Water Quality Impacts of the Delta Tunnels Project
by Tim Stroshane, Policy Analyst, Restore the Delta

Governor Brown's Delta Tunnels Project will have serious detrimental water quality impacts on the Bay-Delta Estuary. Here's how.

The Bay-Delta Estuary northeast of the Bay Area is where fresh waters from Central Valley rivers meet and mix with tidal flows originating from the Pacific Ocean and San Francisco Bay. It is the largest estuary on the west coast of North America. Its water quality is already seriously compromised by existing water resource development, and the legacies of Gold Rush-era mercury and agribusiness irrigation generating selenium-tainted drainage. The proposed Delta Tunnels Project will worsen these and other water quality problems faced by the Bay-Delta Estuary.

Over a half million people depend on good water quality in the Delta for their livelihoods and enjoyment. To improve the Delta as a fishable, swimmable, drinkable, and farmable region will require protecting and enhancing the Estuary's water quality, pure and simple. If we are to leave generations to come an Estuary with sustained and diverse ecological fertility, the Estuary deserves and needs water cleansed of the pollutants that now plague it, like mercury, selenium, and pesticides.

Water Quality and Bay-Delta Estuary Flows

Historically, this Estuary has been enormously productive, a magnet for many aquatic species to reproduce in and migrate through. Its native species evolved to take advantage of the Estuary's annual and seasonal variations in water quality and flow. As the seasons change, the Bay Delta Estuary cycles through such ecological roles as aquatic nursery, restaurant, and crossroads. The health of this diverse ecosystem depends on having variable and good water quality that benefits each of these roles.

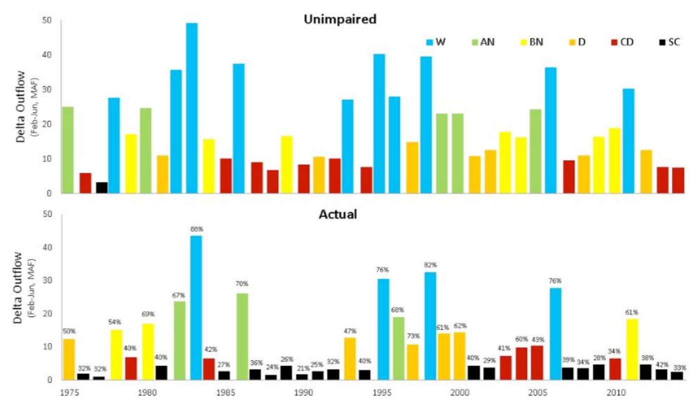

Figure 3: Persistent, man-made drought experienced by the San Francisco Bay-Delta estuary ecosystem. Bars represent the volume of Delta fresh water outflows that would be expected under current landscape conditions without storage or diversion (upper panel; unimpaired) and those that actually occurred (lower panel; actual). Colors represent water year types (W=wet, AN=Above Normal, BN = Below Normal, etc.). Black bars represent Super-critically Dry (SC) runoff conditions that occur naturally in <3% of years (e.g., 1977 in the upper panel). Actual outflows have been equal to or less than the Super-critical threshold in 19 of 40 years since 1975 (47.5% of years). Since 1995, Wet years and Above Normal years have occurred naturally 40% of the time, but the estuary has only experienced those conditions in 20% of years. Since 1995, Super-critically Dry conditions have occurred in the estuary in twice as many years as Wet + Above Normal conditions.

Source: The Bay Institute, February 2015.

The Estuary has been subjected to man-made drought since the 1970s. The comparison here shows that the Delta has experienced vastly lower actual flows (and consequently poorer water quality) relative to the fresh water that would have otherwise been available had upstream water consumption storage, and Delta exports not reduced outflow from the Estuary.

How the Tunnels' Will Affect Water Quality

There is always water in the Bay-Delta Estuary. The key water quality question is how salty it is and how long it stays in the Delta (that is, its residence time). This is determined by whether the inland push of tidal flow (laden with salty seawater) is greater or less than the freshwater flows draining Central Valley rivers, and how much so. A century ago, waters in Carquinez Strait were fresh most of the year all the way down to Crockett where C&H Sugar established its sugar refinery.[i]

The Tunnels proposed in the "California Water Fix" by Governor Jerry Brown and his Department of Water Resources (DWR), along with several thirsty state and federal water contractors south of the Delta, threatens the Estuary's water quality future.[ii]

The Tunnels' water quality effects are largely expected by DWR and the CWF agencies to be only slightly better than for the Tunnels project when it was marketed in 2014 as the Bay Delta Conservation Plan.[iii] The main water quality impacts of the Tunnels result from its reduction of fresh water flow through the Delta to Suisun Bay and the rest of San Francisco Bay, and from tidal wetland habitat restoration. (Compared to BDCP last year, there is less habitat restoration planned for California Water Fix / California Eco Restore.)

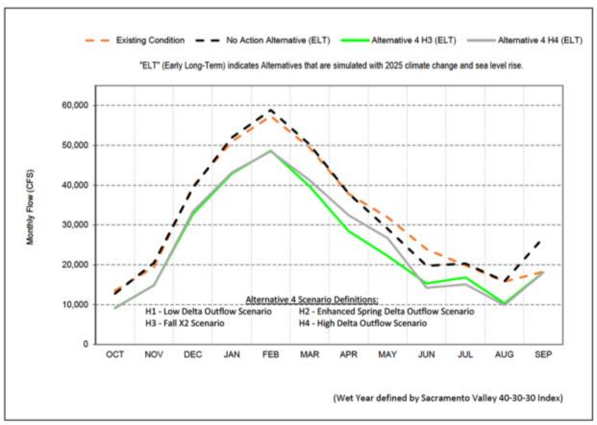

Figure 4.3.2-7
Sacramento River Flow downstream of North Delta Intakes for Alternative 4A, Average Wet Years

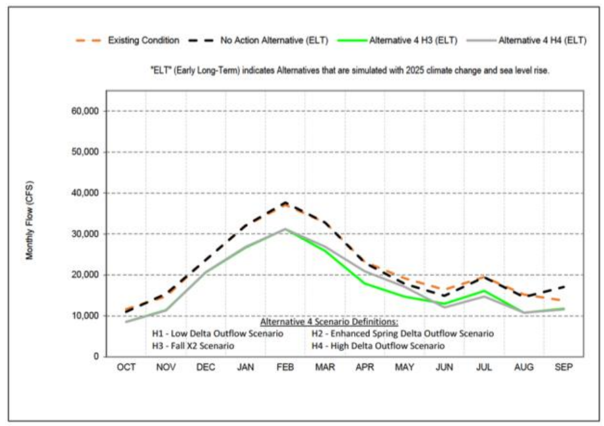

Figure 4.3.2-8
Sacramento River Flow downstream of North Delta Intakes for Alternative 4A, Long-Term Average

Source: Bay Delta Conservation Plan/California Water Fix, Recirculated Draft EIR/Supplemental Draft EIS, July 2015.

Modeling shows that long-term average Sacramento River flows below the north Delta intake diversions would *decrease* between 6 to 38 percent from current and future flows without the Tunnels project, and in wet years river flows would decrease between 7 and 42 percent. Overall, monthly lower Sacramento River flows are projected to decrease between 20 and 24 percent.[iv] This will increase residence time of water in the Bay-Delta Estuary relative to current conditions and to a future without the Tunnels.[v] The residence time increase also means that the lower-flowing and more polluted San Joaquin River will make up greater fractions of water in the western Delta, Franks Tract, and at Contra Costa Water District's Rock Slough intakes. Meanwhile, better quality Sacramento River water diverted into the Tunnels will improve state and federal export water quality.[vi]

Salinity

The Delta Tunnels will more than triple spikes in excess of salinity objectives along the Sacramento River downstream of the Tunnels, and along the San Joaquin River at Prisoners

Point. Outright violations of salinity objectives are expected to more than double with the Tunnels in place.[vii] These violations will degrade water quality for Delta agriculture and for fish and wildlife beneficial uses.

Along the lower Sacramento River, salinity violations will more than double, and will occur about a quarter of the time that salinity objectives are in effect, up from about 11 percent of the time now and with the Delta Tunnels in place. These conditions will worsen relative to current and future conditions between May and September, especially in drought years (which are expected to increase in frequency). Interior Delta salinity will also worsen between March and September (such as along the South Mokelumne River and at San Andreas Landing on the San Joaquin), as well as between February and June at Prisoners Point along the San Joaquin.[viii]

The Tunnels will be bad for Suisun Marsh. Tunnels modeling results show that every month's average salinity will increase about 56 percent over present conditions and about 60 percent over future conditions in the Beldon Landing area, 28 percent over present conditions and 27 percent over future conditions near Sunrise Duck Club, and 27 percent over present conditions and 26 percent over future conditions along Suisun Slough near Volanti Slough.[ix] This altered salinity regime could result in less habitat for fish and other aquatic species native to the Bay-Delta Estuary, as well as affect agricultural soils and vegetation in Suisun Marsh.

Harmful Algal Blooms

Algae occur naturally in all fresh and marine water environments. Most species are harmless under normal circumstances, but some "cyanobacteria" (also known as "blue-green algae") which use photosynthesis can "bloom" or undergo a rapid population boom during periods of slack flow and rising temperatures. Their sheer biomass can cause, according to the USEPA, a dramatic reduction or complete consumption of all dissolved oxygen in the water, suffocating oxygen- respiring organisms like fish, and can produce "cyanotoxins" that pose a significant potential threat to human and ecological health and affect taste, odor and safety of drinking water. They can degrade water ways used for recreation and as drinking water supplies. They thrive not only in warm temperatures and stagnant water, but they consume large nutrient inputs of nitrogen and phosphorous, which are key fertilizer inputs for agricultural land uses that, in excess, can drain to water ways.[x]

When these conditions combine, harmful algal blooms can result. These conditions are ripest in August and September in the Estuary, but drought can increase harmful algal bloom activity. The most common blue-green algae species in the Bay-Delta Estuary is called *Microcystis*, and in 2014 DWR scientists reported *Microcystis* algal blooms running beyond October into December—water residence time was that long. Their toxin is deadly to wildlife, dogs, and human beings, and exposure can cause liver cancer in humans. It is a dangerous ecological and public health threat.

The Delta Tunnels are likely to increase residence times and slow flows in the western and central Delta. Its recirculated Draft EIR/S this year acknowledges that "it is possible that increases in the frequency, magnitude, and geographic extent of of *Microcystis* blooms in the Delta would occur relative to Existing Conditions"[xi] as well as compared with the "no action alternative" (or the future condition of the Delta without Tunnels).

Pesticides

The San Joaquin River is an impaired water body for chlorpyrifos, diazinon, diuron, DDT, and Group A pesticides (human carcinogens) under the Clean Water Act.[xii] Increasing that river's fraction of water contributed to the Delta will result in more concentrated pesticides reaching central and western Delta water ways from the San Joaquin, and with longer residence times, its pesticide burdens stay longer. This translates into better water quality for the state and federal export pumps (because better quality Sacramento River water is isolated in the Tunnels) and for their agribusiness and southern California customers. Meanwhile the Bay-Delta Estuary would be left with a worsening dangerous pesticide "cocktail" supplied by the San Joaquin River's agricultural effluent.

Mercury

Mercury is a toxic legacy pollutant left over from the Gold Rush era, when mercury was used to help process gold ore in the Sierra mines. Now found in sediments throughout the Sacramento Valley, Bay-Delta Estuary, and San Francisco Bay, mercury is activated ecologically when wetland sediments are wetted and disturbed. Bacteria in the sediments then process mercury into "methyl mercury" (MeHg), making it bio-available, and toxic.

Little is understood by scientists about how methylation of mercury actually occurs chemically, except that they know that bacteria common to wetlands facilitate the process.[xiii] The single largest increase in food web MeHg bioaccumulation occurs when its aqueous form is taken up by algal cells or phytoplankton. One 2008 report found this concentration increases typically in the range of *10,000 to 100,000 times*. Consumption of algae and phytoplankton by higher trophic levels of the food web are much less bioaccumulative. ***But the huge concentration increase at the bottom of the food web is sufficient to pass on MeHg at levels harmful to food web consumers such as fish and human beings.***[xiv]

Mercury's toxicity depends on the path by which humans, fish, and wildlife are exposed. MeHg is highly toxic and can pose a variety of human health risks. Illness from MeHg can take the form of loss of sensation in the hands and feet, and in extreme cases loss of gait coordination, slurred speech, blindness, and mental disturbances. For pregnant women, exposure of the fetus and young children can lead to cerebral palsy and/or mental retardation many months after birth, all effects that indicate MeHg's ability to cross the placenta as well as the blood-brain barrier. It can be excreted in breast milk consumed by babies.[xv]

The greatest concentrations of MeHg in tissue of fish and wildlife (birds and mammals) are derived through dietary exposure—consumption of lower trophic level species that are contaminated with MeHg. Fish can experience altered hormone expression, reduced spawning success and reduced fertility, liver necrosis, and altered predator avoidance behavior. More subtle behavioral effects may occur at lower concentrations of MeHg.[xvi]

The Bay Delta Conservation Plan ***intended*** to mitigate the potential effects of methylmercury (MeHg) mobilization into bioavailability and bioaccumulation resulting from water and habitat development activities of the Bay Delta Conservation Plan. But "at this time," it said, "there is no proven method to mitigate methylation and mobilization of mercury into the aquatic system resulting from inundation of restoration areas. *The mitigation measures...are meant to provide a list of current research that has indicated potential to mitigate mercury methylation."*[xvii]

BDCP provided no mitigation method at all, just a list of "adaptive management" research issues to be handled later.[xviii] *The implied message was to "trust us" to build the Twin Tunnels project and BDCP will handle this problem later.*

For both tunnels construction and habitat restoration work in and around the Bay-Delta Estuary, DWR and its partners would have to handle MeHg on a case by case basis.[xix]

How to minimize microbial methylation activity is especially difficult. Removing from new wetlands habitat the same bacteria methylating mercury but that help recycle other nutrients would dramatically reduce the productivity of these same newly inundated wetlands to such an extent that it "would run directly counter to the goals and objectives of the BDCP," as the EIR/EIS states. With habitat restoration comes the likelihood that the legacy mercury contamination in the Delta from the Gold Rush could reignite an epidemic of mercury toxicity in Delta ecosystems if not managed extremely carefully.

Suffice it to say that methylmercury contamination in the Delta makes habitat restoration success far from assured for the purposes of BDCP and California EcoRestore.

The ratio of mercury concentrations in largemouth bass tissue was for Alternative 4 Tunnels scenarios well over 1.5 to *twice or more* the toxicity threshold.[xx] (DWR and its partners try to divert attention from the toxicity threshold by comparing these levels to continuation of the status quo No Action Alternative[xxi], but the important comparison is to the toxicity threshold for ecological and public health protection.)

California WaterFix Alternative 4A modeling in 2015 shows that the Tunnels project despite having less habitat restoration and no Yolo Bypass improvements would have only slightly less effect on fish tissue concentrations of mercury. Moreover, fish tissue concentrations at several Estuary locations would still be more than 1.5 to 2 times the USEPA's mercury guidance concentration. This analysis, however does not reflect California EcoRestore's habitat restoration efforts, which cumulatively can be expected to have impacts similar to the Tunnels and the Bay Conservation Plan last year.[xxii]

Selenium

Tunnels water exports from the Delta would increase the frequency and reliability with which irrigation water would be delivered and applied to agricultural lands in the western San Joaquin Valley, lands with high, naturally-occurring levels of selenium. Selenium occurs naturally in mineral deposits like coal and oil, as well as other marine-derived sediments.[xxiii] (Presser 1999) Wastes from agriculture, industry, mining, and gas and oil refineries can increase selenium contamination in estuaries and bays.

Selenium is necessary to the health of most vertebrate species and for human health when provided in small doses. Adequate amounts of selenium are found in a well-balanced human diet.

But at just slightly elevated levels, selenium becomes actively poisonous. As concentrations rise further, selenium can cause embryonic defects, reproductive problems, and death in vertebrate animals.

As a chemical element, selenium is chemically similar to sulfur. They both react with mineral and organic compounds. Selenium can readily substitute for sulfur in salts as well as in certain amino acids, the building blocks of proteins.[xxiv] Selenium's ability to substitute chemically for sulfur in both salt chemistry and organic amino acids opens pathways to toxicity, excessive gene mutation, and ecological damage in metabolic and reproductive systems of the body, leading to sterility. Changes in the structure of many antibodies (such as from substitution of selenium atoms for sulfur atoms) can compromise the organism's immune defenses, making it more susceptible to disease.[xxv]

In the spring of 1983, federal wildlife biologists found that a majority of birds nesting at Kesterson National Wildlife Refuge near the San Joaquin River in Merced County had deformed embryos and chicks. Nearly two-thirds of Refuge birds had missing eyes and feet, protruding brains, and twisted beaks, legs and wings. The number of breeding birds able to reproduce collapsed. These birds had been poisoned and the reservoir at Kesterson became synonymous with "toxic disaster," a western Love Canal.

The direct culprit for these disfiguring effects on wildlife was selenium.[xxvi] It arrived at Kesterson by agricultural drain water from the San Luis Drain, which was constructed by the US Bureau of Reclamation. The water had originally come from the Delta, before it was used to irrigate crops upslope from Kesterson, where soil selenium levels are high.

As it is drained off, selenium concentrates naturally in the depositional environments of estuaries and marshes (the latter of which existed at Kesterson). Although selenium dissolved in water represents only a small proportion of exposures[xxvii], in the water column of a flowing river it can become problematic when flows slow down due to changing geomorphology of the stream channel, or at conclusion of a flood.[xxviii] Incorporated into detritus or suspended sediments, selenium may undergo "partitioning" reactions in the water column that determine whether selenium remains dissolved or enters what chemists refer to as its "particulate phase."[xxix] Once partitioned, it may deposit to the bed of the quiet water body. There it gets incorporated into bacteria or phytoplankton, where it gains immediate entry into an aquatic food web when these organisms are consumed by their immediate predators (such as zooplankton and other open water or bottom-dwelling consumers).

Retiring these lands from irrigated production has yielded much of the selenium load and concentration reductions that have been achieved so far in the Grassland and northern Westlands Water District area.

The Grassland Bypass Project attempts to bioconcentrate selenium in salt-tolerant plants and discharge remaining effluent into a segment of the San Luis Drain that ultimately drains into Mud Slough (north), thence to the San Joaquin River. This method is insufficient to reduce the selenium threat to the sloughs tributary to the San Joaquin River. So the Grassland drainers obtained a grant through Panoche Drainage District to attempt a $37 million pilot treatment plant for selenium-contaminated drainage. It may not prove cost-effective. Its discontinuance would undermine BDCP's belief that selenium would not be an important contaminant stressor in the Delta. Other methods may one day use solar energy to separate selenium from drain water. Still, irrigating these lands will continue releasing selenium to drainage water; even if it's separated out, there remain difficult problems of how to sequester and store concentrated selenium to keep it out of food webs.

Mostly, the reduced selenium loads in the San Joaquin River appear attributable at best to retirement of lands from irrigation service. What drainage is generated in the Grassland area and in the Westlands Water District is largely held on-site as groundwater drainage containing selenium, and selenium in soil and source rock upslope of these lands. The longer irrigation continues on these lands, the more selenium drainage and soil contamination will build up. Flood events can mobilize pulse loads that can be quite large (see "context" discussion above and Table 2), and their toxicity long-lasting in downstream water bodies from Mud Slough all the way to the Delta and Suisun Marsh.

Retirement of the drainage impaired lands of the western San Joaquin Valley has been found time and again to be the most cost-effective solution to the problem of selenium-tainted irrigation drainage.[xxx] Land retirement is the best and cheapest option for slowing the rate at which selenium loads and concentrations reach the Delta, and for sequestering selenium in its source rock and soils longer into the future. Stop applying water exported from the Delta to these lands so that no more seleniferous drainage is intentionally created. The natural reservoir of selenium has been documented to hold up to at least another 300 years' worth of tainted drainage at current rates.[xxxi] The National Research Council's 2012 report on Bay-Delta sustainable water management cited this selenium reservoir as well, stating in part:

> Irrigation drainage, contaminated by selenium from those soils, is also accumulating in western San Joaquin Valley groundwaters. The problem is exacerbated by the recycling of the San Joaquin River when water is exported from the delta. While control of selenium releases has improved, how long those controls will be effective is not clear because of the selenium reservoir in groundwater.
>
> ...Other aspects of water management also could affect selenium contamination. For example, infrastructure changes in the delta such as construction of an isolated facility could result in the export of more Sacramento River water to the south, which would allow more selenium-rich San Joaquin River water to enter the bay. The solutions to selenium contamination must be found within the Central Valley and the risks from selenium to the bay are an important consideration in any infrastructure changes that affect how San Joaquin River water gets to the bay.[xxxii]

The State Water Resources Control Board, which has maintained a relatively light regulatory touch, approved a 2010 basin plan amendment and waiver of discharge requirements for Grassland Bypass Project that only goes through 2019 when it must decide whether another extension for the project is warranted. Whatever its faults, it does not preclude retirement of these lands in the future.[xxxiii]

Of course, ending application of Delta waters to irrigate western San Joaquin Valley drainage impaired lands could reduce the need for deliveries to the San Luis Unit of the Central Valley Project by up to a million acre-feet per year. ***This reduction could provide by itself dramatically improved reliability for all other CVP contractors' allocations, without the investment of billions for the Delta Tunnels Project.***

Endnotes

[i] See Contra Costa Water District's historical studies of salinity in the Delta, Suisun Bay, and Carquinez Strait. Accessible online at http://www.ccwater.com/366/CCWD-Reports.

[ii] California WaterFix partners also include the Metropolitan Water District of Southern California, Kern County Water Agency, Alameda County Zone 7 Water Agency, Westlands Water District, and US Bureau of Reclamation.

[iii] Bay Delta Conservation Plan/California Water Fix, *Recirculated Draft Environmental Impact Report/Supplemental Environmental Impact Statement (RDEIR/SDEIS)*, 2015, p. 4.1-43, lines 11-24.

[iv] Estimates derived by Restore the Delta from graphical analysis interpolating data in Figures 4.3.2-7 and 4.3.2-8 from the Recirculated Draft EIR/EIS, Section 4.3. See also Appendix B, Tables B.7-28, B.7-30, B.7-31, and B.7-34, for the Sacramento River downstream of the north Delta diversion facility, Sacramento River at Rio Vista, Delta outflow, and San Joaquin River flow at Vernalis, pp. B-357 to B-370. These tables show that most changes are *decreases* in flow of 5 percent or more compared with Existing Conditions and the No Action Alternative (especially along the Sacramento River downstream of the north Delta intakes. Only slight improvements occur in just a handful of months and water year types. Most San Joaquin River flows at Vernalis between February and September in most water year types decrease greater than 5 percent relative to existing conditions as well.

[v] Here the California Department of Water Resources and its California WaterFix water-contractor partners opt for faith-based analysis of water quality impacts under Alternative 4A conditions. They opted not to conduct residence time modeling for the Recirculated Draft EIR/EIS, as they had done for Alternative 4 (with habitat restoration and Yolo Bypass improvements) in 2013 and 2014. "Under the two operational scenarios of Alternative 4A [California WaterFix], a portion of the Sacramento River water which would be conveyed through the Delta to the south Delta intakes under Existing Conditions would be replaced at various locations throughout the Delta by other source water due to diversion of Sacramento River water at the north Delta intake under Alternative 4A. The change in flow paths of water through the Delta that would occur under Alternative 4A could result in localized increases in residence time in various Delta sub-regions, and decreases in residence time in other areas. In general, *there is substantial uncertainty regarding the extent that operations and maintenance of Alternative 4A would result in a net increase in water residence times at various locations throughout the Delta relative to Existing Conditions*." (Emphasis added.) Bay Delta Conservation Plan/California WaterFix, Recirculated Draft EIR/EIS, Section 4.3.4, p. 4.3.4-67. DWR and its partners could not be troubled to model residence time behavior for Alternative 4A and the other California WaterFix alternatives (2D and 5A). However, the water source "fingerprinting" analyses in both last year's and this year's modeling appendices show replacement of good quality Sacramento River water with lower-flow and poorer quality San Joaquin River water, so it is reasonable, in the absence of more definitive modeling, that relative to existing conditions residence times will increase with the Tunnels project under both Alternatives 4 and 4A.

[vi] Bay Delta Conservation Plan Draft EIR/EIS, Appendix 8D (figures for Alternative 4, Scenarios H3 and H4), 2013; BDCP/California WaterFix, Recirculated Draft EIR/Supplemental Draft EIS, Appendix B, Section B.4.2 (figures for No Action Alternative, Alternative 4A, Scenarios H3 and H4), 2015; analyzed by Restore the Delta.

[vii] Bay Delta Conservation Plan/California WaterFix, Recirculated Draft EIR/EIS, Appendix B, Table EC-1, p. B-129. "Spikes" here means daily exceedances of a salinity objective, while compliance with objectives is determined by comparing multi-day running averages with an objective. When the running average is exceeded, a violation is then deemed to occur by regulators.

[viii] *Ibid.*, Appendix B, Tables EC-8A and EC-8B, pp. B-134 to B-135.

[ix] *Ibid.*, Appendix B, Tables EC-5, EC-6, and EC-7, pp. B-131 to B-132.

[x] USEPA Region 9, *Frequently Asked Question and Resources for Harmful Algal Blooms and Cyanobacterial Toxins*, Version 1, July 2015. Accessible at http://www2.epa.gov/sites/production/files/2015-07/documents/habs_faqs-and-resources_v1-july2015.pdf.

[xi] Bay Delta Conservation Plan/California WaterFix RDEIR/SDEIS, p. 4.3.4-67.

[xii] US EPA, 2010 California California 303(d) List of Water Quality Limited Segments. Accessible online at http://gispublic.waterboards.ca.gov/pub/303d/2010_USEPA_approv_303d_List_Final_122311wsrcs.xls.

[xiii] Charles N. Alpers, et al, *Sacramento-San Joaquin Delta Regional Ecosystem Restoration Implementation Plan, Ecosystem Conceptual Model: Mercury*, prepared January 24, 2008, pp. 12-13. Accessible online at https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=6413. "The net formation of …(MeHg) in sediment and/or water is the result of competing microbiological and abiotic reactions…"

[xiv] *Ibid.*, p. 19.

[xv] *Ibid.*, pp. 27-28.

[xvi] *Ibid.*, pp. 29-36. General types of effects on fish and wildlife include DNA alteration, tissue and organ damage, abnormal development, reproductive toxicity and endocrine disruption, behavior problems, immune-system effects, and population-level effects.

[xvii] Bay Delta Conservation Plan, Chapter 3, Section 3.4.12, *Methylmercury Management*, p. 3.4-260, lines 17-21.

[xviii] These research approaches include:

- Characterize soil mercury concentrations and loads on a project-by-project basis.
- Sequester MeHg using low-intensity chemical dosing techniques using metal-based coagulants like ferric sulfide or poly-aluminum chloride. These floculants bind with dissolved organic carbon and MeHg to flocculate and deposit mercury out of solution.
- Minimize microbial methylation activity in restored wetlands.
- Design restored wetland habitat to enhance photodegradation of MeHg.
- Remediate sulfur-rich sediments with iron to prevent the biogeochemical reactions that methylate mercury.
- Cap mercury-laden sediments (essentially entomb and bury them permanently to keep from mobilizing and methylating mercury).

The research "measures" BDCP proposes do not include basic toxicological research into mercury's effects on these and other fish and aquatic species found in the Delta.

[xix] Bay Delta Conservation Plan Environmental Impact Report/Environmental Impact Statement, Chapter 8, *Water Quality*, p. 8-260, lines 30-35; p. 8-446, lines 39-42, and p. 8-447, lines 1-2. "Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management...would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect...is considered adverse."

[xx] Environmental Water Caucus, *Comment Letter on Bay Delta Conservation Plan and Draft Environmental Impact Report/Statement*, June 11, 2014, Figure 9, pp. 85-86. Accessible online at http://ewccalifornia.org/reports/bdcpcomments6-11-2014-3.pdf.

[xxi] Bay Delta Conservation Plan/California WaterFix, Recirculated Draft EIR/Supplemental EIS, 2015, Section 4.3.4, p. 4.3.4-33, lines 15-45.

[xxii] Based on Equation 1 calculations according to Appendix 8I of the Bay Delta Conservation Plan Draft EIR/EIS in 2013-2014 and Appendix B (Tables Hg-5 and Hg-7) and Appendix 8I of the Recirculated Draft EIR/Supplemental EIS in 2015. See also Environmental Water Caucus, *Comment Letter*, June 11, 2014, above.

[xxiii] T.S. Presser, "Selenium Pollution," in *Encyclopedia of Environmental Science*, ed. D.E. Alexander and R.W. Fairbridge, Kluwer Academic Publishers, 1999, pp. 554-556.

[xxiv] Selenium substitutes in salts (such as selenates for sulfates) as well as in certain amino acids (e.g., seleno-cysteine and seleno-methionine). See Presser, *ibid*., and T.S. Presser and S.N. Luoma, Forecasting selenium discharges to the San Francisco Bay-Delta Estuary: ecological effects of a proposed San Luis Drain extension, United States Geological Survey Professional Paper 1646, 2006, p. 40.

[xxv] Presser, 1999, *ibid.*, p. 555.

[xxvi] See in *Selenium and Agricultural Drainage: Implications for San Francisco Bay and the California Environment.* Proceedings of the Second Selenium Symposium, March 23, 1985, reports by: H.M. Ohlendorf, Aquatic Birds and Selenium in the San Joaquin Valley; M.K. Saiki, Concentrations of Selenium in Aquiaticn Food-Chain Organisms and Fish Exposed to Agricultural Tile Drainage Water; M.A. Sylvester, Results of U.S. Geological Survey Studies Pertaining to the Agricultural Drainage Problem of the Western San Joaquin Valley; I. Barnes, Sources of Selenium; and A.W. Kilness and J.L. Simmons, Toxic Effects of Selenium on Wildlife Species and Other Organisms.

[xxvii] Presser and Luoma, above, 2006; C.E. Schlekat, D.G. Purkerson, S.N. Luoma, Modeling selenium bioaccumulation through arthropod food webs in San Francisco Bay, California, *Environmental Toxicology and Chemistry* 23(12): 3003-3010, 2004; H.A. Roditi and N.S. Fisher, Rates and Routes of trace elements uptake in

zebra mussels, *Limnology and Oceanography* 44(7): 1730-1749, 1999; R. Alquezar, S.J.Markich, and J.R. Twining, Comparative accumulation of ^{109}Cd and ^{75}Se from water and food by an estuarine fish (*Tetractenos glaber*), *Journal of Environmental Radioactivity* 99(1): 167-180, 2008.

[xxviii] Presser and Luoma, 2006, *ibid.*, p. 6.

[xxix] *Ibid.*, p. 41.

[xxx] "Land retirement is a key strategy to reduce drainage because it can effectively reduce drainage to zero if all drainage-impaired lands are retired." Page 2, USGS Open File Report 2008-1210, Technical Analysis of In-Valley Drainage Management for the Western San Joaquin Valley, California. Accessed at http://pubs.usgs.gov/of/2008/1210/of2008-1210.pdf.

[xxxi] T. Stroshane, *Testimony on Recent Salinity and Selenium Science and Modeling for the Bay-Delta Estuary*, plus appendices, prepared for the California Water Impact Network, August 17, 2012, for Workshop #1, Ecosystem Changes and the Los Salinity Zone, before the State Water Resources Control Board.

[xxxii] National Research Council, Committee on Sustainable Water and Environmental management in the California Bay-Delta, *Sustainable Water and Environmental Management in the California Bay-Delta*, Washington, DC: The National Academies Press, 2012, p. 94. Accessible online 8 May 2014, at http://www.nap.edu/catalog.php?record_id=13394.

[xxxiii] Environmental Coalition Letter to Karl E. Longley, Chairman, Central Valley Regional Water Quality Control Board, *Re: Public Hearing Comments on Draft Waste Discharge Requirements for surface water discharges from the Grasslands Bypass Project*, July 29, 2015; and Environmental Coalition Letter to Karl E. Longley, *Re: Public Hearing Comments on Draft Waste Discharge Requirements for surface water discharges from the Grasslands Bypass Project*, June 22, 2015.