury enters the Delta from the Sacramento, Mokelumne and San Joaquin Rivers.

Evaluation of legacy mine sites, associated contaminated waterway reaches, and other methyl and total mercury sources that contribute to tributary inputs to the Delta is ongoing. More detailed source analyses for the tributary watersheds will be conducted by future mercury TMDL programs for those watersheds and by proposed implementation actions for the Delta mercury control program (see Chapter 4 in the Proposed Basin Plan Amendment draft staff report).

2.4 Beneficial Uses, Applicable Standards & Extent of Impairment

2.4.1 Sacramento-San Joaquin Delta Estuary Beneficial Uses

The Federal Clean Water Act and the State Water Code (Porter-Cologne Water Quality Act) require the State to identify and protect the beneficial uses of its waters. Table 2.3 lists the existing beneficial uses of the Delta. Contact recreation (REC-1) and wildlife habitat (WILD) are impaired because of elevated mercury concentrations in fish throughout the Delta. Municipal and domestic supply (MUN) is impaired because of elevated mercury concentrations in water in the Yolo Bypass. The Basin Plan does not include a commercial and sport fishing (COMM) designation for the Delta, which includes uses of water for commercial or recreational collection of fish, shellfish, or other organisms intended for human consumption or bait purposes. However, as described in Appendix C, commercial and sport fishing take place in the Delta. Some sport and commercial species (e.g., striped bass and largemouth bass) are impaired by mercury, while others (e.g., salmon and clams) are not. The Proposed Basin Plan Amendment draft staff report (Chapter 2) considers adoption of a COMM beneficial use for the Delta.

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[6] Flouring is the division of mercury into extremely small globules, which gives it a white, flour-like appearance. If the floured mercury has surface impurities such as oil, grease, clay or iron and base metal sulfides, it will not coalesce into larger drops or form an amalgam with gold (Beard, 1987). Mercury was used for gold recovery throughout the Sierra Nevada. Floured mercury was formed by the pounding of boulders and gravels over liquid mercury in hydraulic mining-related sluice boxes (Hunerlach *et al.*, 1999), as well by intense grinding in the hardrock milling systems, and was transported downstream with tailings.

Table 2.3: Existing Beneficial Uses of the Delta (a)

Beneficial Use	Status
Municipal and domestic supply (MUN)	Existing (b)
Agriculture – irrigation and stock watering (AGR)	Existing
Industry – process (PROC) and service supply (IND)	Existing
Contact recreation (REC-1) (c)	Existing (b)
Non-contact recreation (REC-2) (c)	Existing
Freshwater habitat (warm and cold water species)	Existing
Spawning, reproduction and/or early development of fish (SPWN) (warm water species)	Existing
Wildlife habitat (WILD)	Existing (b)
Migration of aquatic organisms (MIGR) (warm and cold water species)	Existing
Navigation (NAV)	Existing

(a) This table lists the beneficial uses designated for the Delta in Table II-1 of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (CVRWQCB, 1998).
(b) These are beneficial uses impaired by mercury in the Delta.
(c) REC-1 includes recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing and fishing. REC-2 includes recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, hunting and sightseeing.

2.4.2 Applicable Standards & Extent of Impairment

The narrative water quality objective for toxicity in the Basin Plan states, "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life." The narrative toxicity objective further says that "The Regional Water Board will also consider … numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U.S. Food and Drug Administration, the National Academy of Sciences, the USEPA, and other appropriate organizations to evaluate compliance with this objective" (CVRWQCB, 1998). Four potential criteria were evaluated to determine whether the Delta was in compliance with the narrative objective. They are the USEPA and USFWS fish tissue criteria for protection of human and wildlife, the USEPA aqueous methylmercury criterion for drinking water, the United Nations aqueous total mercury guidance level to protect livestock, and the California Toxic Rule (CTR) aqueous total mercury criterion for protection of human and wildlife health. Each is reviewed below and a determination made as to whether the recommended criteria or objective is met in the Delta or not.

2.4.2.1 Fish Tissue Criteria

In 1971 a human health advisory was issued for the Sacramento-San Joaquin Delta advising pregnant women and children not to consume striped bass. In 1994 an interim advisory was issued by the California Office of Environmental Health Hazard Assessment for San Francisco Bay and Delta recommending no consumption of large striped bass and shark because of elevated concentrations of mercury and polychlorinated biphenyls (OEHHA, 1994). Additional monitoring indicates that several more species, including largemouth bass and white catfish (two commonly-caught local sport fish), also have elevated concentrations of mercury in their tissue (Davis *et al.*, 2003; Slotton *et al.*, 2003; LWA, 2003; SWRCB-DWQ, 2002).

The Delta was listed for mercury because of the 1971 and 1994 fish advisories and because some fish tissue concentrations exceeded the National Academy of Sciences (NAS) guidelines for protection of wildlife health. The NAS wildlife guideline is 0.5-mg/kg-mercury in whole, freshwater fish (NAS, 1973). The USEPA has since published a recommended criterion for the protection of human health of 0.3 mg/kg mercury in fish tissue (USEPA, 2001). Similarly, the USFWS has provided guidance on safe methylmercury ingestion rates for sensitive wildlife species (USFWS, 2002, 2003 & 2004). The Delta TMDL cites the USEPA and USFWS recommended criteria for protection of human and wildlife health, as these are the more protective.

Significant regional variations in fish tissue mercury concentrations are observed in the Delta. Elevated concentrations occur along the periphery of the Delta while lower body burdens are measured in the central Delta. A summary of fish tissue methylmercury concentrations by Delta subarea is provided in Chapter 4 (Tables 4.7 and 4.10) and Appendix C. Concentrations are greater than recommended as safe by the USEPA and USFWS at all locations except in the central Delta. Percent reductions in fish methylmercury levels ranging from 0% to 75% in the peripheral Delta subareas will be needed to meet the numeric targets for wildlife and human health protection.

2.4.2.2 Aqueous Criteria & Guidance

The USEPA recommends a safe level of 70 ng/l methylmercury in drinking water to protect humans (USEPA, 1987). This level was released through USEPA's Integrated Risk Information System (IRIS) and was based on USEPA's recommended methylmercury reference dose for lifetime exposure. Methylmercury concentrations in the Delta typically range from 0.02 to 0.3 ng/l (Section 6.2.1). The maximum observed concentration in the Delta between March 2000 and April 2004 was 0.70 ng/l in Prospect Slough in March 2000 (Appendix M). The USEPA IRIS drinking water criterion is not expected to be exceeded in the Delta.

The United Nations recommends a guidance level of 10,000 ng/l unfiltered total mercury to protect livestock drinking water (Ayers and Westcot, 1985). Unfiltered mercury concentrations in the Delta typically range from 0.26 to 100 ng/l (Table 7.4 in Chapter 7). The maximum concentration ever observed in the Delta was 696 ng/l at Prospect Slough on January 10, 1995. The United Nations recommended livestock guidance level is not expected to be exceeded in the Delta.

The USEPA promulgated the CTR in April 2000 (USEPA, 2000). The CTR mercury objective is 0.05 µg/L (50 ng/l) total recoverable mercury for freshwater sources of drinking water. The CTR criterion was developed to protect humans from exposure to mercury in drinking water and in contaminated fish. It is enforceable for all waters with a municipal and domestic water supply or aquatic beneficial use designation. This includes all subareas of the Delta. The CTR does not specify duration or frequency. The Central Valley Water Board has previously employed a 30-day-averaging period with an allowable exceedance frequency of once every three years.[7] The USFWS and U.S. National Marine Fisheries Service are concerned that the mercury objective in the CTR may not protect threatened and

[7] Personal communication from P. Woods (USEPA Region 9) to J. Marshack (CVRWQCB), 4 December 2001.

endangered species and requested that the USEPA reevaluate the criterion. The USEPA has not released a reevaluation. Therefore, the CTR objective of 50 ng/l is applicable to the Delta.

An evaluation of unfiltered total mercury concentrations in Delta water demonstrates that the CTR is not exceeded anywhere in the Delta except downstream of the Cache Creek Settling Basin in the Yolo Bypass and possibly in Putah Creek, Prospect Slough and Marsh Creek (Section 7.5). The exceedances downstream of Cache Creek may be addressed by the Cache Creek mercury control program (CVRWQB, 2005) adopted in October 2005 and proposed upgrades of the Cache Creek Settling Basin described in Chapter 4 of the Proposed Basin Plan Amendment draft staff report. Prospect Slough is downstream of Cache Creek and potential exceedances of the CTR could be corrected with decreases in mercury loads from Cache Creek and its Settling Basin. Putah and Marsh Creeks are both on the 303(d) list because of elevated mercury concentrations. Exceedance of the CTR downstream of these water bodies will be addressed by load reductions to be determined by their TMDLs. Chapters 7 and 8 will provide additional evaluations of total mercury loads from these watersheds and potential reduction strategies.

2.4.2.3 San Francisco Bay Mercury TMDL's Allocation for Total Mercury in Central Valley Outflows

As a component of the mercury control program for the San Francisco Bay, San Francisco Water Board staff developed a target for San Francisco Bay sediment mercury concentration (particle-bound mercury mass divided by sediment mass) of 0.2 mg/kg and assigned the Central Valley a five-year average total mercury load allocation of 330 kg/yr at Mallard Island or a decrease of 110 kg/yr in mercury sources to the Delta. Compliance with the allocation can be assessed by one of two methods:

> "First, attainment may be demonstrated by documentation provided by the Central Valley Water Board that shows a net 110 kg/yr decrease in total mercury entering the Delta from within the Central Valley region. Alternatively, attainment of the load allocation may be demonstrated by multiplying the flow-weighted suspended sediment mercury concentration by the sediment load measured at the RMP Mallard Island monitoring station. If sediment load estimates are unavailable, the load shall be assumed to be 1,600 million kg of sediment per year. The mercury load fluxing past Mallard Island will be less than or equal to 330 kg/yr after attainment of the allocation." (Johnson & Looker, 2004)

Central Valley Water Board staff will recommend to the Central Valley Water Board that the 110 kg total mercury reduction be met by reductions in total mercury entering the Delta from within the Central Valley. Reduction efforts are recommended for the Cache Creek, Feather River, American River and Putah Creek watersheds because they export the largest volume of highly contaminated sediment (see Chapter 8 in this TMDL report and Chapter 4 in the Proposed Basin Plan Amendment draft staff report). Load calculation methods and strategies for meeting reduction in total mercury loading to San Francisco Bay are discussed in more detail in Chapters 7 and 8 of this report.

Key Points

- The Federal Clean Water Act (CWA) requires States to identify water bodies that do not meet their designated beneficial uses and to develop programs to eliminate impairments. States refer to the control program as a Total Maximum Daily Load (TMDL) program. A TMDL is the total maximum daily load of a pollutant that a water body can assimilate and still attain beneficial uses.
- The State of California Porter-Cologne Water Quality Control Act requires the Central Valley Water Board to develop a water quality control plan for each water body in the Central Valley that does not meet its designated beneficial uses. The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (the Basin Plan) is the legal document that describes the beneficial uses of all water bodies in these basins, adopted water quality objectives to protect them, and, if the objectives are not being met, an implementation program to correct the impairment.
- The TMDL development, implementation planning, and preliminary Basin Planning phases of the Delta mercury management strategy should be complete in 2006 with the release of the Proposed Basin Plan Amendment draft staff report, which includes this revised TMDL report. The final staff report will be presented to the Central Valley Water Board for their consideration in late 2006.
- In 1990 the Central Valley Water Board identified the Delta as impaired by mercury because fish had elevated levels of mercury that posed a risk for human and wildlife consumers. In addition, the San Francisco Bay mercury control program identified Central Valley outflows via the Delta as one of the principal sources of total mercury to San Francisco Bay and assigned the Central Valley a load reduction of 110 kg/yr. Therefore, the final mercury TMDL control plan for the Delta must ensure protection of human and wildlife health in the Delta and meet the San Francisco Bay load allocation to the Central Valley.
- The scope of the Delta methylmercury TMDL includes all waterways within the legal Delta boundary. This TMDL report addresses both methyl and total mercury. Reductions in aqueous methylmercury are required to reduce methylmercury concentrations in fish. Reductions in total mercury loads are needed to maintain compliance with the USEPA's criterion of 50 ng/l; to prevent increases in total mercury discharges from causing increases in aqueous and fish methylmercury in the Delta, thereby worsening the impairment; and to meet the San Francisco Bay TMDL allocation to the Central Valley.
- Elevated fish mercury concentrations occur along the periphery of the Delta while lower body burdens are measured in the central Delta. Concentrations are greater than recommended as safe by the USEPA and USFWS at all locations except in the central Delta. Percent reductions in fish methylmercury levels ranging from 0% to 73% in the peripheral Delta subareas will be needed to meet the numeric targets for wildlife and human health protection.