Exhibit DWR-652

REPORT ON THE EFFECTS OF THE CALIFORNIA WATERFIX ON WATER QUALITY AT CITY OF STOCKTON'S WATER TREATMENT PLANT INTAKE LOCATION ON THE SAN JOAQUIN RIVER

Prepared for:

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Prepared by:

ROBERTSON - BRYAN, INC.
Solutions for Progress

March 2017

STKN-032

EXHIBIT DWR-652

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Prepared for:

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ACRONYMS AND ABBREVIATIONS

Bay-Delta WQCP	San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan
BDCP	Bay Delta Conservation Plan
CEQA	California Environmental Quality Act
CVP	Central Valley Project
CWF	California WaterFix
Delta	Sacramento-San Joaquin Delta
DOC	dissolved organic carbon
DWR	California Department of Water Resources
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
ft/s	feet per second
MCL	maximum contaminant level
NAA	No Action Alternative
NEPA	National Environmental Policy Act
OEHHA	Office of Environmental Health Hazards Assessment
RBI	Robertson-Bryan, Inc.
RDEIR/SDEIS	Recirculated Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement
SWP	State Water Project
TOC	total organic carbon
TTHM	total trihalomethanes
USEPA	United States Environmental Protection Agency
WTP	water treatment plant

1 QUALIFICATIONS

My name is Dr. Michael Bryan. I am a Principal Scientist and Managing Partner at Robertson-Bryan, Inc. (RBI). I received a Bachelor of Science degree in Fisheries Biology from the University of Wisconsin-Stevens Point in 1986, a Master of Science degree in Fisheries Biology from Iowa State University in 1989, and a Doctor of Philosophy degree in Toxicology and Fisheries Biology from Iowa State University in 1993.

I have 23 years of experience in assessing impacts of water resource projects on water quality and aquatic biological resources in California. My expertise includes assessing measured and modeled data developed to characterize the environmental effects of projects for determining impacts to beneficial uses of waters throughout northern California, with a focus on Central Valley water bodies from Shasta Reservoir to the Sacramento-San Joaquin Delta (Delta). I have worked closely with the Central Valley Regional Water Quality Control Board over the past two decades to assist in developing and adopting eight new water quality objectives for the Central Valley Water Quality Control Plan (Basin Plan). For the California WaterFix (CWF), I led a team of scientists and engineers at RBI in the preparation of the Water Quality Chapter of the Environmental Impact Report/Environmental Impact Statement (EIR/EIS).

My responsibilities at RBI include serving as the Firm's Managing Partner and technical lead for the practice areas of water quality, fisheries biology, and California Environmental Quality Act/National Environmental Policy Act documentation. Prior to my work at RBI, I was employed by Surface Water Resources, Inc., where I used modeling output from hydrologic models (e.g., PROSIM and CALSIM), temperature models (e.g., Bureau of Reclamation's [Reclamation] lower Sacramento River and lower American River temperature models), and salmon early life stage mortality models (e.g., Reclamation's mortality models for the lower Sacramento and American rivers) along with other studies and monitoring data to assess the potential impacts of water diversion and reservoir and dam re-operation projects on water quality and fish resources in the State Water Project and Central Valley Project reservoirs, rivers and Delta. My expertise also includes designing and implementing field and modeling studies to evaluate the impacts of wastewater treatment plant discharges on receiving water beneficial uses. A copy of my statement of qualifications has been submitted as Exhibit DWR-33.

2 PURPOSE AND ORGANIZATION OF REPORT

The City of Stockton diverts water from the San Joaquin River at the southwest tip of Empire Tract for treatment at the City's Delta Water Supply Project Water Treatment Plant (DWSPWTP; hence forth "WTP") [Exhibit STKN-010, p. 5, ln. 16–17]. The WTP is described in Mr. Granberg's testimony as consisting of "*pre-ozonation, flocculation/sedimentation, microfiltration membrane filtration, chlorine disinfection, treated water storage, and chloramine residual disinfection for distribution.*" [Exhibit STKN-010, pg. 5, ln. 21–23.] Testimony provided by the City of Stockton, presented by Mr. Robert Granberg [Exhibit STKN-010], raised concerns about how the CWF may affect bromide, chloride, EC, nitrate, organic carbon, pesticides, other toxins, temperature, and *Microcystis* levels in the San Joaquin River at the City of Stockton's drinking water diversion location, and how such water quality changes may impact the City in operating its WTP. Mr. Granberg states: *"Of great concern is that the proposed change would, or threatens to, degrade water quality by various means. Water quality at the DWSPWTP intake will be affected by the changes in San Joaquin River flows and Sacramento River flows resulting from the added points of diversion, associated operational changes, or both, and the adverse changes in water quality could result in substantial injury to the City as a lawful user of water. Any increase in contaminants is of concern to the City's water supply and can lead to, at a minimum, drinking water quality permit violations, increased operational costs, threats to public health, and other adverse effects on end users."* [Exhibit STKN-010, pg. 10, Ln. 12–19]

In his written testimony, Mr. Granberg further stated [Exhibit STKN-010, pg. 10-11]: "*Specific water quality constituents (described in the City's comments on the BDCP/WaterFix environmental documents) with the potential to result in injury to the City's water supply include the following:*

- *Electrical Conductivity*
- *Cyanobacteria (e.g., Microcystis)*
- *Bromide*
- *Chloride*
- *Organic Carbon*
- *Nitrate/ Nitrite*
- *Pesticides*
- *Other toxins*
- *Water Temperature.*"

Testimony by Mr. G. Fred Lee on behalf of the California Sportfishing Protection Alliance [Exhibit CSPA-6], Mr. Tim Stroshane on behalf of Restore the Delta [Exhibit RTD-10rev2], and Ms. Barbara Barrigan-Parrilla on behalf of Restore the Delta [Exhibit RTD-20] also raised concerns about the effects of the CWF at the City of Stockton drinking water diversion location. Mr. Lee stated [Exhibit CSPA-6, pg. 22]: "*Based on my many years of professional experience in evaluating impacts of raw water quality on water treatment and the quality of the treated water, reducing the amount of Sacramento River water at the city's intake will be strongly detrimental to the city's ability to produce a high-quality treated water supply.*" Ms. Barrigan-Parrilla stated [Exhibit RTD-20, pg. 37, ln. 12–15]: "*Meanwhile, water quality impacts (including increased risk of turbidity, salinity, mobilization of mercury, methyl mercury, and selenium from Delta channel sediments) from the construction and operation of these facilities could result in increased treatment costs beyond those contemplated in Stockton's water rate study.*" Furthermore, Mr. Stroshane stated [Exhibit RTD-10rev2, pg.44:ln.22–pg.45:ln.18.]: "*The City of Stockton is concerned about the future reliability of water quality at its DWSP intake and potential water treatment cost increases if Petitioned facilities are constructed and operated. The City of Stockton alleges that Petitioners have failed to use data collected near the City's Delta Water Supply Project (DWSP) for impact analysis of potential harm. ... The City stated that 'Buckley Cove cannot be considered representative of the water quality available at the City's intake."*

This report has been prepared as the technical basis for the expert opinions that I present in my written rebuttal testimony regarding the degree to which the CWF would affect the constituents/parameters identified above that are of concern to the City of Stockton, California Sportfishing Alliance, and Restore the Delta. First, an overview of how the CWF EIR/EIS water quality assessment was conducted for the Delta and the adequacy of that assessment to identify potential impacts, including impacts to the City of Stockton at its WTP intake, is provided. Detailed assessments of the specific constituents/parameters of concern identified in Mr. Granberg's and Ms. Barrigan-Parrilla's testimony follows. Mr. Lee's testimony did not specify constituents of concern at the City's intake; but the following discussion provides a comprehensive address of water quality and, thus, also addresses Mr. Lee's testimony.

3 PROJECT WATER QUALITY EFFECTS IN THE SAN JOAQUIN RIVER AT CITY OF STOCKTON'S DRINKING WATER TREATMENT PLANT INTAKE

3.1 EIR/EIS ASSESSMENT OF THE MUNICIPAL AND DOMESTIC WATER SUPPLY USE OF THE SAN JOAQUIN RIVER

> ***The EIR/EIS adequately assessed protection of the Municipal and Domestic Water Supply (MUN) beneficial use of the San Joaquin River and thus at the City of Stockton's diversion of river water at its WTP intake location for this use.***

The State of California regulates surface water quality through adoption and enforcement of water quality standards. A water quality standard has three parts:

1. the beneficial uses of water that have been designated and are to be protected,
2. the water quality criteria/objectives adopted that, when met, shall protect the beneficial uses, and
3. an antidegradation policy.

Because all water quality regulation in the State starts with the designated beneficial use, and its protection through enforced criteria/objectives and the antidegradation policy, the EIR/EIS water quality assessment was designed to follow this paradigm.

The BDCP/CWF EIR/EIS water quality assessment was designed to assess whether implementation of the project would result in water quality changes anywhere within the affected environment (i.e., upstream of the Delta, within the Delta, or within the Central Valley Project [CVP]/State Water Project [SWP] Export Service Area) that would cause significant adverse impacts to beneficial uses in any water body or water body segment (Chapter 8, Water Quality in Draft EIR/EIS Section 8.4.1, RDEIR/SDEIS Section 8.3.1, and Final EIR/EIS Section 8.3.1). The water quality assessment for the Delta region consisted of both qualitative and quantitative assessments for specific constituents or constituent groups. For the quantitative assessments, which relied on output from the Delta Simulation Model II (DSM2), specific locations in the Delta were selected for which modeling output was summarized, presented, and assessed. In addition to the assessment locations being geographically distributed across the Delta (i.e., northern, southern, western, eastern, and central Delta), the assessment also focused on the San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan (Bay-Delta WQCP) compliance locations for regulated parameters, which include electrical conductivity (EC) for the protection of the Delta's Agricultural Supply [AGR] beneficial use and chloride for the protection of the Delta's Municipal and Domestic Supply [MUN] beneficial use.

The assessment locations were chosen such that the modeled water quality changes under the CWF alternatives, relative to baselines, would be representative of water quality changes in the various geographic portions of the Delta as a whole (Chapter 8, Water Quality in Draft EIR/EIS Sections 8.2.2.3 and 8.4.1.3, RDEIR/SDEIS Section 8.3.1.3, and Final EIR/EIS Sections 8.1.2.3 and 8.3.1.3). The assessment was done on a comparative basis (i.e., alternatives as compared to baselines) to understand the relative effect on water quality among the alternatives and geographically across the Delta. This allowed determination of water bodies or reaches of water bodies within the Delta where a given constituent may be most affected by a CWF alternative. Thus, even though water quality in the Delta varies spatially, and locations in the Delta may not have identical water quality to the chosen locations for assessment, given the comparative manner and purposes of the assessment, the effects of the CWF at the locations assessed were considered representative of the effects of the CWF in the various areas of the Delta.

Based on the frequency and magnitude of the water quality changes at each assessment location, as compared to adopted water quality criteria/objectives or other scientifically based effects thresholds, impact determinations for designated beneficial uses of the water bodies and water body reaches could be determined for CEQA and NEPA purposes in the EIR/EIS. The frequency, magnitude, and geographic extent of the water quality changes modeled for the Delta assessment locations were compared to the Thresholds of Significance defined for the assessment for the purposes of making impact determinations. The Thresholds of Significance used addressed whether the CWF would cause one or more of the following to occur (Chapter 8, Water Quality in Draft EIR/EIS Section 8.4.2.3 and Final EIR/EIS Section 8.3.2.3).

1. Exceedance of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality thresholds identified for this assessment, by frequency, magnitude, and geographic extent that would result in adverse effects on one or more beneficial uses within affected water bodies.

2. Increase levels of a bioaccumulative pollutant by frequency, magnitude, and geographic extent such that the affected water body (or portion of a water body) would be expected to have measurably higher body burdens of the bioaccumulative pollutant in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.

3. Cause long-term degradation of water quality, resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects on one or more beneficial uses.

4. Further degrade water quality by measurable levels, on a long-term basis, for one or more parameters that are already impaired and, thus, included on the state's Clean Water Act Section 303(d) list for the water body, such that beneficial use impairment would be made discernibly worse.

The City of Stockton's diversion of water from the Delta is located on the San Joaquin River near Venice Island. The City's WTP intake location is between the Prisoners Point assessment location, which is a Bay-Delta WQCP compliance location assessed for EC, and the San Joaquin River at Buckley Cove assessment location, which was assessed for all other water quality constituents that were quantitatively modeled. These locations are representative for purposes of assessing the effects of the CWF on water quality at the City of Stockton intake even though the specific water quality itself at Prisoners Point and Buckley Cove is not identical to the water quality at the City's intake location (i.e., it varies somewhat across this reach of river). To be clear, the relative effects of the CWF at these locations on the river's designated beneficial uses of water (including the MUN use) are representative of the relative effects of the CWF on the MUN use at the City's WTP intake. In other words, based on findings from all assessment locations in the Delta, the EIR/EIS made impact findings to beneficial uses designated to water bodies and water body segments, not just to the assessment locations themselves, because the beneficial uses (the cornerstone of the State's water quality standards) are designated by water body and water body segment, not by individual locations or diversion locations.

The water quality constituent chloride provides a good example of the above concept. The Bay-Delta WQCP contains a water quality objective for chloride for the protection of the MUN beneficial use that must be met either at the San Joaquin River at Antioch or Contra Costa Pumping Plant #1 for a designated number of days each year. The primary source of chloride in the Delta is sea water intrusion. The Bay-Delta WQCP uses these two locations for the purposes of enforcing the objective and protecting the MUN beneficial use throughout the Delta because if the objective is met at these locations, which are in the western Delta closer to the sea water source, the MUN use will be protected throughout the remainder of the Delta, which receives less sea water intrusion. This is true despite chloride levels at other Delta locations being somewhat different from what they are at the compliance assessment locations. This is important because the MUN beneficial use is designated for all channels within the Delta – not just at the chloride objective compliance locations.

Thus, when the EIR/EIS assessment showed non-adverse effects of the CWF at its assessment locations across the Delta or for a portion of the Delta, such findings were used to make less-than-significant (CEQA)/non-adverse (NEPA) impact determinations to beneficial uses for the entire Delta or defined portions of the Delta, based on the representative nature of the individual assessment locations. Hence, when the EIR/EIS assessment showed less-than-significant/non-adverse impacts of the CWF at its assessment locations across the Delta with regard to the MUN use, it showed less-than-significant/non-adverse impacts of the CWF to the MUN use at the City of Stockton's WTP intake location as well.

In summary, by determining the CWF-driven changes in water quality at the geographically distributed assessment locations, as well as the Bay-Delta WQCP assessment locations for EC and chloride, and comparing those changes to the Thresholds of Significance listed above for the purposes of making impact determinations, the EIR/EIS assessment determined (among other things) whether the CWF would adversely impact the MUN beneficial use of the San Joaquin River, or any segment of it. In so doing, the EIR/EIS assessment appropriately addressed whether the CWF would impact the City of Stockton's beneficial use of San Joaquin River water by its diversion and treatment of river water for municipal supply use (i.e., the MUN beneficial use at the City's WTP intake location).

3.2 DIFFERENCE BETWEEN EIR/EIS ANALYSIS AND THIS ANALYSIS

Even though the EIR/EIS provided an adequate assessment of water quality with regard to protection of the MUN and other beneficial uses of San Joaquin River water as discussed above, additional assessment was done to accommodate the City of Stockton's desire to see CWF water quality effects at the City's specific WTP intake location and to address concerns raised by Mr. Granberg in his testimony [Exhibit STKN-010]. Hence, this assessment is simply focused on a single location and the water quality constituents that are of concern to the City that were specifically identified in Mr. Granberg's testimony. This assessment also addresses Mr. Lee's [Exhibit CSPA-6] and Ms. Barrigan-Parrilla [Exhibit RTD-20]. In addition, this assessment focuses on CWF-driven changes to the identified parameters that may cause exceedances of applicable drinking water Maximum Contaminant Levels (MCLs), criteria/objectives, or other relevance science-based thresholds for the purposes of determining whether such CWF water quality changes would adversely impact the City's treated water supply (i.e., the MUN beneficial use). As indicated by this last statement, both this assessment and that performed in the EIR/EIS ultimately address whether CWF changes to San Joaquin River water quality are of sufficient frequency and magnitude to adversely impact the MUN beneficial use. The only real difference is that the EIR/EIS assessment does so for the entire San Joaquin River, and other water bodies within the affected environment, and this assessment does so for the City of Stockton's drinking water diversion location only.

3.3 CONSTITUENT-SPECIFIC EVALUATIONS

The findings from this site-specific analysis affirm the water quality findings presented in the EIR/EIS. Both analyses find that the CWF would not result in substantial degradation of water quality or increased exceedances of adopted water quality objectives or criteria and thus would not adversely impact the municipal and domestic supply or industrial supply beneficial uses of San Joaquin River at the City of Stockton's WTP intake location.

The constituent classes identified in Mr. Granberg's testimony [Exhibit STKN-010, pg. 10–11] are addressed in the following sections.

Some of the constituent assessments are based upon DSM2 output conducted for DWR's case-in-chief for the water rights petition, which consists of the following scenarios: No Action Alternative (NAA), CWF operational range scenario 4A-H3 (4A-H3), CWF operational range scenario 4A-H4 (4A-H4), CWF boundary scenario 1 (Boundary 1 or BNDY 1) which has reduced Delta outflow, and CWF boundary scenario 2 (Boundary 2 or BNDY 2), which has higher Delta outflow. The constituent assessments relying on this modeling include bromide, chloride, EC, nitrate, and organic carbon. Source-water fingerprinting output for the upstream end of DSM2 channel 37, which is the DSM2 output location closest to the City's WTP intake location, was used to support the assessment of these water quality constituents.

The methodology for calculating constituent concentrations from the source-water fingerprinting output (referred to as the mass-balance methodology) is the same methodology defined in the CWF EIR/EIS[1]. In addition, for bromide and chloride, a second method of estimating concentrations based on the relationship between these constituents and EC, which is directly modeled by DSM2, was also used. This methodology is also described in the CWF EIR/EIS[2].

3.3.1 Bromide

> ***Collectively, the information presented below indicates that the CWF is anticipated to result in bromide concentrations at the City's WTP intake location in the San Joaquin River that would be very similar to that which would occur under the NAA, and thus would not substantially degrade water quality with regard to bromide. There are no adopted water quality objectives or criteria for bromide in the San Joaquin River and thus no exceedances of receiving water quality objectives or criteria would occur for the CWF. Therefore, the bromide concentrations that would occur at the site for the CWF would not adversely impact the river's municipal and industrial supply beneficial uses. As such, I would not expect bromide concentrations that would occur for the CWF to adversely impact the City of Stockton when diverting and treating water from the San Joaquin River for these beneficial uses.***

The primary source of bromide to the City's diversion location in the San Joaquin River is sea water intrusion into the Delta and background bromide concentrations in the San Joaquin River itself (**Table 1**). There are no adopted state or federal surface water quality criteria or objectives for bromide that are applicable to the Delta. Other guidance is used to identify a bromide threshold for this analysis.

Table 1. Source water concentrations for dissolved bromide.

Source Water	Sacramento River	San Joaquin River	Bay Water	East Side Tributaries	Delta Ag. Return Waters
Mean (µg/L)	15	251	13,149–32,951	16	456
Source: Table 8-43 in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan Draft EIR/EIS and of the Bay Delta Conservation Plan/California WaterFix Partially Recirculated Draft EIR/Supplemental Draft EIS and Final EIR/EIS.					

In 1998, a panel of three water quality and treatment experts, engaged by the California Urban Water Agencies, produced a report titled "Bay-Delta Water Quality Evaluation, Draft Final

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[1] Section 8.4.1.3, *Plan Area*, in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan Draft EIR/EIS; Section 8.3.1.3, *Plan Area*, in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan/California WaterFix Partially Recirculated Draft EIR/Supplemental Draft EIS and Final EIR/EIS.

[2] *Ibid.*

Report." California Urban Water Agencies had charged the panel with developing potential regulatory scenarios, defining appropriate treatment process criteria, and estimating the Delta source water quality required to achieve compliance under the anticipated regulatory scenarios. The panel identified two regulatory scenarios for their evaluation: 1) a near-term scenario consisting of the then current (and still current today) treatment rules governing pathogen inactivation and disinfection, and 2) a long-term scenario which included substantially more stringent versions of these rules than were in place at the time and remain in-place today.

The long term scenario was based on the then current (and still current) regulatory requirements of 80 μg/L total trihalomethanes (TTHMs), 60 μg/L haloacetic acids, and 10 μg/L bromate (as running annual averages) all being reduced by half, as well as an additional 1 to 2-log inactivation of *Giardia* and 1-log inactivation of *Cryptosporidium* being imposed by future rule-making. For this long-term scenario, the panel recommended receiving water bromide levels of 50 μg/L to provide users adequate flexibility in their choice of treatment method and still be able to comply with the reduced DBP levels in treated water defined for this scenario. For the near-term regulatory scenario, which also is the current regulatory requirements today, total organic carbon (TOC) from 4 to 7 mg/L and bromide from 100 to 300 μg/L was determined to be acceptable to provide users adequate flexibility in their choice of treatment method (CALFED Water Quality Program 2007, as cited in Chapter 8 of the RDEIR/SDEIS, p. 8-8, and Final EIR/EIS p. 8-44 to 8-45).

The EIR/EIS assessment for bromide used 50 μg/L and 100 μg/L as assessment thresholds. The 50 μg/L threshold proved to be of little utility for assessing bromide changes in interior Delta locations and the San Joaquin River near the City of Stockton's WTP intake location because this threshold was shown from modeling to be exceeded 100% of the time for all scenarios modeled. This coupled with the fact that the panel of three water quality and treatment experts, engaged by the California Urban Water Agencies, determined that bromide from 100 to 300 μg/L was determined to be acceptable to provide users adequate flexibility in their choice of treatment methods for compliance with current regulated DBPs (e.g., TTHMs of 80 μg/L) led me to use 100 to 300 μg/L as assessment threshold levels for bromide for this site-specific assessment.

Based on the information above, and the fact that there are no adopted water quality objectives or criteria for bromide, this assessment used 100 μg/L and 300 μg/L bromide to evaluate the frequency with which these thresholds would be exceeded at the City's diversion location on a mean monthly basis for the NAA and for 4A-H3, 4A-H4, Boundary 1, and Boundary 2 scenarios.

Bromide was assessed using two different modeling approaches. The first approach was mass-balance methodology, in which the DSM2-modeled source water fractions were multiplied by long-term average bromide concentrations in each source water to estimate the concentration at the site for each scenario. These flow fractions were used together with source water constituent concentrations derived from historical data to estimate a given constituent concentration at assessment locations according to Equation 1.

$$f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR}) = C_i \qquad \text{(Equation 1)}$$

In the above equation, $f_{x,i}$ is the mean monthly flow fraction from source X at assessment location i, C_X is the constituent concentration from source X, and C_i is the constituent concentration at assessment location.

The second methodology uses a relationship between bromide and EC (with EC modeled directly by DSM2) to estimate bromide concentrations at the site for each scenario. Both are valid methods and it is uncertain which method most accurately models bromide concentrations at the site so both are presented and interpreted below

Mass-Balance Methodology

Using the mass-balance methodology output, box-and-whisker plots and exceedance plots for mean monthly bromide concentrations at the City of Stockton's WTP intake location in the San Joaquin River are presented for NAA, 4A-H3, 4A-H4, Boundary 1, and Boundary 2 conditions, for all water years modeled (i.e., 1976–1991) and by water year types in Figure 1 through Figure 6.

When looking at the exceedance plot for all years, bromide concentrations are very similar among all five scenarios for approximately 67% of the time when bromide concentrations are the lowest. For the 33% of the time when bromide concentrations at the site are the highest, 4A-H3, 4A-H4, Boundary 1 and Boundary 2 all show a similar or lower frequency with which any given bromide concentration would be exceeded, relative to the NAA. The exception would be for Boundary 1, which would have higher mean monthly bromide concentrations than the NAA about 1% of the time when bromide concentrations are highest. This is also noted in the box-and-whisker plots (**Figure 1**). Based on these findings, the CWF would be expected to result in similar or lower mean monthly bromide concentrations at the site most of the time, relative to the NAA.

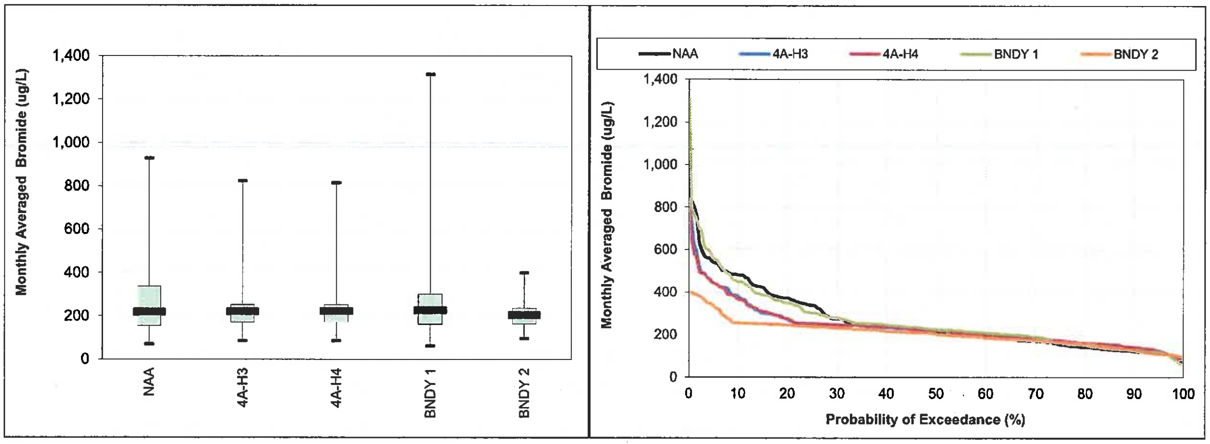

Figure 1. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for all water years (1976–1991), based on mass-balance methodology.

In wet years, mean monthly bromide concentration always remain well below 300 µg/L at the site for 4A-H3, 4A-H4, and Boundary 2, but are above 300 µg/L about 4% of the time for Boundary 1 and about 12% of the time for the NAA. As such, the CWF would typically result in similar or lower mean monthly bromide concentrations at the site in wet years, relative to the NAA (**Figure 2**).

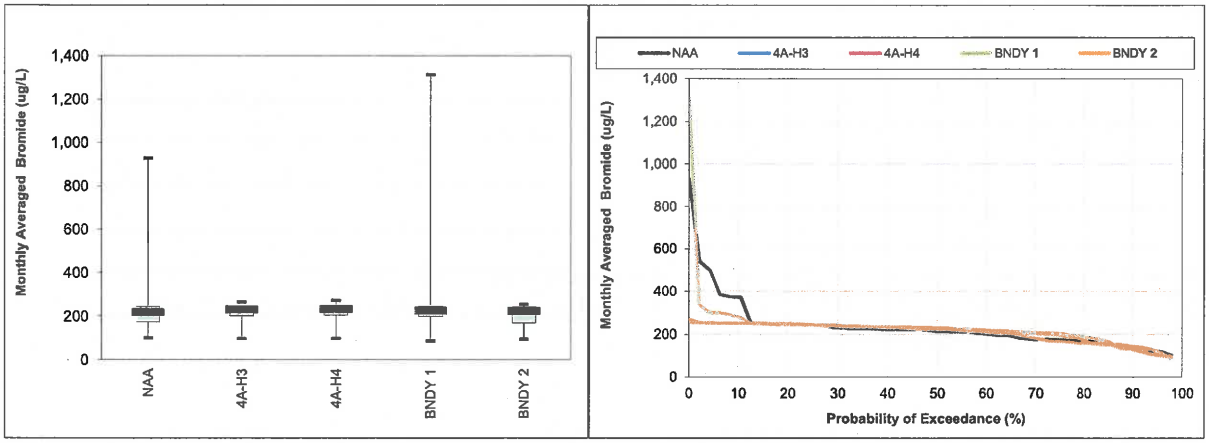

Figure 2. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for wet years (1976–1991), based on mass-balance methodology.

Scenarios 4A-H3, 4A-H4, and Boundary 2 all show a similar or lower frequency with which any given mean monthly bromide concentration would be exceeded during above normal years, relative to the NAA. The frequency with which any given mean monthly bromide concentration would be exceeded under Boundary 1 would be similar to or lower than that of the NAA approximately 86% of the time when bromide concentrations are lowest. However, the frequency with which mean monthly bromide concentrations at the City's diversion site would exceed a given concentration during the 14% of the time when bromide concentrations are at their highest (475–800 µg/L) would be greater under Boundary 1, relative to the NAA. Based on these findings, the CWF would be expected to result in similar or lower mean monthly bromide concentrations at the site in above normal years, relative to the NAA (**Figure 3**).

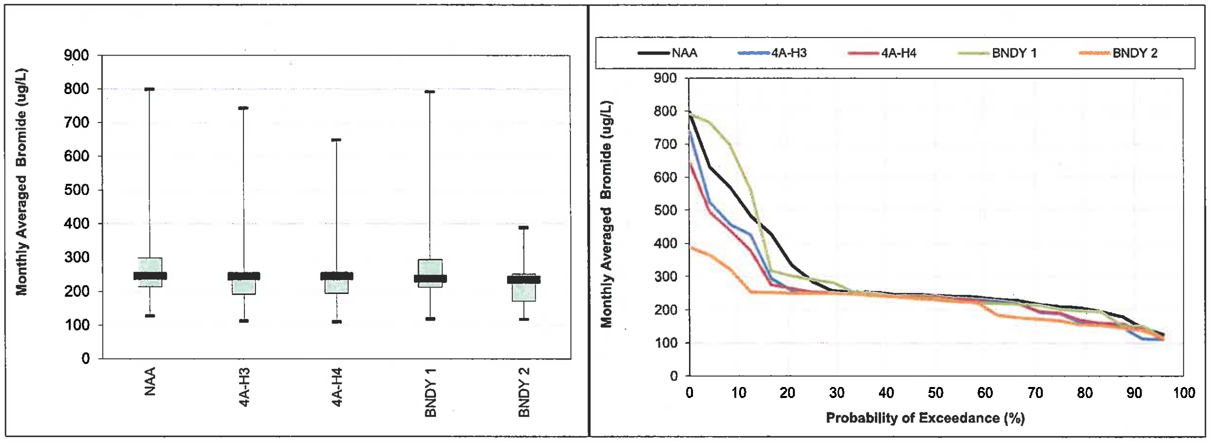

Figure 3. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for above normal years (1976–1991), based on mass-balance methodology.

In below normal years, mean monthly bromide concentrations at the City's diversion location would remain below the 300 μg/L at all times for 4A-H3, 4A-H4, and Boundary 2. Mean monthly bromide concentrations would exceed 300 μg/L approximately 15% of the time for Boundary 1 and about 27% of the time for the NAA. Based on these findings, the CWF would be expected to result in similar or lower mean monthly bromide concentrations at the site in below normal years, relative to the NAA **(Figure 4)**.

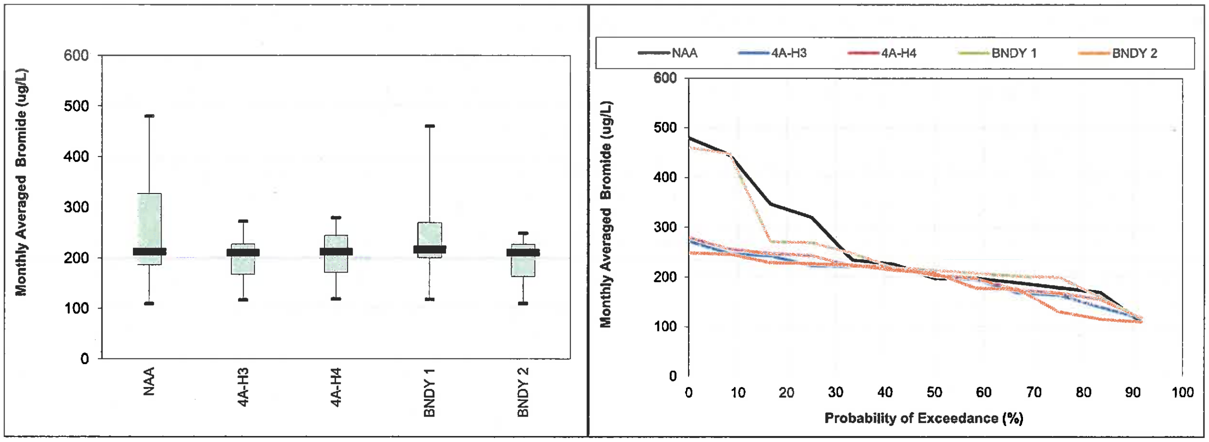

Figure 4. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for below normal years (1976–1991), based on mass-balance methodology.

In dry years, mean monthly bromide concentrations at the City's diversion location would remain below 300 μg/L approximately 98% of the time for Boundary 2, 85% of the time for 4A-H3 and 4A-H4, 80% of the time for Boundary 1, and 78% of the time for the NAA. When bromide concentrations at the site were modeled to exceed 300 µg/L, the frequency with which any given bromide concentration would be exceeded for 4A-H3, 4A-H4, Boundary 1, and Boundary 2 would be similar to or lower than that for the NAA. Based on these findings, the CWF would be expected to result in similar or lower mean monthly bromide concentrations at the site in dry years, relative to the NAA (**Figure 5**).

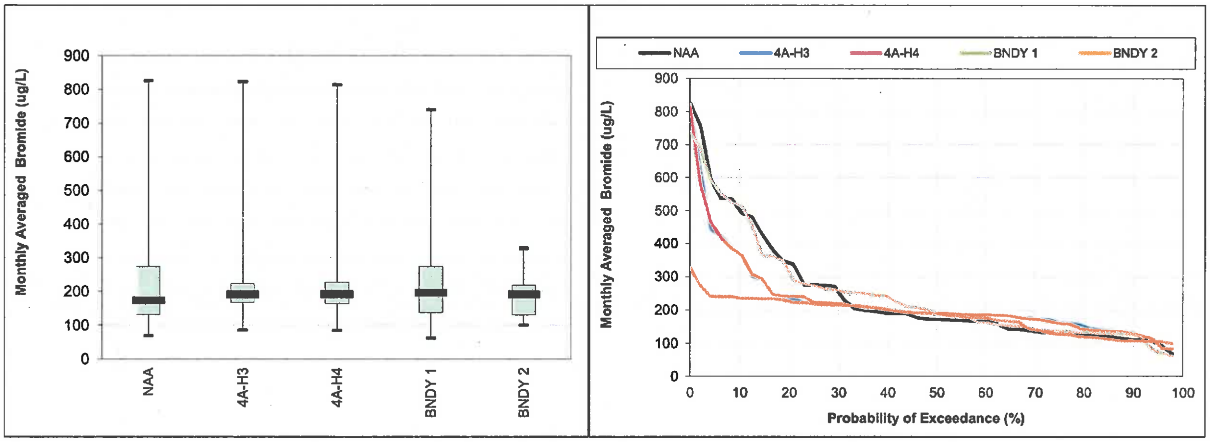

Figure 5. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991), based on mass-balance methodology.

In critical years, mean monthly bromide concentrations at the City's diversion location would remain below 300 µg/L approximately 85% of the time for Boundary 2, 65% of the time for 4A-H3 and 4A-H4, 58% of the time for the NAA, and 54% of the time for Boundary 1. When bromide concentrations at the site were modeled to exceed 300 µg/L, the frequency with which any given bromide concentration would be exceeded for 4A-H4 and Boundary 2 would be lower than that for the NAA. This would also be the case for 4A-H3 and Boundary 1, with the exception of about 5% of the time when highest bromide concentrations would occur for Boundary 1 and 1% of the time for 4A-H3 when their mean monthly concentrations would be greater than those for the NAA. Based on these findings, the CWF would be expected to result in lower mean monthly bromide concentrations at the site nearly all of the time when bromide concentrations are above 300 µg/L, relative to the NAA. When mean monthly bromide concentrations are below 300 µg/L, concentrations at the site would sometimes be higher and sometimes be lower for the CWF scenarios compared to the NAA (**Figure 6**).

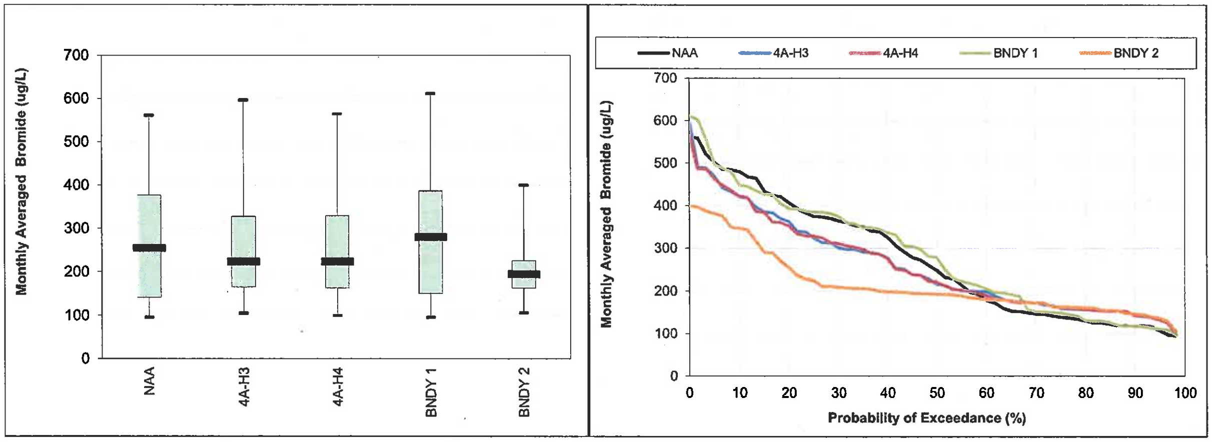

Figure 6. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for critical years (1976–1991), based on mass-balance methodology.

The long-term average concentration of bromide at the site for 4A-H3, 4A-H4, Boundary 1 and Boundary 2, for the entire modeled period, would be similar to or lower than that modeled to occur for the NAA **(Table 2)**.

Finally, the frequency with which bromide concentrations at the City's diversion location would exceed the thresholds of 100 µg/L and 300 µg/L are presented in Table 2. The frequency with which these thresholds would be exceeded at the City's diversion locations would be similar to or lesser than that for the NAA. In particular, the 300 µg/L threshold would be exceeded less often under 4A-H3, 4A-H4, and Boundary 2 compared to the NAA, and would be exceeded with similar frequency for Boundary 1, relative to the NAA (Table 2).

Table 2. Bromide concentrations and frequency of exceeding threshold concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location, based on mass-balance methodology.

	Period Average Concentration (µg/L) (Difference from NAA)					Frequency of Threshold Exceedance (%) 100 µg/L (300 µg/L)				
Period	NAA	4A-H3	4A-H4	BNDY 1	BNDY 2	NAA	4A-H3	4A-H3	BNDY 1	BNDY 2
All	261	237 (-24)	236 (-25)	265 (4)	204 (-57)	98 (28)	98 (16)	98 (17)	97 (26)	99 (7)
Drought	288	270 (-18)	269 (-19)	295 (7)	208 (-80)	95 (42)	98 (33)	98 (37)	93 (43)	100 (12)

In summary, the mass-balance methodology indicates that the CWF would typically result in lower mean monthly bromide concentrations at the City's drinking water diversion location, and would result in long-term average concentrations lower than that which would occur at the site for the NAA. Consequently, both the 100 µg/L and 300 µg/L threshold levels would be exceeded less frequently at this location for the CWF than for the NAA.

EC-to-Bromide Relationship Methodology

Results from the EC-to-bromide relationship modeling methodology are presented for all years modeled, and by water year type, in Figure 7 through Figure 12. For the entire period modeled (water years 1976–1991), the frequency with which any given bromide concentration would be exceeded differs little among the five scenarios. The exception would be for Boundary 1, which would have higher mean monthly bromide concentrations than the NAA about 2% of the time when bromide concentrations are highest. This is also noted in the box-and-whisker plots. At mean monthly bromide concentrations of about 330 µg/L and higher, the probability of exceeding any given bromide concentration would be similar for 4A-H3 and 4A-H4, relative to the NAA. Below about 330 µg/L, the probability of exceeding a given bromide concentration for 4A-H3 4A-H4, Boundary 1, and Boundary 2 would be similar to or higher than that for the NAA (**Figure 7**).

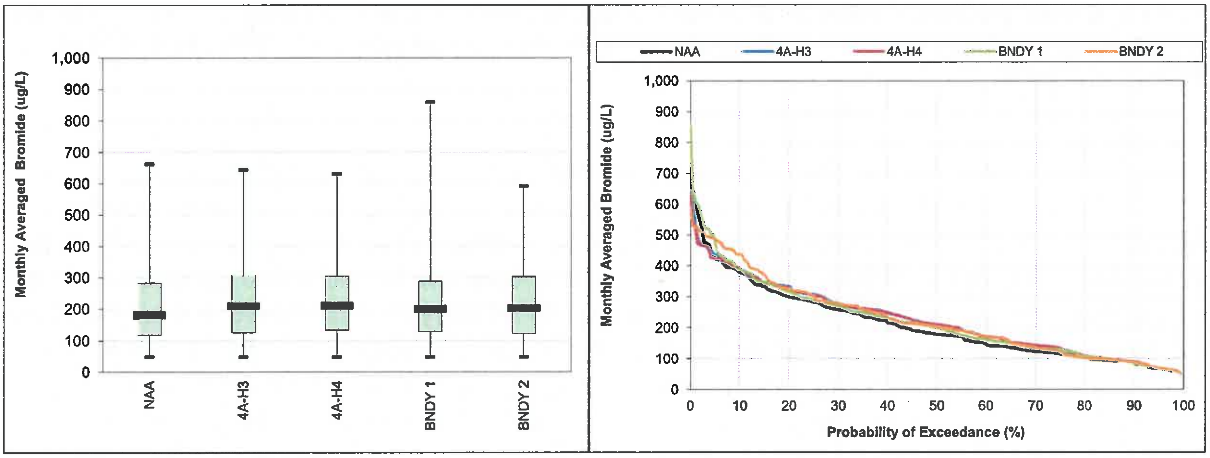

Figure 7. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for all water years (1976–1991), based on EC-to-bromide relationship.

In wet years, mean monthly bromide concentrations always remain below 300 µg/L at the site for 4A-H3 and 4A-H4, but are above 300 µg/L about 3% of the time for Boundary 2, 3% of the time for Boundary 1 and about 6% of the time for the NAA. Maximum modeled mean monthly bromide concentrations at the site would be lowest for 4A-H3 and 4A-H4 (about 300 µg/L), slightly higher for Boundary 2 (about 340 µg/L), and substantially higher for the NAA (about 600 µg/L) and Boundary 1 (about 875 µg/L). Thus, the CWF would typically result in similar or lower mean monthly bromide concentrations at the site in wet years., with lower concentrations occurring when mean monthly bromide levels would exceed about 250 µg/L under the NAA (**Figure 8**).

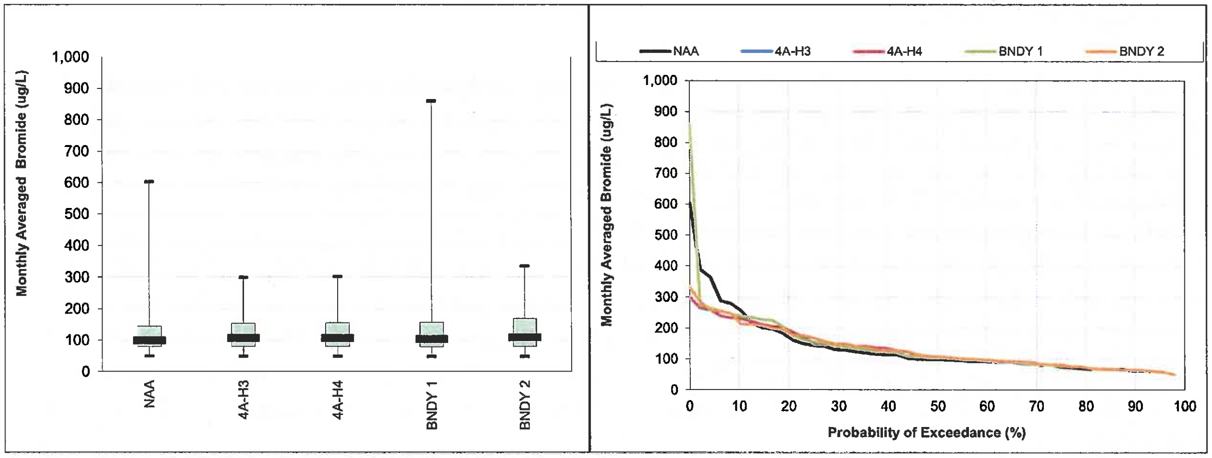

Figure 8. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for wet years (1976–1991), based on EC-to-bromide relationship.

During above normal years, when mean monthly bromide levels at the site were modeled to be below 300 µg/L, 4A-H3, 4A-H4, Boundary 1, and Boundary 2 all show a similar to somewhat higher frequency with which any given mean monthly bromide level would occur, relative to the NAA. When site mean monthly bromide levels were modeled to be above 300 µg/L (about 25% of the time), the frequency with which any given mean monthly bromide concentration would be exceeded would typically be lesser for 4A-H3, 4A-H4, and Boundary 2 than for the NAA. Conversely, for Boundary 1, the frequency with which any given mean monthly bromide level greater than 300 µg/L would be exceeded would be greater than that for the NAA, with the exception of levels above about 650 µg/L. The NAA would exceed mean monthly bromide levels of about 650 µg/L 1–2% of the time, but none of the other alternatives modeled would exceed 650 µg/L. Based on these findings, the CWF would be expected to typically result in somewhat higher mean monthly bromide levels at the site when levels would be below 300 µg/L, but would result in concentration similar or lower than those for the NAA when mean monthly bromide concentrations exceed 300 µg/L (**Figure 9**).

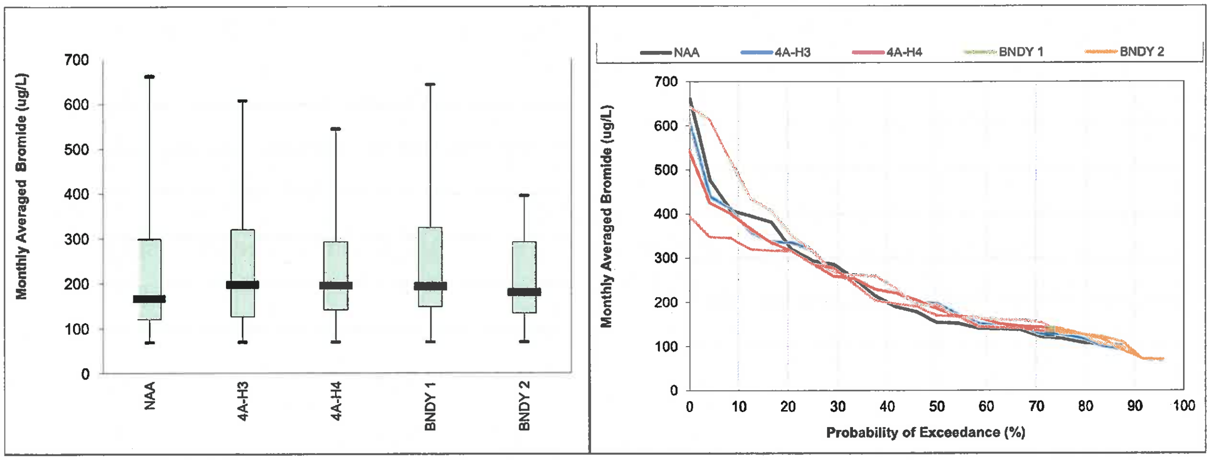

Figure 9. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for above normal years (1976–1991), based on EC-to-bromide relationship.

Modeled findings are similar to those for below normal years to those discussed above for above normal years. Mean monthly bromide concentrations at the City's diversion location were modeled to be at or above 300 µg/L about 12% of the time for 4A-H3, 4A-H4, and Boundary 2, about 17% of the time for the NAA, and about 19% of the time for Boundary 1. Maximum modeled mean monthly bromide concentrations reached at the site would be lowest for 4A-H3 and 4A-H4 (about 350–375 µg/L), somewhat higher and similar to each other for NAA and Boundary 2 (about 410–420 µg/L), and highest for Boundary 1 (about 515 µg/L). Based on these findings, the CWF would be expected to result in similar or lower mean monthly bromide concentrations at the site when concentration would be 300 µg/L or greater for the NAA (**Figure 10**).

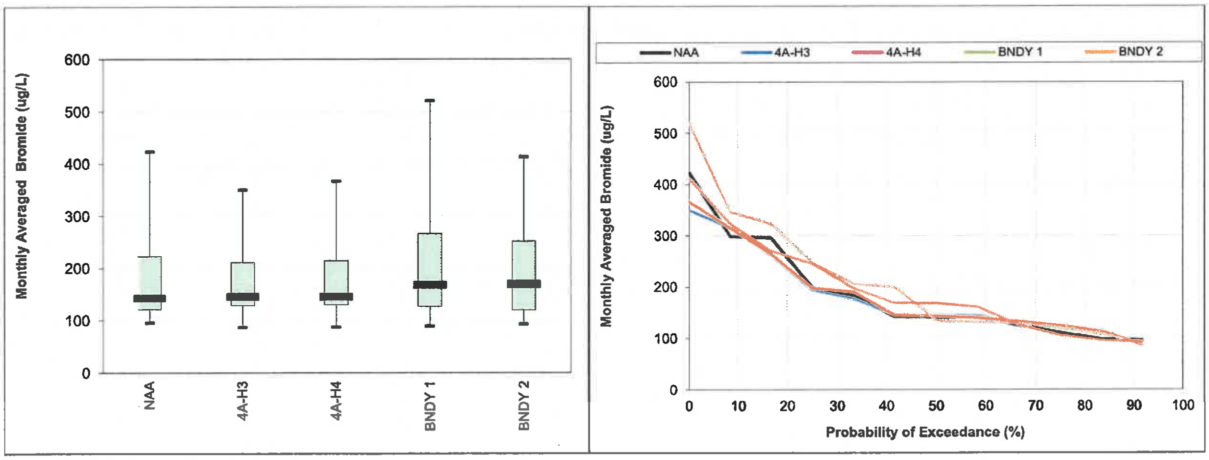

Figure 10. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for below normal years (1976–1991), based on EC-to-bromide relationship.

In dry years, mean monthly bromide concentrations at the City's diversion location would typically be similar to or somewhat higher than those for the NAA, except during about 5–6% of the time when bromide levels would be highest, when 4A-H3, 4A-H4, Boundary 1, and Boundary 2 levels would typically be lower than those for the NAA. Maximum modeled mean monthly bromide concentrations at the site would be lowest for Boundary 1 and Boundary 2, and similar for 4A-H3, 4A-H4, and the NAA. Based on these findings, the CWF would be expected to generally result in similar or somewhat higher mean monthly bromide concentrations at the site in dry years, relative to the NAA (**Figure 11**).

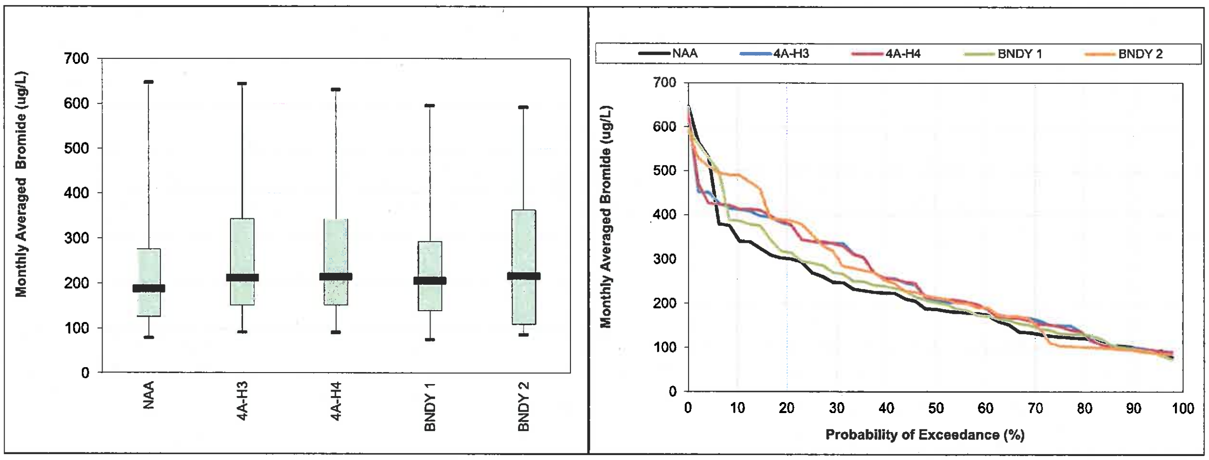

Figure 11. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991), based on EC-to-bromide relationship.

In critical years, mean monthly bromide concentrations at the City's diversion location would typically be similar to or somewhat higher than those for the NAA. The frequency with which 300 µg/L would be exceeded at the site would be about 30% for the NAA and about 32–40% for the other modeled scenarios. Maximum modeled mean monthly bromide concentrations at the site would be lowest for the NAA, and somewhat higher for the other scenarios modeled. Based on these findings, the CWF would be expected to result in similar or somewhat higher mean monthly bromide concentrations at the site in critical years, relative to the NAA (**Figure 12**).

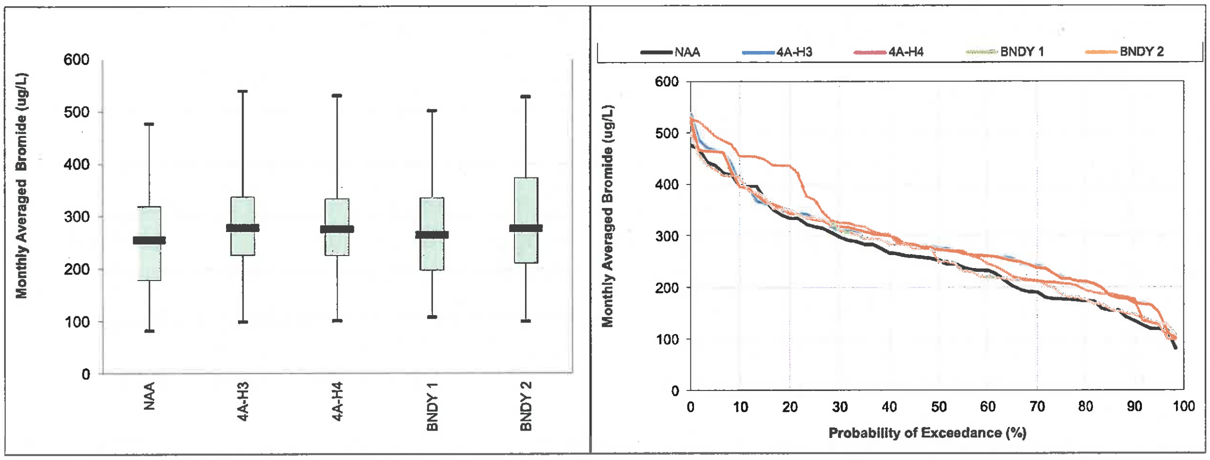

Figure 12. Box-and-whisker and probability of exceedance plots for monthly average bromide concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for critical years (1976–1991), based on EC-to-bromide relationship.

Using the EC to bromide relationship modeling methodology, the average concentration of bromide at the site for 4A-H3, 4A-H4, Boundary 1 and Boundary 2 would be similar to, but slightly higher than that modeled to occur for the NAA. Period average concentrations for all five scenarios were modeled to be below the 300 µg/L bromide threshold for the entire period modeled (1976–1991) and for the drought period modeled (1987–1991) (**Table 3**).

Finally, the frequency with which bromide at the City's diversion location would exceed threshold bromide levels of 100 µg/L and 300 µg/L are presented in Table 3. As shown in this table, the frequency with which these bromide levels would be exceeded at the City's diversion locations would be similar (i.e., within 8%) among the scenarios for the entire period modeled and for the drought period modeled.

Table 3. Bromide concentrations and frequency of exceeding threshold concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location, based on a EC-to-bromide modeling methodology.

	Period Average Concentration (µg/L) (Difference from NAA)					Frequency of Threshold Exceedance (%) 100 µg/L (300 µg/L)				
Period	NAA	4A-H3	4A-H4	BNDY 1	BNDY 2	NAA	4A-H3	4A-H3	BNDY 1	BNDY 2
All	211	225 (14)	225 (14)	223 (12)	227 (16)	81 (20)	83 (27)	84 (27)	84 (22)	82 (26)
Drought	267	287 (20)	287 (20)	273 (6)	284 (17)	95 (37)	97 (45)	97 (45)	95 (40)	90 (38)

The CWF effects on long-term average bromide concentrations determined from the EC-to-bromide relationship methodology showed greater increases in bromide concentrations compared to the mass-balance methodology. It is not certain which of these methodologies produces the most accurate estimate of CWF effect on bromide at this assessment location. Consequently the largest modeled bromide increase from the two methods was used (i.e., EC-to-bromide methodology) to further assess the degree to which increases in modeled bromide could contribute to increased total trihalomethane (TTHM) formation in the City's treated drinking water. This is a conservative approach.

This analysis uses two models to characterize how bromide changes could affect TTHM concentrations. The selection of these models was based on the model having a bromide variable as a component, showing good predictive ability, having general applicability, and derived from data with bromide concentrations in the same ranges as those that were modeled to occur for the NAA and CWF scenarios. The models used are Amy et al. 1998 and Sohn et al. 2004. The specified long-term average increases in bromide concentrations listed **Table 4** are estimated to result in the corresponding percentage increase in TTHM concentration in a treated water supply.

Table 4. Period (1976–1991) average bromide concentrations modeled for the NAA and CWF scenarios, difference from the NAA for the CWF scenarios, and the estimated bromide-driven change in period average total trihalomethane (TTHM) concentration in the City's treated drinking water diverted from the San Joaquin River, relative to the NAA.

	Period Average Concentration (µg/L) (Difference from NAA)					Incremental Increase (%) in TTHM Based on Increase in Average Bromide Concentration [a]				
Period	NAA	4A-H3	4A-H4	BNDY 1	BNDY 2	NAA	4A-H3	4A-H4	BNDY 1	BNDY 2
All	211	225 (14)	225 (14)	223 (12)	227 (16)	na	0.1–0.9%	0.1–0.9%	0.1–0.8%	0.2–1.0%
Drought	267	287 (20)	287 (20)	273 (6)	284 (17)	na	0.2–1.0%	0.2–1.0%	0.1–0.3%	0.1–0.9%

Notes:

[a] Range shown is the minimum and maximum predicted percent increase from the following models:

Amy GL, Siddiqui M, Ozekin K, Zhu HW, Wang C. Empirical based models for predicting chlorination and ozonation byproducts: haloacetic acids, chloral hydrate, and bromate. USEPA 1998 EPA report CX 819579.

Sohn J, Amy G, Cho J, Lee Y, Yoon Y. Disinfectant decay and disinfection by-products formation model development: chlorination and ozonation by-products. Water Res 2004; 38:2461–78.

The TTHM models were also used to estimate the increase in TTHM concentrations for the 5th, 25th, 50th, 75th, and 90th percentile modeled annual average bromide concentrations determined from the EC-to-bromide relationship. The results presented in **Table 5** show the estimated increase in TTHM concentrations vary across percentiles and CWF scenarios. At median annual average bromide concentrations, with the CWF the estimated increase in TTHMs ranges from 0.3–4.1%. At the higher, 95th percentile bromide concentration, the annual average bromide concentration with the CWF is modeled to be less than the NAA, so that the estimated TTHM concentrations would be lower.

Table 5. Annual average (1976–1991) bromide concentrations modeled for the NAA, difference from the NAA for the CWF scenarios, and the estimated bromide-driven change in annual average total trihalomethane (TTHM) concentration in the City's treated drinking water diverted from the San Joaquin River, relative to the NAA.

Percentile	Annual Average Concentration (µg/L)	Difference from NAA (µg/L)				Incremental Change (%) in TTHM Concentration Based on Increase in Average Bromide Concentration [a]			
	NAA	4A-H3	4A-H4	B1	B2	4A-H3	4A-H4	B1	B2
5th	102	0	3	-4	7	0.0%	0.1–0.4%	↓	0.2–0.9%
25th	171	2	4	8	0	0.0–0.2%	0.1–0.3%	0.1–0.6%	0.0%
50th	187	50	49	29	62	0.5–3.4%	0.5–3.3%	0.3–2.1%	0.7–4.1%
75th	253	13	15	6	28	0.1–0.7%	0.1–0.8%	0.1–0.3%	0.2–1.5%
95th	336	-12	-15	-23	-27	↓	↓	↓	↓

Notes:

↓ = Annual average bromide concentration at the City's diversion location was modeled to decrease, relative to the NAA. Therefore, the CWF-driven effect on TTHM levels in the City's treated water supply from bromide would also be a decrease, and thus was not quantified in this table.

[a] Range shown is the minimum and maximum predicted percent increase from the following models:

Amy GL, Siddiqui M, Ozekin K, Zhu HW,Wang C. Empirical based models for predicting chlorination and ozonation byproducts: haloacetic acids, chloral hydrate, and bromate. USEPA 1998 EPA report CX 819579.

Sohn J, Amy G, Cho J, Lee Y, Yoon Y. Disinfectant decay and disinfection by-products formation model development: chlorination and ozonation by-products. Water Res 2004;38:2461–78.

Findings from this Analysis Relative to EIR/EIS Impact Determinations

Findings from this analysis are stated above, and conclude that the bromide concentrations that would occur at the site for the CWF would not adversely impact the San Joaquin River's municipal and industrial supply beneficial uses.

The Final EIR/EIS (Chapter 8, p. 8-924–926) stated that Alternative 4A would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. Alternative 4A would not result in any substantial change in long-term average bromide concentration or exceed threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 µg/L assessment threshold concentration would be 5% or less at all locations assessed, which is considered to be less than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the Alternative 4A would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not CWA Section 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact was determined in the Final EIR/EIS to be less than significant (CEQA) and not adverse (NEPA).

This Analysis Affirms the EIR/EIS Analysis

The analysis presented here and the analysis within the Final EIR/EIS reach the same conclusion, which is that the CWF would not change bromide concentrations in the San Joaquin River by frequency and magnitude that would adversely impact the municipal and industrial beneficial uses designated for the river. Consequently, it is not expected that bromide concentrations with the CWF would cause adverse impacts to the City of Stockton when diverting and treating San Joaquin River water for use as a municipal and industrial water supply.

3.3.2 Chloride

> ***Collectively, the information presented below indicates that the CWF is anticipated to result in chloride concentrations at the City's WTP intake location in the San Joaquin River that would typically be very similar to that which would occur under the NAA, and thus would not substantially degrade water quality with regard to chloride. The increases in chloride concentrations that could occur at this site for the CWF during some periods, relative to the NAA, would not be of a magnitude and frequently that would cause an exceedance of the applicable 250 mg/L MCL, on a mean monthly basis, and thus would not adversely impact the river's designated municipal and industrial supply beneficial uses. As such, I would not expect the chloride concentrations that would occur for the CWF to adversely impact the City of Stockton when diverting and treating water from the San Joaquin River for these beneficial uses.***

The primary source of chloride to the City's diversion location in the San Joaquin River is sea water intrusion into the Delta (**Table 6**). The applicable state secondary MCLs for chloride in the Delta are 250 mg/L (recommended level), 500 mg/L (upper level), and 600 mg/L (short-term level). The Region 5 Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) incorporates the MCLs by reference as surface water quality objectives, but does not specify an averaging period for assessment of compliance.

Table 6. Source water concentrations for chloride.

Source Water	Sacramento River	San Joaquin River	Bay Water	East Side Tributaries	Delta Ag. Return Waters
Mean (mg/L)	6.38	81.4	3,757–9,414	2.36	136
Source: Table 8-45 in in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan Draft EIR/EIS and of the Bay Delta Conservation Plan/California WaterFix Partially Recirculated Draft EIR/Supplemental Draft EIS and Final EIR/EIS					

In addition, the Bay-Delta Water Quality Control Plan (Bay-Delta WQCP) specifies the objectives shown in **Table 7** that are to be met at one of the locations indicated, in the western Delta for specified periods of time according to water year type. Because the primary source of chloride to the Delta is sea water intrusion, the Bay-Delta WQCP has identified chloride objectives to be met in the western Delta. When these objectives (adopted to protect the MUN beneficial use within the Delta) are met, then locations east of these compliance points, such as the City of Stockton's diversion location, are also protected.

Table 7. Bay-Delta WQCP objectives for chloride for protection of municipal and industrial supply.

Location	Year Type	Objective [a]
Contra Costa Canal @ Pumping Plant No. 1; or San Joaquin River @ Antioch Water Works Intake	Wet	<150–240 days/calendar year (66%)
	Above Normal	<150–190 days/calendar year (52%)
	Below Normal	<150–175 days/calendar year (48%)
	Dry	<150–165 days/calendar year (45%)
	Critical	<150–155 days/calendar year (42%)

Notes:

[a] Municipal and industrial water supply beneficial use objective, specified as a maximum mean daily value for at least the number of days shown during the calendar year. Must be provided in intervals of not less than two weeks duration (percentage of calendar year shown in parentheses).

As described above for bromide, chloride was also assessed using two different modeling approaches: 1) the mass-balance methodology and the chloride-to-EC modeling methodology. These methodologies are the same as those described and used in the EIR/EIS.[3]

Mass-Balance Methodology

Based on the mass-balance methodology, box-and-whisker plots and exceedance plots for chloride for the NAA, 4A-H3, 4A-H4, Boundary 1, and Boundary 2 conditions are presented for all years modeled and by water year types in Figure 13 through Figure 18. The maximum modeled mean monthly chloride concentrations for 4A-H3, 4A-H4, and Boundary 2 never exceed 250 mg/L, whereas modeling indicates that the NAA and Boundary 1 would infrequently exceed the 250 mg/L objective at the City's diversion location. When looking at the exceedance plot for all years, mean monthly chloride concentrations are very similar among all five scenarios for 70% of the time when chloride concentrations are the lowest. For the 30% of the time when chloride concentrations at the site are the highest, 4A-H3, 4A-H4, Boundary 1, and Boundary 2 all show a similar or lower frequency with which any given mean monthly chloride level would occur (i.e., show lower chloride concentrations), relative to the NAA. This is also noted in the box-and-whisker plots (**Figure 13**).

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[3] [3] Section 8.4.1.3, *Plan Area*, in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan Draft EIR/EIS; Section 8.3.1.3, *Plan Area*, in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan/California WaterFix Partially Recirculated Draft EIR/Supplemental Draft EIS and Final EIR/EIS.

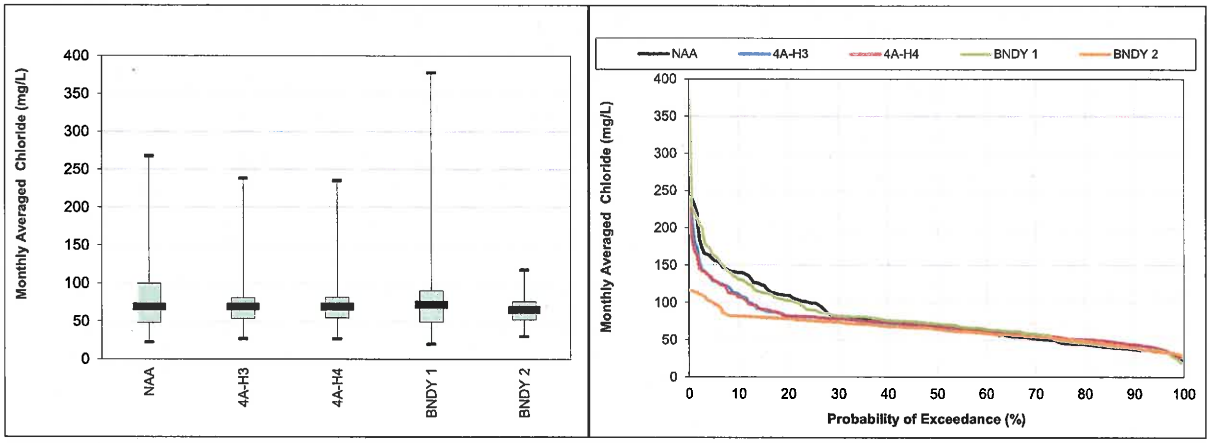

Figure 13. **Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for all years (1976–1991), based on mass-balance methodology.**

In wet years, mean monthly chloride concentration always remain well below 100 mg/L at the site for 4A-H3, 4A-H4, and Boundary 2, but are above 100 mg/L about 2% of the time for Boundary 1 and about 11% of the time for the NAA (**Figure 14**).

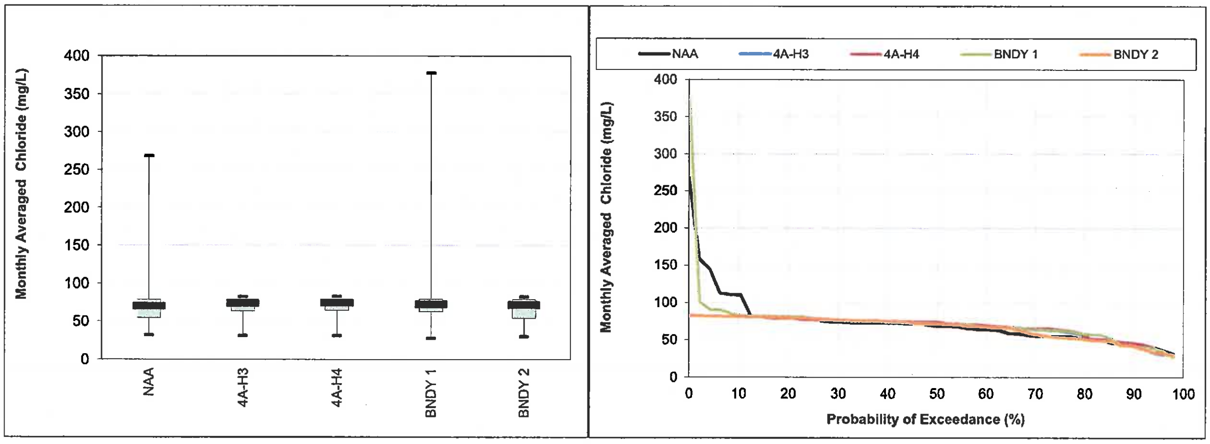

Figure 14. **Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for wet years (1976–1991), based on mass-balance methodology.**

In above normal years, mean monthly chloride concentrations at the City's diversion location would remain below the 250 mg/L MCL at all times for all five scenarios modeled. Moreover, 4A-H3, 4A-H4, and Boundary 2 all show a similar or lower frequency with which any given chloride level would occur (i.e., show lower chloride concentrations), relative to the NAA. Boundary 1 would more frequently result in higher mean monthly chloride concentrations at the diversion location at chloride levels between about 140 mg/L and 230 mg/L, relative to the NAA, but would always remain below the MCL of 250 mg/L (**Figure 15**).

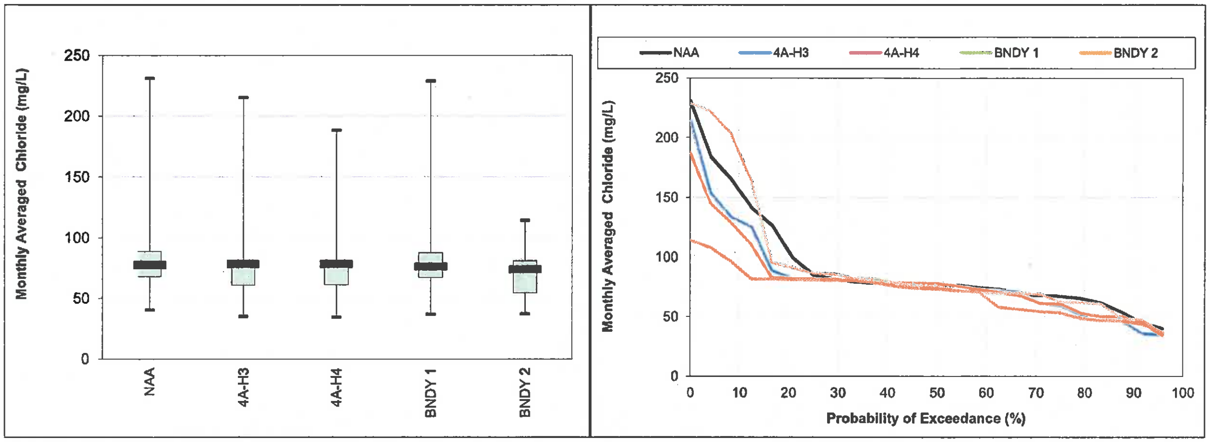

Figure 15. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for above normal years (1976–1991), based on mass-balance methodology.

Similarly, in below normal years, mean monthly chloride concentrations at the City's diversion location would remain below the 140 mg/L MCL at all times for all five scenarios modeled. Moreover, 4A-H3, 4A-H4, and Boundary 2 all show a similar or lower frequency with which any given chloride level would occur, relative to the NAA. Boundary 1 would more frequently result in higher mean monthly chloride concentrations at the diversion location at chloride levels between about 55 mg/L and 70 mg/L, relative to the NAA, but would always remain well below the MCL of 250 mg/L (**Figure 16**).

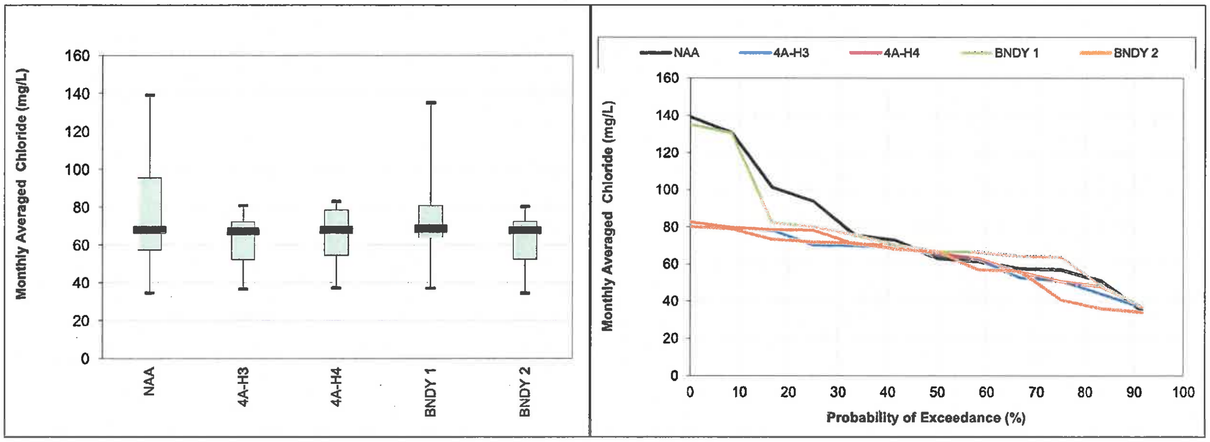

Figure 16. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for below normal years (1976–1991), based on mass-balance methodology.

In dry years, mean monthly chloride concentrations at the City's diversion location would remain below the 250 mg/L MCL at all times for all five scenarios modeled. Moreover, 4A-H3, 4A-H4, and Boundary 2 all show a lower frequency with which any given mean monthly chloride level would occur during the 30% of time when chloride concentration are highest, relative to the NAA (**Figure 17**).

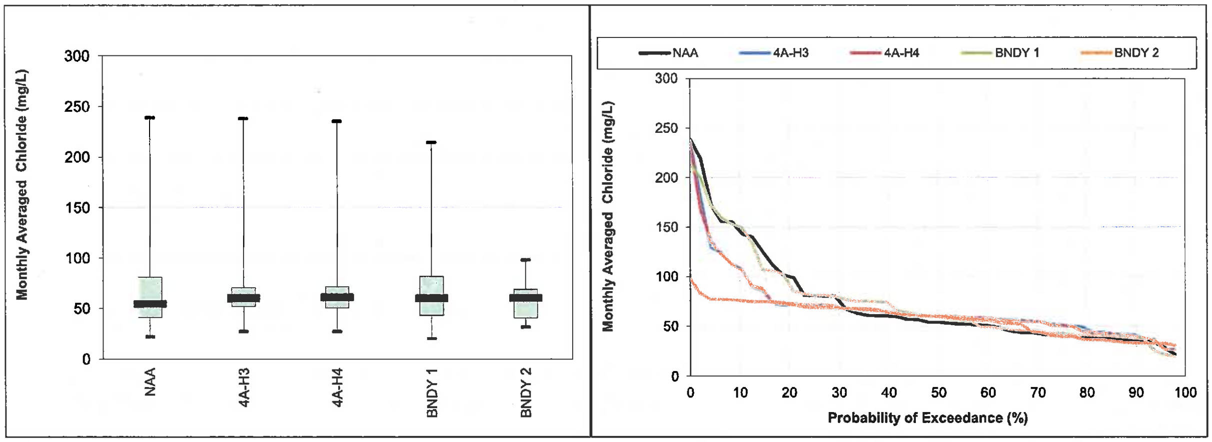

Figure 17. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991), based on mass-balance methodology.

Similar findings are shown for critical water years, with the mean monthly chloride concentration remaining below 180 mg/L, and thus the 250 mg/L MCL, for all scenarios at all times. 4A-H3, 4A-H4, and Boundary 2 all show a lower frequency with which any given mean monthly chloride level would occur during the 55% of time when chloride concentration are highest, relative to the NAA (**Figure 18**).

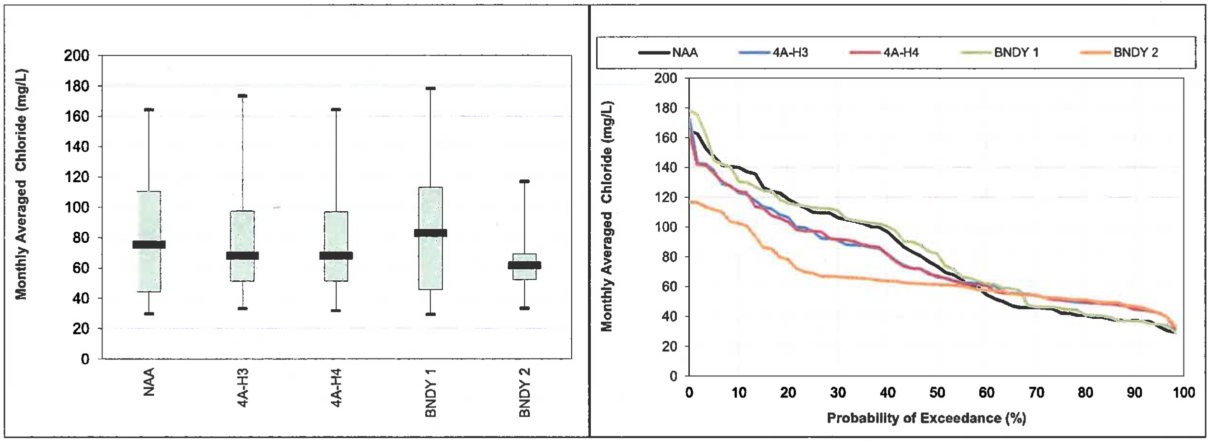

Figure 18. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for critical years (1976–1991), based on mass-balance methodology.

The average chloride concentration at the City's diversion location would be 80 mg/L or less for all five scenarios for all years modeled and 87 mg/L or less for all five scenarios for the drought years modeled. These levels are well below the lowest applicable MCL of 250 mg/L. For both all years modeled and drought years modeled, the average chloride concentration at the City's diversion location would be lower for 4A-H3, 4A-H4, and Boundary 2 than for the NAA. This modeling shows no exceedance of the 250 mg/L MCL for 4A-H3, 4A-H4, or Boundary 2. Both the NAA and Boundary 1 show an exceedance of the 250 mg/L MCL, on a mean monthly basis, 1% of the time (**Table 8**).

Table 8. Period average (1976–1991) chloride concentrations and frequency of exceeding the 250 mg/L MCL in the San Joaquin River at the City of Stockton's drinking water diversion location, based on the mass-balance methodology.

	Period Average Concentration (mg/L)					Frequency of Objective Exceedance (%) 250 mg/L				
Period	NAA	4A-H3	4A-H4	B1	B2	NAA	4A-H3	4A-H3	B1	B2
All	79	73	73	80	64	1	0	0	1	0
Drought	85	81	81	87	64	0	0	0	0	0

EC-to-Chloride Relationship Modeling Methodology

Results from the EC-to-chloride relationship modeling methodology are presented for all years modeled, and by water year type, in Figure 19 through Figure 24.

For all years, mean monthly chloride concentrations are very similar among all five scenarios. The maximum modeled mean monthly chloride concentrations for all five scenarios never exceed 250 mg/L. This is also noted in the box-and-whisker plots (**Figure 19**).

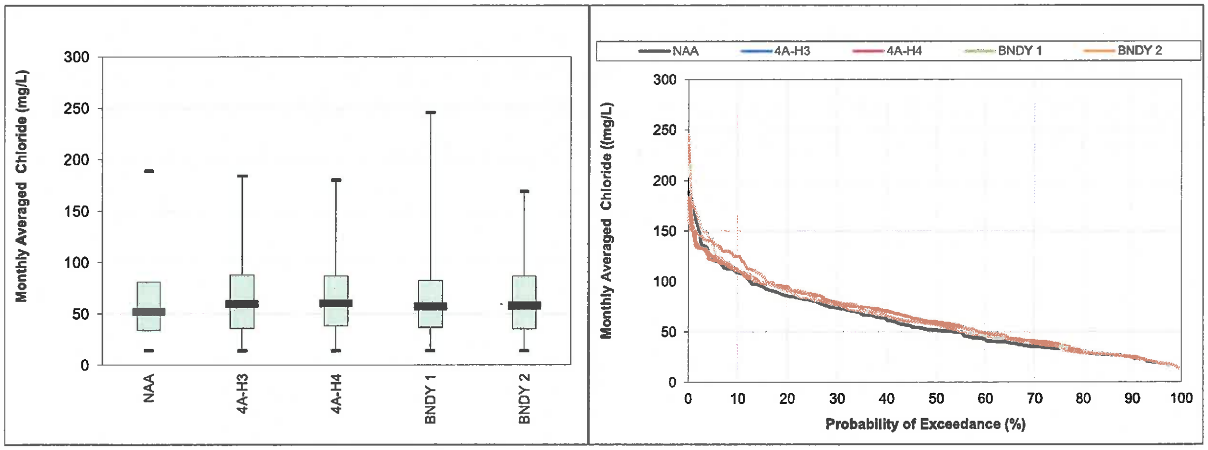

Figure 19. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for all years (1976–1991), based on EC-to-chloride relationship.

In wet years, mean monthly chloride concentrations at the City's diversion location would remain below the 250 mg/L MCL at all times for all five scenarios modeled. Moreover, mean monthly chloride concentration always remain below 100 mg/L at the site for 4A-H3, 4A-H4, and Boundary 2, but are above 100 mg/L about 2% of the time for Boundary 1 and about 5% of the time for the NAA (**Figure 20**).

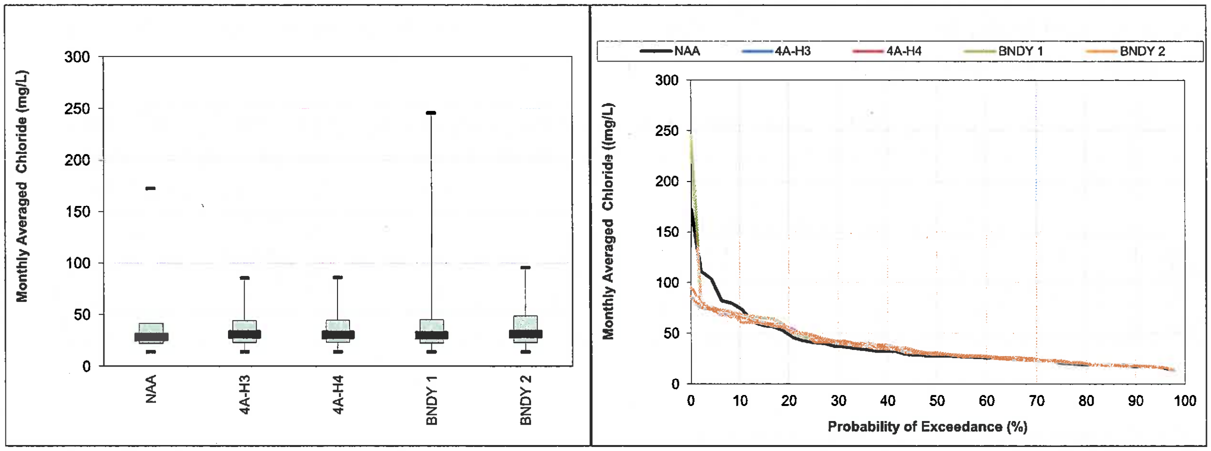

Figure 20. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for wet years (1976–1991), based on EC-to-chloride relationship.

In above normal years, mean monthly chloride concentrations at the City's diversion location would remain below the 250 mg/L MCL at all times for all five scenarios modeled. Moreover, 4A-H3, 4A-H4, and Boundary 2 all show a similar or lower frequency with which any given chloride level would occur, relative to the NAA, at chloride levels above about 70 mg/L. Boundary 1 would more frequently result in higher mean monthly chloride concentrations at the diversion location at chloride levels between about 85 mg/L and 180 mg/L, relative to the NAA, but would always remain well below the MCL of 250 mg/L (**Figure 21**).

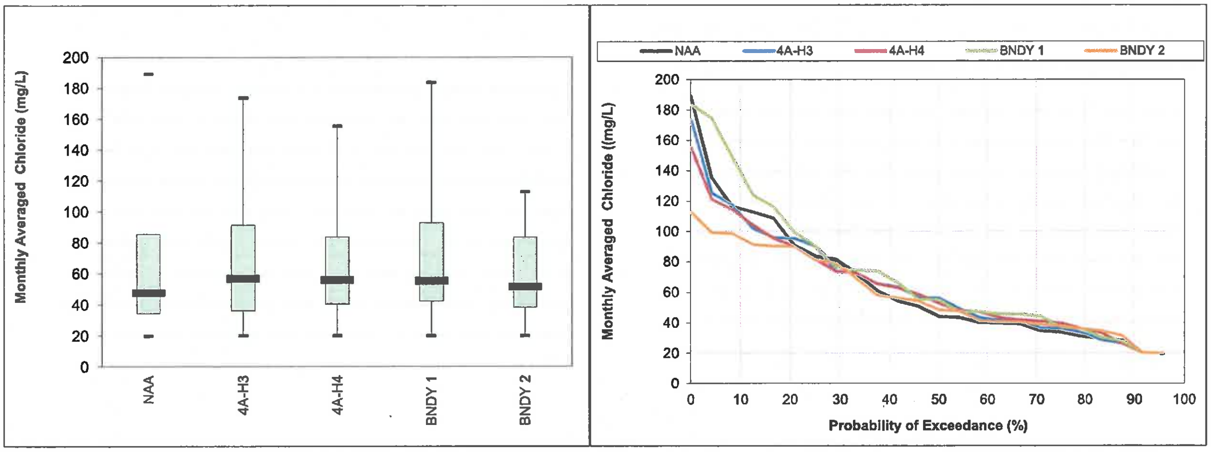

Figure 21. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for above normal years (1976–1991), based on EC-to-chloride relationship.

In below normal years, mean monthly chloride concentrations at the City's diversion location would remain below the 250 mg/L MCL at all times for all five scenarios modeled. Moreover, 4A-H3 and 4A-H4 show a similar or lower frequency with which any given chloride level would occur, relative to the NAA. Boundary 1 and Boundary 2 would more frequently result in higher mean monthly chloride concentrations at the diversion location at chloride levels between about 40 mg/L and 150 mg/L, relative to the NAA, but would always remain well below the MCL of 250 mg/L (**Figure 22**).

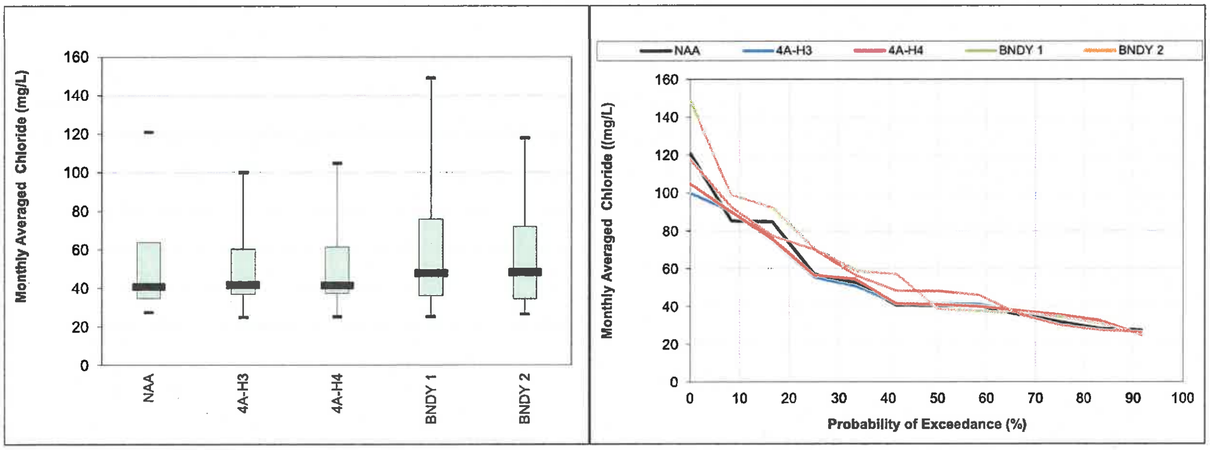

Figure 22. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for below normal years (1976–1991), based on EC-to-chloride relationship.

In dry years, mean monthly chloride concentrations at the City's diversion location would remain below the 250 mg/L MCL at all times for all five scenarios modeled. 4A-H3, 4A-H4, Boundary

1, and Boundary 2 would often have a higher frequency with which any given mean monthly chloride level would occur. However, during the 5% of time when mean monthly chloride concentrations would be highest in dry years (between about 120 mg/L and 185 mg/L), the frequency with which any give mean monthly chloride level would be exceeded for 4A-H3, 4A-H4, Boundary 1, and Boundary 2 would be similar to or lesser than that for the NAA (**Figure 23**).

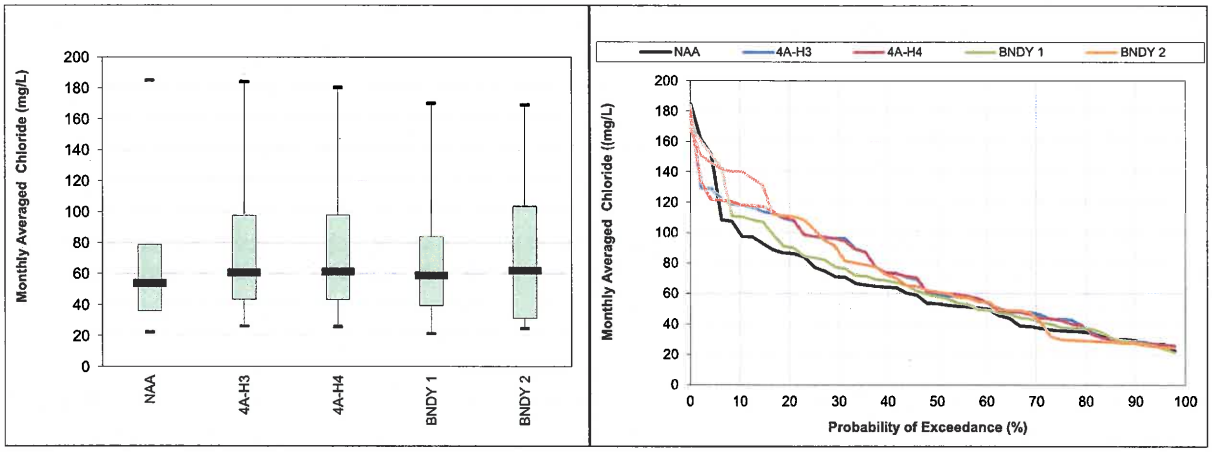

Figure 23. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991), based on EC-to-chloride relationship.

In critical water years, the mean monthly chloride concentration always remaining below the 250 mg/L MCL for all five scenarios at all times (**Figure 24**). During the 20% of time when mean monthly chloride concentrations would be highest in critical years (between about 100 mg/L and 155 mg/L), the frequency with which any give mean monthly chloride level would be exceeded for 4A-H3, 4A-H4, and Boundary 1 would be similar to or lesser than that for the NAA, with the frequency of exceeding chloride levels in this range being somewhat greater for Boundary 2.

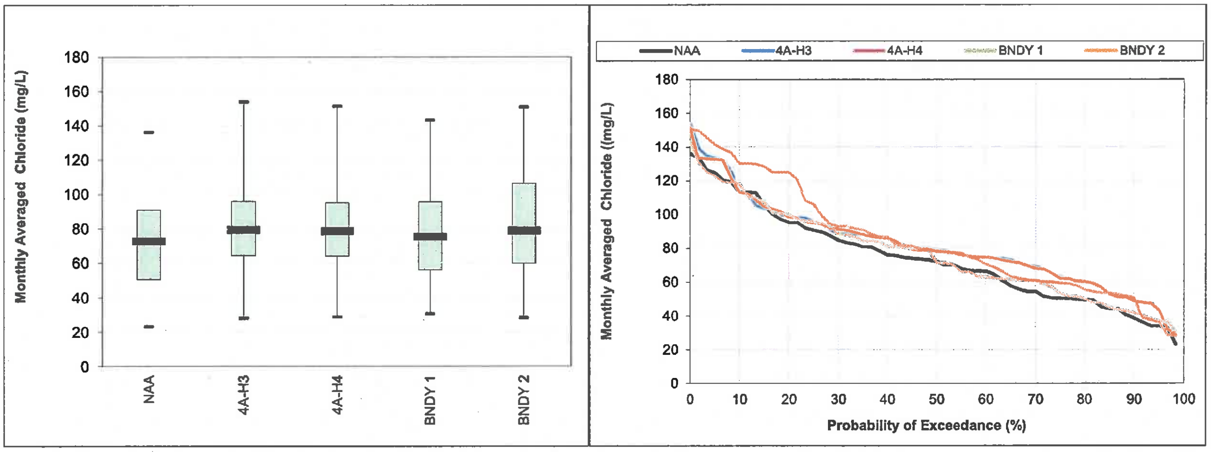

Figure 24. Box-and-whisker and probability of exceedance plots for monthly average chloride concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for critical years (1976–1991), based on EC-to-chloride relationship.

Using the EC to chloride relationship modeling methodology, the average concentration of chloride at the site for 4A-H3, 4A-H4, Boundary 1 and Boundary 2 would be similar to, but slightly higher than that modeled to occur for the NAA. The 250 mg/L recommended contaminant level for the secondary MCL applicable to the City's diversion location would never be exceeded, on a mean monthly basis, under any of the five scenarios assessed (**Table 9**).

Table 9. Period average (1976–1991) chloride concentrations and frequency of exceeding the 250 mg/L MCL in the San Joaquin River at the City of Stockton's drinking water diversion location, based on an EC-to-chloride relationship methodology.

	Period Average Concentration (µg/L)					Frequency of Objective Exceedance (%) 250 mg/L				
Period	NAA	4A-H3	4A-H4	B1	B2	NAA	4A-H3	4A-H3	B1	B2
All	60	64	64	64	65	0	0	0	0	0
Drought	76	82	82	78	81	0	0	0	0	0

Findings from this Analysis Relative to EIR/EIS Impact Determinations

Findings from this analysis are stated above, and conclude that the chloride concentrations that would occur at the site for the CWF would not adversely impact the San Joaquin River's municipal and industrial supply beneficial uses.

The Final EIR/EIS (Chapter 8, p. 8-931–933) stated that Alternative 4A would not result in substantially increased chloride concentrations in the Delta on a long-term average basis that would result in adverse effects on the municipal and industrial water supply beneficial use. Additional exceedance of chloride objectives is not expected, and substantial long-term degradation is not expected that would result in adverse effects on the municipal and industrial water supply beneficial use. Chloride concentrations would be reduced under Alternative 4A in water exported from the Delta to the SWP/CVP Export Service Areas thus reflecting a potential improvement to chloride loading in the lower San Joaquin River. Chloride is not a bioaccumulative constituent, thus any increased concentrations under the Alternative 4A would not result in chloride bioaccumulation impacts on aquatic life or humans. Based on these findings, this impact was determined in the Final EIR/EIS to be less than significant (CEQA) and not adverse (NEPA)

This Analysis Affirms the EIR/EIS Analysis

The analysis presented here and the analysis within the Final EIR/EIS reach the same conclusion, which is that the CWF would not change chloride concentrations in the San Joaquin River by frequency and magnitude that would adversely impact the municipal and industrial beneficial uses designated for the river. Consequently, it is not expected that chloride concentrations with the CWF would cause adverse impacts to the City of Stockton when diverting and treating San Joaquin River water for use as a municipal and industrial water supply.

3.3.3 EC

> ***Collectively, the information presented below indicates that the CWF is anticipated to result in EC levels at the City's WTP intake location that would sometimes be higher and other times lower than that for the NAA, with long-term average EC levels for the CWF and NAA being similar (within 5%), and thus would not substantially degrade water quality with regard to EC. The increases in EC levels that would be anticipated to occur at this site for the CWF, relative to the NAA, would not be of a magnitude that would cause an exceedance of the applicable drinking water MCLs, on a mean monthly basis, with the exception of a single month in the modeled period of record (1976–1991) for Boundary 1 for the 900 μS/cm MCL. Based on these findings, the EC levels that would occur at the site for the CWF would not adversely impact the river's municipal and industrial supply beneficial uses. As such, I would not expect EC levels that would occur for the CWF to adversely impact the City of Stockton when diverting and treating water from the San Joaquin River for these beneficial uses.***

With regard to "salinity," EC is the parameter regulated under the Bay-Delta Water Quality Control Plan (WQCP) and State Water Board Decision 1641 (D-1641) to protect the agricultural supply (AGR) beneficial use in Delta waters. Chloride, rather than EC, is the constituent regulated to protect the municipal and domestic supply (MUN) beneficial use and the industrial supply beneficial uses with regards to salinity. There is a strong relationship between EC and chloride in Delta waters. Consequently, the chloride analysis presented above addresses the CWF salinity effects on municipal and industrial supply beneficial uses. Nevertheless, because Mr. Granberg identified EC as a constituent of concern to the City in his written testimony [Exhibit STKN-010, pg. 10–11], it is addressed here.

The primary source of EC to the City's diversion location in the San Joaquin River is sea water intrusion into the Delta and agricultural return water. The applicable state secondary MCLs for EC in the Delta are 900 μS/cm (recommended level), 1,600 μS/cm (upper level), and 2,200 µS/cm (short-term level). The Region 5 Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) incorporates the MCLs by reference as surface water quality objectives, but does not specify an averaging period for assessment of compliance. The Bay-Delta WQCP specifies additional EC objectives in the western and southern Delta and export area for the protection of the agricultural supply (AGR) beneficial use and in the San Joaquin River at and between Prisoners Point and Jersey Point for the protection of fish and wildlife beneficial uses. Because the City of Stockton expressed concern over how CWF-driven changes to EC could adversely impact the operation of the City's WTP, this analysis will address compliance with the MCLs.

For all years of the 1976-1991 hydrologic period of record modeled, the probability that any given EC levels would be exceeded at the City's diversion location would be similar among the five scenarios modeled. This is particularly true for EC levels below 300 µS/cm and levels above 500 µS/cm for CWF scenarios 4A-H3 and 4A-H4, relative to the NAA. The probability that any given EC level between 300 and 500 µS/cm would be exceeded at the site would be slightly higher for the CWF, relative to the NAA (**Figure 25**). These findings indicate that EC levels for the CWF at the City's diversion locations would be slightly higher, on average, relative to the NAA. Modeling shows no exceedance of the 900 µS/cm recommended MCL for any of the five scenarios, except Boundary 1 which showed a 1% exceedance frequency. None of the five scenarios modeled showed any exceedance of the upper or short-term MCLs of 1,600 µS/cm and 2,200 µS/cm, respectively.

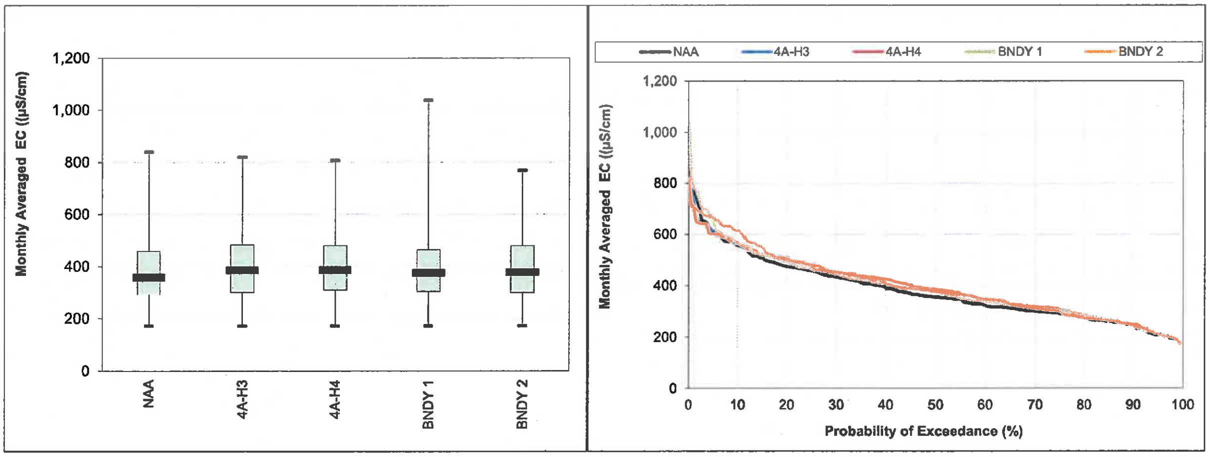

Figure 25. Box-and-whisker and probability of exceedance plots for monthly average EC levels in the San Joaquin River at the City of Stockton's drinking water diversion location for all years (1976–1991).

For wet years, modeling shows no exceedance of the 900 µS/cm recommended MCL for any of the five scenarios, except Boundary 1. The probability that any given EC level below 400 µS/cm would be exceeded during wet years would be nearly the same for all five scenarios modeled. The probability of exceeding EC levels between about 400 and 450 µS/cm would be lower for the CWF scenarios than for the NAA. Highest mean monthly EC levels for CWF scenarios 4A-H3, 4A-H4, and Boundary 2 would be approximately 500 µS/cm, whereas the maximum mean monthly EC would be about 790 µS/cm for the NAA and just over 1,000 µS/cm for Boundary 1 (**Figure 26**). These findings indicate that in wet years, EC levels at the City's diversion locations would be similar to or lower than that for the NAA, and levels for 4A-H3, 4A-H4, and Boundary 2 would be substantially lower for the 10% of the years when EC levels for the NAA would be highest at the site. EC levels for Boundary 1 would exceed 600 µS/cm somewhat more often than for the NAA in about 2% of the years when EC is highest.

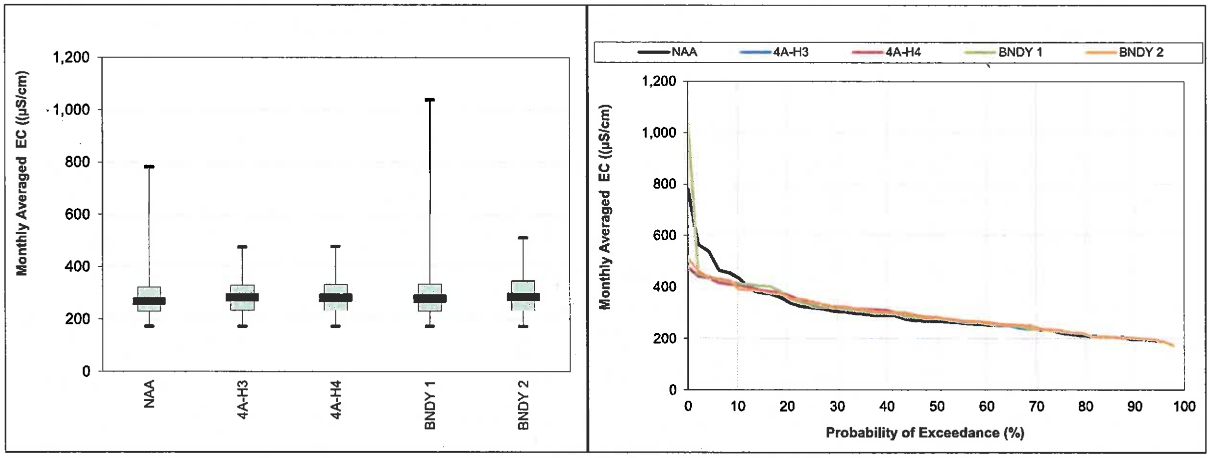

Figure 26. Box-and-whisker and probability of exceedance plots for monthly average EC levels in the San Joaquin River at the City of Stockton's drinking water diversion location for wet years (1976–1991).

In above normal years, modeling shows no exceedance of the 900 µS/cm recommended MCL for any of the five scenarios. Moreover, the probability of exceeding EC levels below 500 µS/cm would be similar among the five scenarios modeled, with the CWF scenarios 4A-H3, 4A-H4, and Boundary 2 having a lower probability of exceeding EC levels above 500 µS/cm, relative to the NAA. Boundary 1 would have a somewhat higher probability of exceeding EC levels above 500 µS/cm, relative to the NAA. The highest mean monthly EC level would occur for the NAA, with maximum mean monthly EC levels being somewhat lower for the CWF scenarios (**Figure 27**).

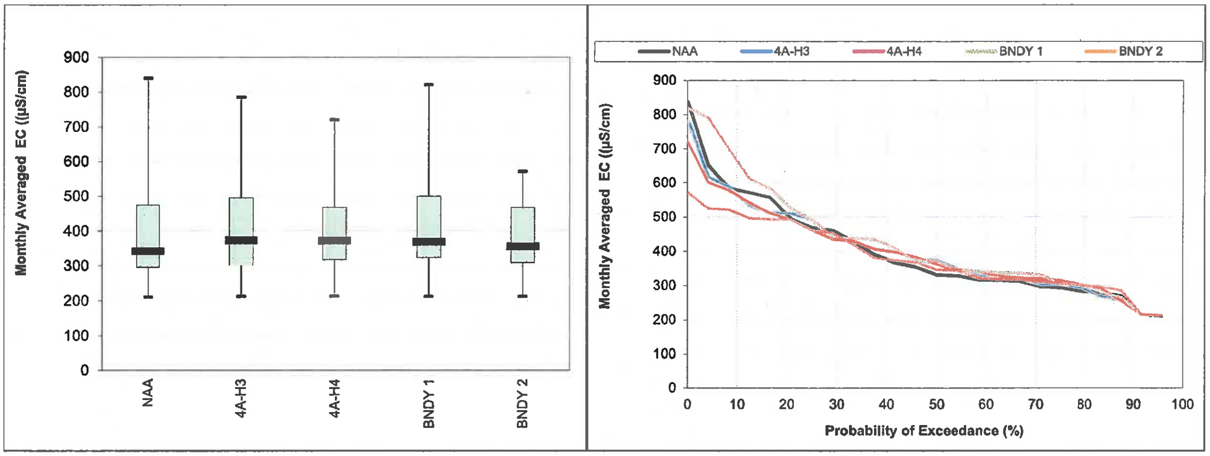

Figure 27. Box-and-whisker and probability of exceedance plots for monthly average EC levels in the San Joaquin River at the City of Stockton's drinking water diversion location for above normal years (1976–1991).

In below normal years, modeling shows no exceedance of the 900 µS/cm recommended MCL for any of the five scenarios. The probability of exceeding EC levels would be similar for CWF scenarios 4A-H3, 4A-H4, and the NAA. The probability of exceeding EC levels above about 300 µS/cm would be somewhat greater for Boundary 1 and Boundary 2, relative to 4A-H3, 4A-H4 and the NAA. The maximum mean monthly EC level would occur for Boundary 1, followed by the NAA, Boundary 2, 4A-H4 and finally 4A-H3 (**Figure 28**).

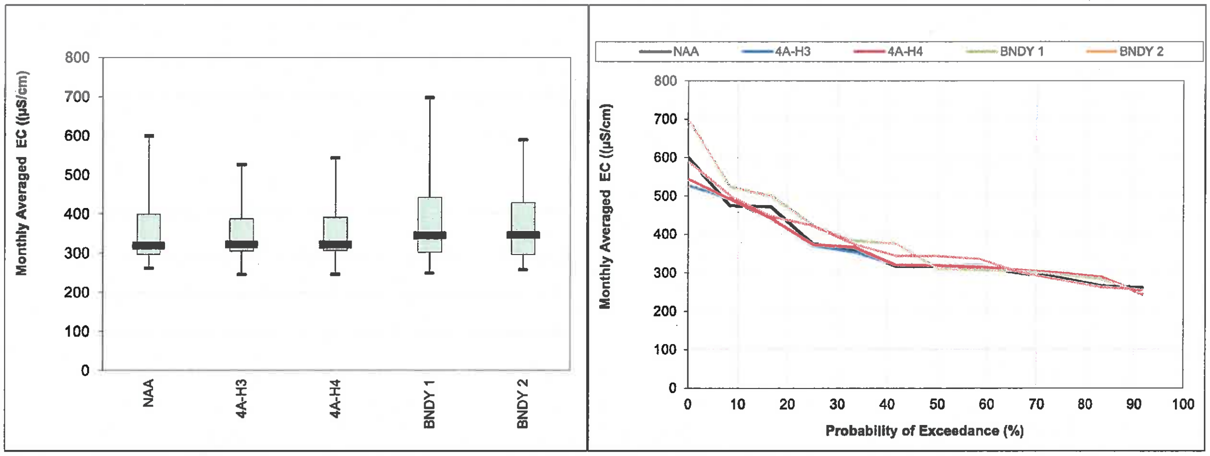

Figure 28. Box-and-whisker and probability of exceedance plots for monthly average EC levels in the San Joaquin River at the City of Stockton's drinking water diversion location for below normal years (1976–1991).

In dry years, modeling shows no exceedance of the 900 µS/cm recommended MCL for any of the five scenarios. The probability of exceeding EC levels below 400 µS/cm would be similar among the five scenarios modeled. The probability of exceeding any given EC levels between 400 and 600 µS/cm would be somewhat higher for the CWF scenarios, relative to the NAA.

Finally, CWF scenarios 4A-H3 and 4A-H4 would exceed EC levels above 600 µS/cm less often compared to the NAA, Boundary 1, and Boundary. Maximum mean monthly EC levels would be approximately 800 µS/cm for the NAA, 4A-H3, and 4A-H4, and about 775 µS/cm for Boundary 1 and Boundary 2 (**Figure 29**).

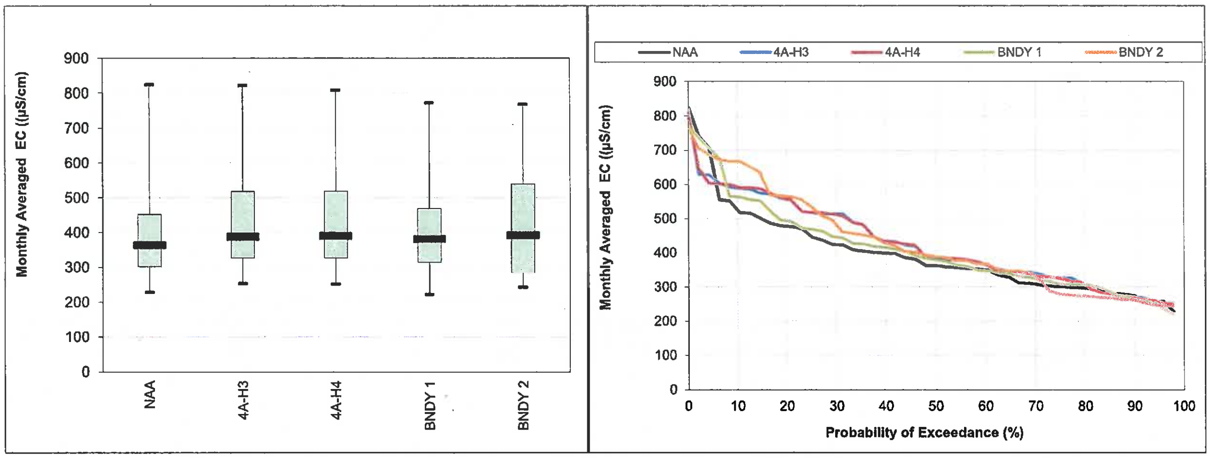

Figure 29. Box-and-whisker and probability of exceedance plots for monthly average EC levels in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991).

In critical years, modeling shows no exceedance of the 900 µS/cm recommended MCL for any of the five scenarios. The probability of exceeding any give EC levels between 300 and 500 µS/cm would be greater for the CWF scenarios than for the NAA. However, the probability of exceeding EC levels above 500 µS/cm would be very similar for the NAA, 4A-H3, 4A-H4, and Boundary 1, and would be greater for Boundary 2. The maximum mean monthly EC level would be about 650 µS/cm for the NAA, 680 µS/cm for Boundary 1, and approximately 700 µS/cm for 4A-H3, 4A-H4, and Boundary 2 (**Figure 30**).

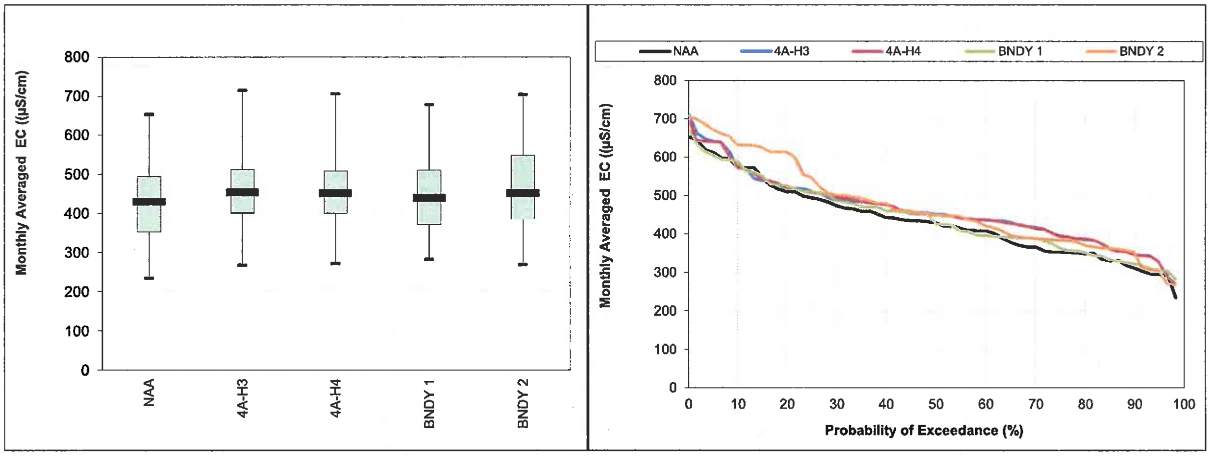

Figure 30. Box-and-whisker and probability of exceedance plots for monthly average EC levels in the San Joaquin River at the City of Stockton's drinking water diversion location for critical years (1976–1991).

The period average EC level at the City's diversion location would be 383 µS/cm for the NAA, and slightly higher (395–399 µS/cm) for the CWF scenarios. These EC levels increase about 50–65 µS/cm for the drought period, depending upon scenario. Modeling shows no exceedance of the 900 µS/cm recommended MCL for any of the five scenarios, except Boundary 1 which showed a 1% exceedance frequency. None of the five scenarios modeled showed any exceedance of the upper or short-term MCLs of 1,600 µS/cm and 2,200 µS/cm, respectively (**Table 10**).

Table 10. Period average (1976–1991) EC levels and frequency of exceeding the 900 µS/cm (recommended) and 1,600 µS/cm (upper) MCLs in the San Joaquin River at the City of Stockton's drinking water diversion location, based on DMS2 modeling output for the 1976-1991 hydrologic period of record.

	Period Average Concentration (µS/cm)					Frequency of MCL Exceedance (%) 900 µS/cm (1,600 µS/cm)				
Period	NAA	4A-H3	4A-H4	B1	B2	NAA	4A-H3	4A-H3	B1	B2
All	383	397	397	395	399	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)
Drought	442	462	463	448	459	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Findings from this Analysis Relative to EIR/EIS Impact Determinations

This analysis finds that the EC levels that would occur at the site for the CWF would not adversely impact the San Joaquin River's municipal and industrial supply beneficial uses.

The EIR/EIS (Draft, Recirculated/Supplemental Draft, and Final) assessed the effects of salinity on the municipal and industrial beneficial uses throughout the Delta, including at the City's drinking water diversion location, by assessing how the CWF would change chloride concentrations, relative to the Bay-Delta WQCP chloride objectives for protection of the municipal and industrial beneficial uses designated for the Delta. Findings from the EIR/EIS assessment of CWF effects on Delta chloride levels and, in turn, impacts to the Delta's municipal and industrial beneficial uses are discussed above under the chloride subsection. The Final EIR/EIS (Chapter 8, p. 8-931–945), based on its assessment of chloride, concludes that the CWF would not alter chloride levels by frequency and magnitude that would adversely impact the San Joaquin River's municipal and industrial supply beneficial uses. Based on the findings, this impact was determined in the Final EIR/EIS to be less than significant (CEQA) and not adverse (NEPA).

This Analysis Affirms the EIR/EIS Analysis

This analysis of EC and chloride, and the Final EIR/EIS analysis for chloride, all reach the same conclusion, which is that the CWF would not change salinity levels in the San Joaquin River (measures by EC or chloride) by frequency and magnitude that would adversely impact the municipal and industrial supply beneficial uses designated for the river. Consequently, the EC levels with the CWF would not be expected to adversely impact the City of Stockton when diverting and treating San Joaquin River water for use as a municipal and industrial water supply.

3.3.4 Nitrate

> ***Collectively, the information presented below indicates that the CWF is anticipated to result in nitrate conditions at the City's WTP intake location in the San Joaquin River that would typically be slightly higher (about 0.1–0.2 mg/L-N on average) than that which would occur under the NAA, but would remain at low levels (always below about 1.6 mg/L) compared to the applicable nitrate objective of 10 mg/L-N for the protection of the municipal and domestic supply beneficial use, and thus would not substantially degrade water quality with regard to nitrate. The increases in nitrate concentrations that would be anticipated to occur at this site for the CWF, relative to the NAA, would not be of a magnitude that would ever cause an exceedance of the applicable 10 mg/L MCL, on a mean monthly basis. Based on these findings, the nitrate concentrations that would occur at the site for the CWF would not adversely impact the municipal and domestic supply beneficial use designated for the river. As such, I would not expect nitrate concentrations that would occur for the CWF to adversely impact the City of Stockton when diverting and treating water from the San Joaquin River for municipal and industrial supply uses.***

The primary source of nitrate to the City's diversion location in the San Joaquin River is San Joaquin River water itself and agricultural return waters within the Delta (**Table 11**).

Table 11. Source water concentrations for nitrate.

Source Water	Sacramento River	San Joaquin River	Bay Water	East Side Tributaries	Delta Ag. Return Waters
Mean (mg/L a N)	0.07-0.21	0.8-1.8	0.07	0.17	0.06-3.8

Source: Table 8-51 in in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan Draft EIR/EIS and of the Bay Delta Conservation Plan/California WaterFix Partially Recirculated Draft EIR/Supplemental Draft EIS and Final EIR/EIS.

The drinking water MCL for nitrate is 10 mg/L-N, which has been incorporated into the Region 5 Basin Plan as the applicable water quality objective for Delta waters.

Using the mass-balance methodology output, box-and-whisker plots and exceedance plots for mean monthly nitrate concentrations at the City of Stockton's drinking water diversion location in the San Joaquin River are presented for NAA, 4A-H3, 4A-H4, Boundary 1, and Boundary 2 conditions, for all years modeled (i.e., 1976–1991) and by water year types in Figure 31 through Figure 36.

The maximum mean monthly nitrate concentration modeled for the City's diversion location is 1.6 mg/L-N or less for all five scenarios modeled for the entire period modeled, and for each water year type individually.

In general, the frequency with which any given nitrate level below 1.6 mg/L-N would be exceeded would be greater for NAA, 4A-H3, 4A-H4, Boundary 1, and Boundary 2 than for the NAA. This is because for the 4A-H3, 4A-H4, and Boundary 2, there would be an increase in the proportion of San Joaquin River water at the City's diversion location and a reduction in the proportion of Sacramento River water at the site, relative to the NAA. Because the San Joaquin River is higher in nitrate than the Sacramento River, this change in source water fractions to the site would result in the higher nitrate concentrations there shown by the modeling. The magnitude of increase in San Joaquin River water and decrease in proportion of Sacramento River water at the site is much lesser for Boundary 1 than for the other scenarios, which is why Boundary 1 nitrate levels are most similar to those of the NAA (**Figure 31 through Figure 36**).

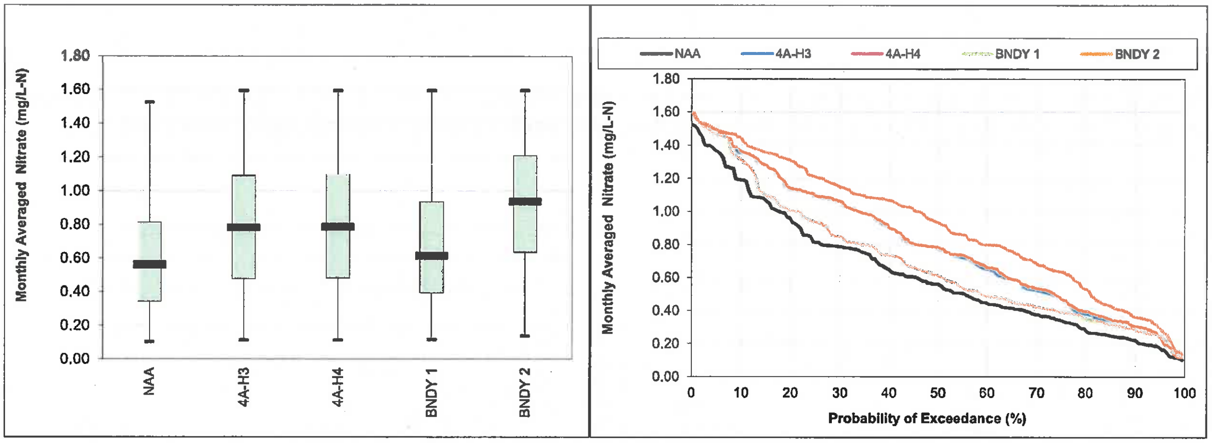

Figure 31. Box-and-whisker and probability of exceedance plots for monthly average nitrate concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for all years (1976–1991).

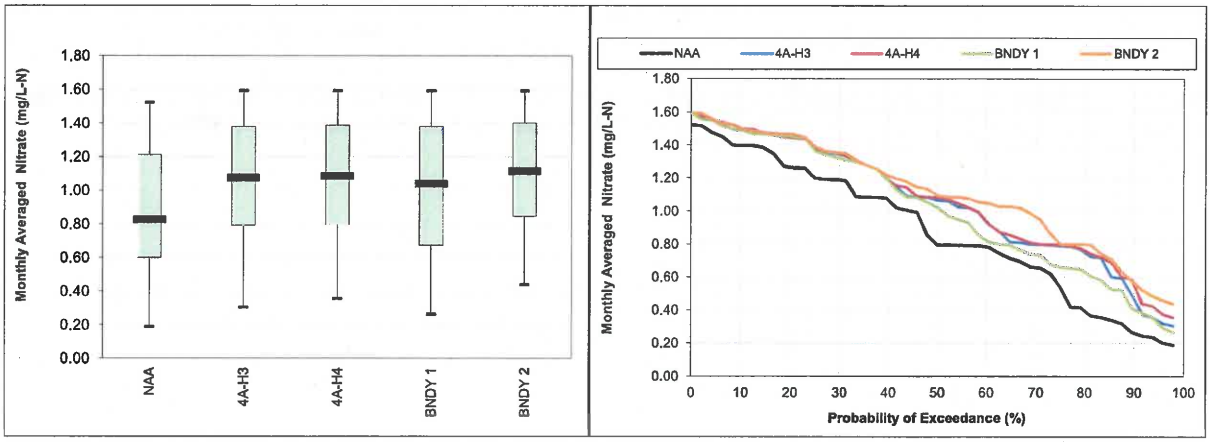

Figure 32. Box-and-whisker and probability of exceedance plots for monthly average nitrate concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for wet years (1976–1991).

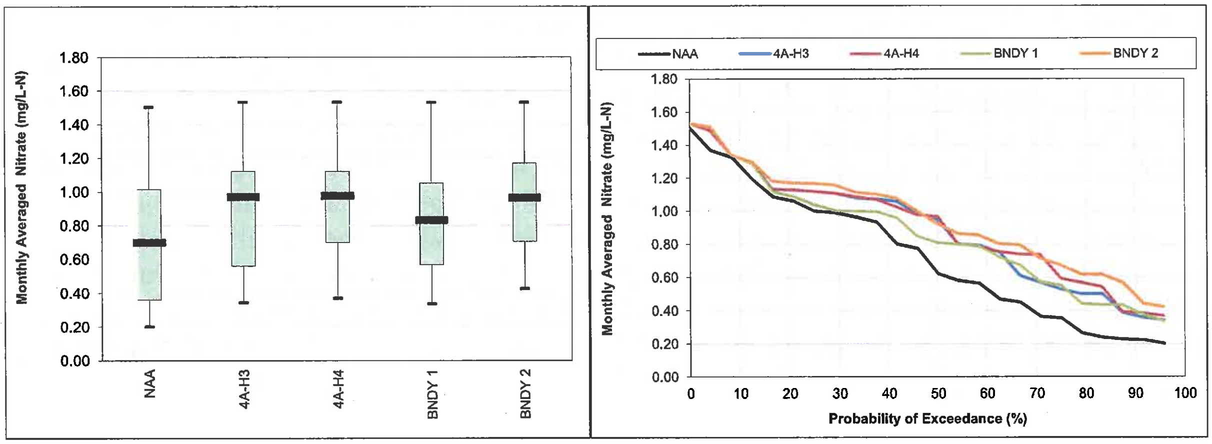

Figure 33. Box-and-whisker and probability of exceedance plots for monthly average nitrate concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for above normal years (1976–1991).

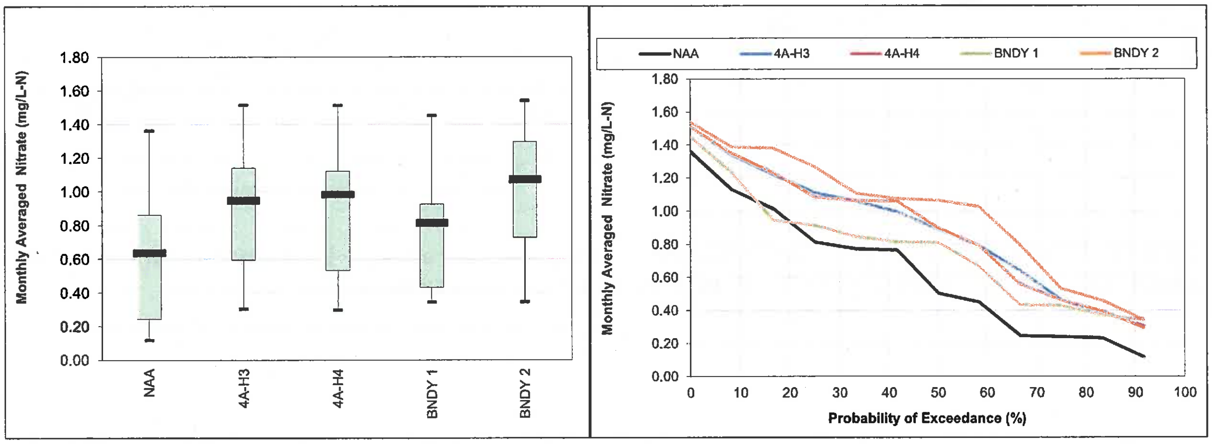

Figure 34. Box-and-whisker and probability of exceedance plots for monthly average nitrate concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for below normal years (1976–1991).

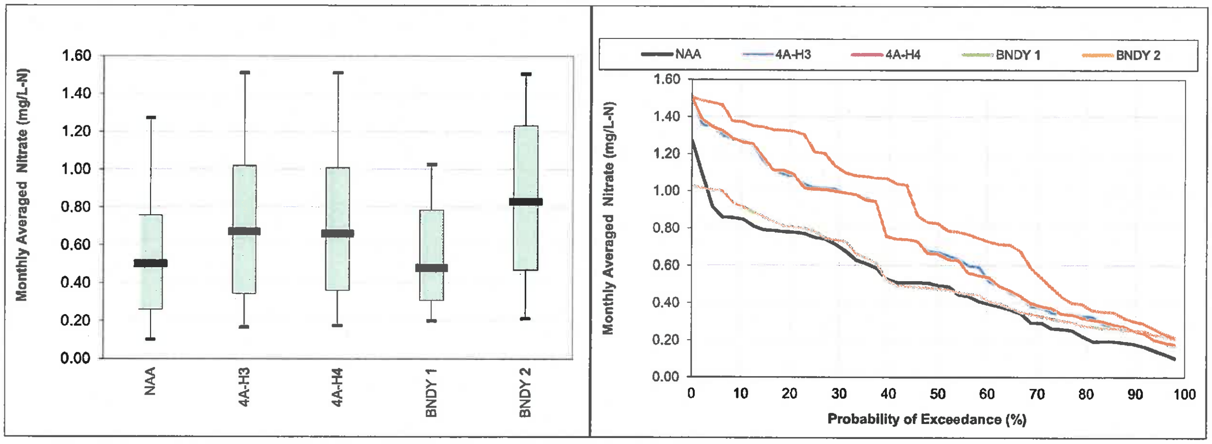

Figure 35. Box-and-whisker and probability of exceedance plots for monthly average nitrate concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991).

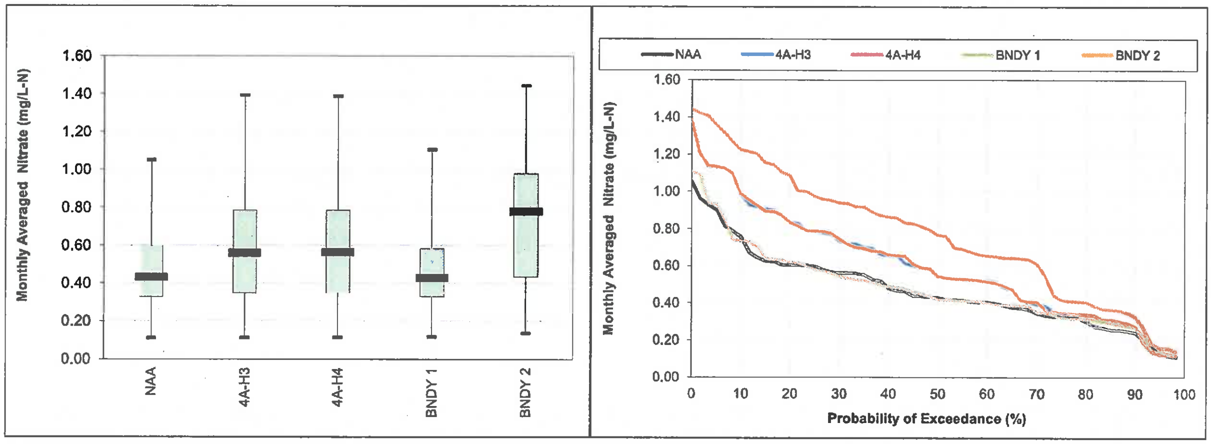

Figure 36. Box-and-whisker and probability of exceedance plots for monthly average nitrate concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991).

The period average nitrate concentration modeled for the City's diversion location for all years (1976–1991) and for the drought years (1987-1991) would be less than 1.0 mg/L-N in all cases for all five scenarios. Consequently, the 10 mg/L-N objective for the protection of the MUN beneficial use would never be exceeded at the site for any of the five scenarios modeled (**Table 12**).

Table 12. Period average (1976–1991) nitrate concentrations and frequency of exceeding the 10 mg/L-N MCL in the San Joaquin River at the City of Stockton's drinking water diversion location.

	Period Average Concentration (mg/L)					Frequency of Objective Exceedance (%) 10 mg/L-N				
Period	NAA	4A-H3	4A-H4	BNDY 1	BNDY 2	NAA	4A-H3	4A-H3	BNDY 1	BNDY 2
All	0.63	0.80	0.81	0.69	0.92	0	0	0	0	0
Drought	0.49	0.61	0.61	0.48	0.77	0	0	0	0	0

Findings from this Analysis Relative to EIR/EIS Impact Determinations

The Final EIR/EIS (chapter 8, p. 8-952–953) stated that Alternative 4A would not result in a substantial, long-term increase in nitrate concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not CWA Section 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Based on the findings, this impact was determined in the Final EIR/EIS to be less than significant (CEQA) and not adverse (NEPA).

This Analysis Affirms the EIR/EIS Analysis

The analysis presented here and the analysis within the Final EIR/EIS reach the same conclusion, which is that the CWF would not change nitrate concentrations in the San Joaquin River by frequency and magnitude that would adversely impact the municipal and industrial beneficial uses designated for the river. Consequently, nitrate concentrations with the CWF are not expected to adversely impact the City of Stockton when diverting and treating San Joaquin River water for use as a municipal and industrial water supply.

3.3.5 Organic Carbon

> ***Collectively, the information presented below indicates that the CWF is anticipated to result in minor increases in average DOC concentrations at the City's WTP intake location (typically 0.1–0.2 mg/L), relative to that which would occur for the NAA, and thus would not substantially degrade water quality with regard to DOC. DOC concentrations would nearly always remain within the 4–7 mg/L range determined to be acceptable to provide WTPs adequate flexibility in their choice of treatment method to maintain compliance with current Disinfectants and Disinfection Byproducts Rules and the drinking water MCLs (CALFED Water Quality Program 2007, as cited in***

> ***Chapter 8 of the RDEIR/SDEIS, p. 8-8, and Final EIR/EIS p. 8-44 to 8-45). When DOC levels at the City's diversion location would be above 7 mg/L in wet and above normal years, the frequency and magnitude with which DOC levels would be above 7 mg/L would be nearly the same for the CWF and the NAA. Based on these findings, the DOC concentrations that would occur at the site for the CWF would not adversely impact the municipal and industrial beneficial uses designated for the San Joaquin River. As such, I would not expect DOC concentrations that would occur for the CWF to adversely impact the City of Stockton when diverting and treating water from the San Joaquin River for municipal and industrial supply uses.***

In Delta waters, dissolved organic carbon (DOC) typically represents 85–90% of total organic carbon (TOC). TOC represents the summation of both particulate organic carbon and DOC. The primary source of DOC to the City's diversion location in the San Joaquin River is San Joaquin River water itself (**Table 13**).

Table 13. Source water concentrations for organic carbon.

Source Water	Sacramento River	San Joaquin River	Bay Water	East Side Tributaries	Delta Ag. Return Waters
Mean (mg/L a N)	1.8–3.0	3.4–4.8	NA	NA	NA

Source: Table 8-52 in Chapter 8, *Water Quality*, of the Bay Delta Conservation Plan Draft EIR/EIS and of the Bay Delta Conservation Plan/California WaterFix Partially Recirculated Draft EIR/Supplemental Draft EIS and Final EIR/EIS.
NA = Not available.

There are no water quality criteria or objectives for DOC. However, as stated under the Bromide section above, in 1998, a panel of three water quality and treatment experts was engaged by the California Urban Water Agencies to determine the Delta source water quality required for WTPs to achieve compliance under two defined regulatory scenarios. For the regulatory scenario reflective of the current regulatory requirements imposed upon WTPs today, TOC from 4 to 7 mg/L was determined to be acceptable to provide WTPs adequate flexibility in their choice of treatment method (CALFED Water Quality Program 2007, as cited in the Final EIR/EIS, p. 8-184).

Based on the information above, the fact that there are no adopted water quality objectives or criteria for organic carbon, and the fact that DOC typically represents about 85–90% of TOC in Delta waters, this assessment used 4 mg/L and 7 mg/L to evaluate the frequency with which these thresholds would be exceeded at the City's diversion location on a mean monthly basis for the five scenarios assessed herein.

The DSM2 model was used to directly model DOC concentrations at the City's diversion location. Box-and-whisker plots and exceedance plots for mean monthly DOC concentrations at this location in the San Joaquin River are presented for NAA, 4A-H3, 4A-H4, Boundary 1, and Boundary 2 conditions, for all years modeled (i.e., 1976–1991) and by water year types for this period in Figure 37 through Figure 42.

For the entire 1976-1991 period of record modeled, the frequency with which mean monthly DOC concentrations at the City's diversion location would exceed 4 mg/L is about the same for all five scenarios modeled (about 30% of the time). Modeling indicates that wet and above normal years would have the greatest range of DOC at the diversion location and the highest mean monthly DOC concentrations for all scenarios. The lowest range and lowest maximum mean monthly DOC levels would occur during below normal, dry, and critical years.

The frequency with which mean monthly DOC concentrations would exceed any given level between 2.25 mg/L and 3.5 mg/L would be somewhat higher for the CWF scenarios than for the NAA. However, the frequency with which DOC concentration would exceed about 3.5 mg/L would be about the same for all CWF scenarios and the NAA (**Figure 37**). This is the case for each water year type as well (**Figure 38 through Figure 42**).

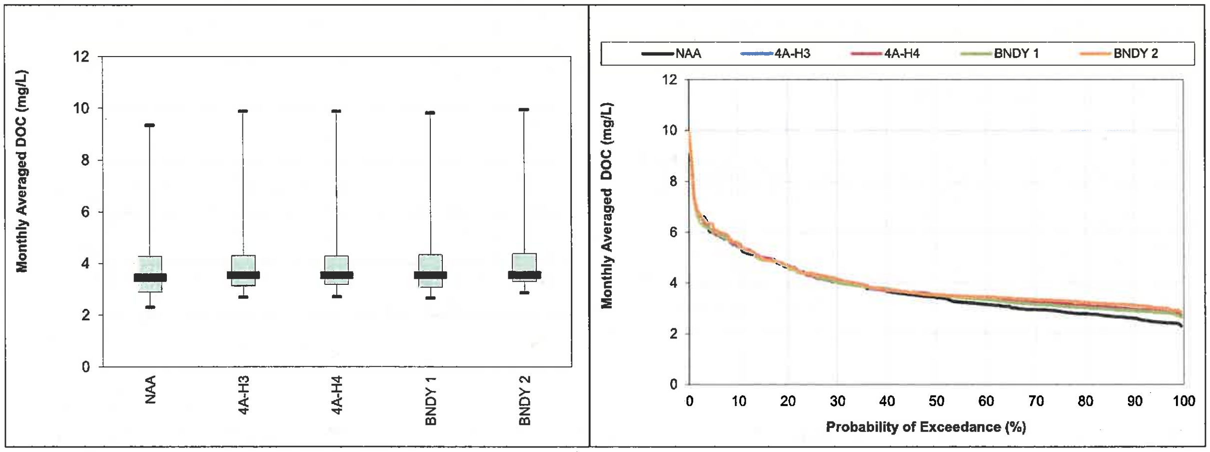

Figure 37. Box-and-whisker and probability of exceedance plots for monthly average dissolved organic carbon (DOC) concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for all years (1976–1991).

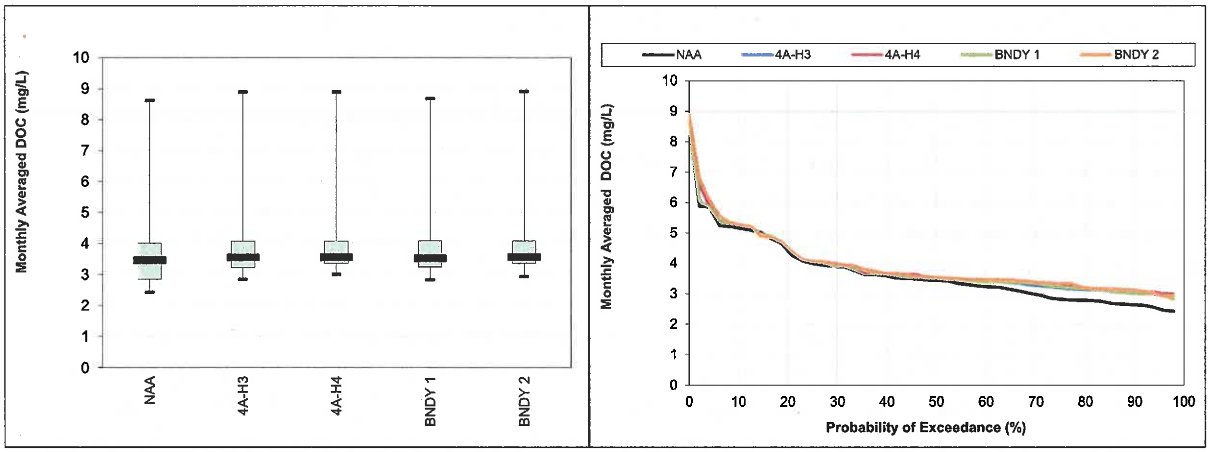

Figure 38. Box-and-whisker and probability of exceedance plots for monthly average dissolved organic carbon (DOC) concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for wet years (1976–1991).

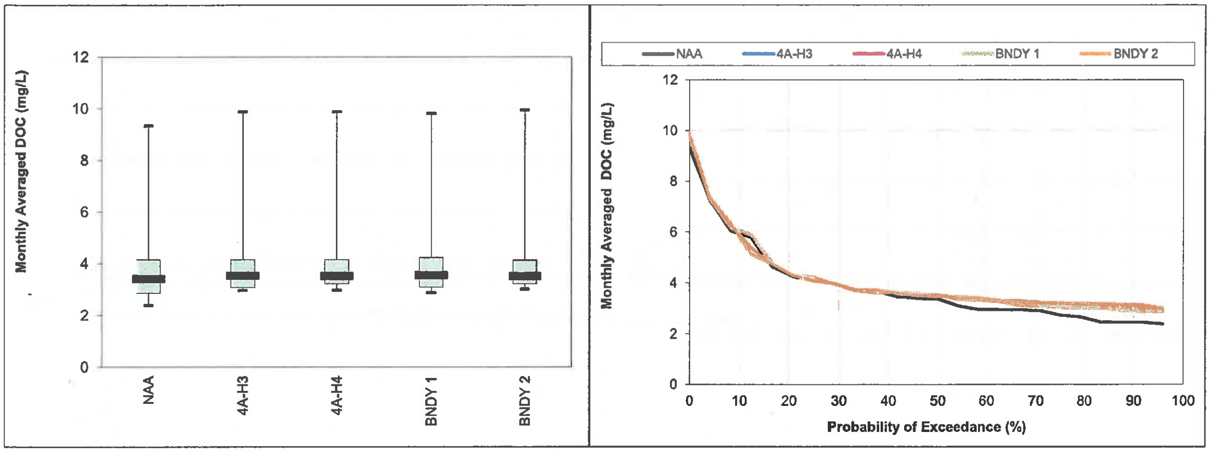

Figure 39. Box-and-whisker and probability of exceedance plots for monthly average dissolved organic carbon (DOC) concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for above normal years (1976–1991).

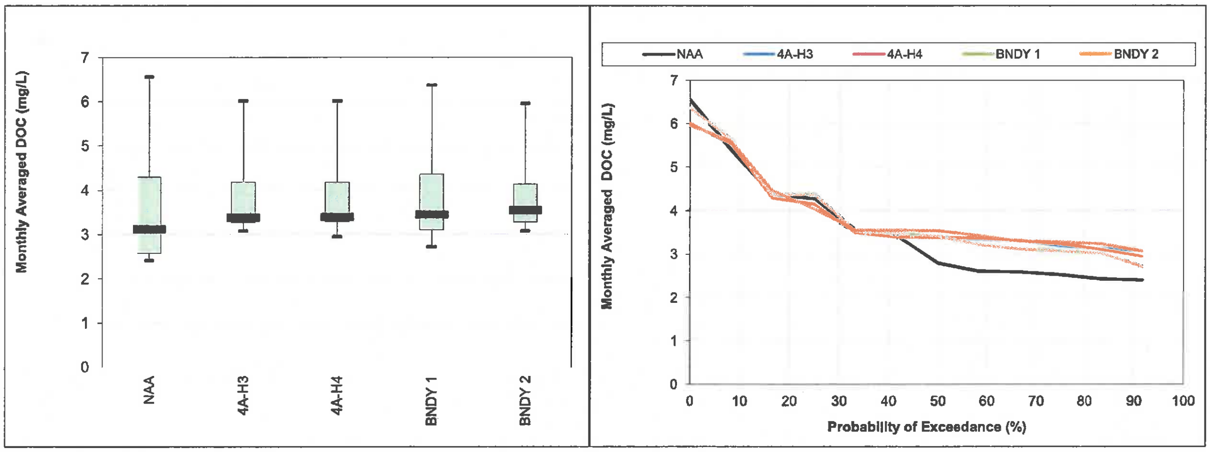

Figure 40. Box-and-whisker and probability of exceedance plots for monthly average dissolved organic carbon (DOC) concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for below normal years (1976–1991).

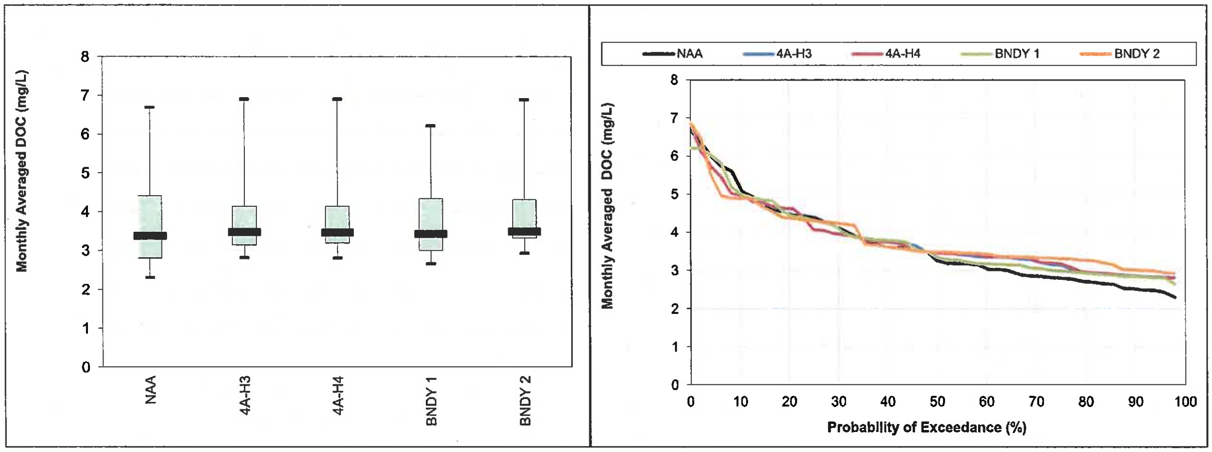

Figure 41. Box-and-whisker and probability of exceedance plots for monthly average dissolved organic carbon (DOC) concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for dry years (1976–1991).

In critical years, the frequency with which mean monthly DOC concentrations would exceed any given level between 2.25 mg/L and 3.5 mg/L would be more similar between the CWF scenarios and the NAA than for the other water year types.

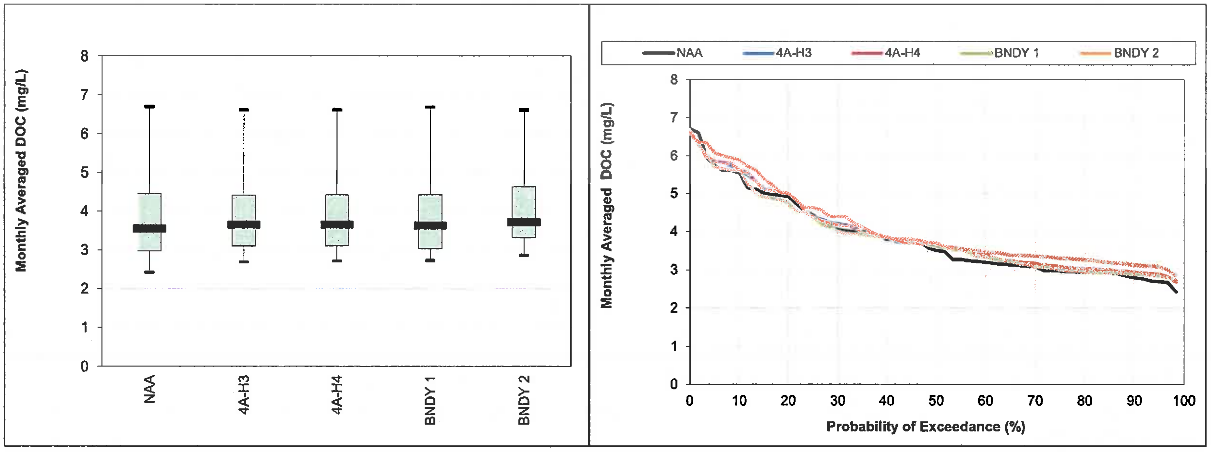

Figure 42. Box-and-whisker and probability of exceedance plots for monthly average dissolved organic carbon (DOC) concentrations in the San Joaquin River at the City of Stockton's drinking water diversion location for critical years (1976–1991).

Modeling shows a period (1976–1991) average DOC concentration at the City's diversion location of 3.8 mg/L for the NAA, 3.9 mg/L for 4A-H3, 4A-H4, and Boundary 1, and 4.0 mg/L for Boundary 2 (**Table 14**). During the drought period (1987-1991), mean monthly DOC concentrations at the diversion location would be 0.1 mg/L higher for the NAA, 4A-H3, 4A-H4, and Boundary 1 and 0.2 mg/L higher for Boundary 2. Mean DOC concentrations would remain below 4.0 mg/L 66-69% of the time overall, and 55%-62% of the time during the drought period modeled for all five scenarios, with equal or lesser exceedance of this threshold for 4A-H3, 4A-H4, and Boundary 1, relative to the NAA. Modeling output showed DOC concentrations exceeding 7.0 mg/L at the City's diversion location only in wet and above normal years, and would remain below this level at all times in below normal, dry, and critical years.

Table 14. Period average (1976–1991) DOC concentrations and frequency of exceeding 4 mg/L and 7 mg/L thresholds in the San Joaquin River at the City of Stockton's drinking water diversion location.

Period	Period Average Concentration (µg/L)					Frequency of Threshold Exceedance (%) 4 mg/L (7 mg/L)				
	NAA	4A-H3	4A-H4	BNDY 1	BNDY 2	NAA	4A-H3	4A-H3	BNDY 1	BNDY 2
All	3.8	3.9	3.9	3.9	4.0	31 (2)	31 (2)	31 (2)	31 (2)	34 (2)
Drought	3.9	4.0	4.0	4.0	4.2	40 (0)	38 (0)	38 (0)	40 (0)	45 (0)

Findings from this Analysis Relative to EIR/EIS Impact Determinations

The Final EIR/EIS (chapter 8, p. 8-955–957) stated that long-term average DOC concentrations for some Delta interior locations are predicted to increase by as much as 0.2 mg/L. Increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not Clean Water Act Section 303(d) listed for any water body within the affected environment. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. Based on the findings, this impact was determined in the Final EIR/EIS to be less than significant (CEQA) and not adverse (NEPA).

This Analysis Affirms the EIR/EIS Analysis

The analysis presented here and the analysis within the Final EIR/EIS reach the same conclusion, which is that the CWF would not change DOC concentrations in the San Joaquin River by frequency and magnitude that would adversely impact the municipal and industrial beneficial uses designated for the river. Consequently, it is not expected that DOC concentrations with the CWF would cause adverse impacts to the City of Stockton when diverting and treating San Joaquin River water for use as a municipal and industrial water supply.

3.3.6 Pesticides

> ***This analysis identified pesticides regulated in drinking water with primary MCLs, and assessed their registration status (banned or still in use), target usage, and environmental fate in water to determine whether one or more pesticide would be***

> ***expected to increase to levels of concern for the municipal and industrial supply beneficial uses in the San Joaquin River at the City's WTP intake location due to the CWF. A total of 34 pesticides were evaluated, with 27 of these having drinking water MCLs. Of these, 16 have been phased out of use. None of the pesticides having active registrations would be expected to have their concentrations increased substantially, to levels of concern, in the San Joaquin River at the City's WTP intake, due to the CWF. For many current use pesticides that lack drinking water MCLs, aquatic life uses are more sensitive to pesticides than is the municipal and domestic water supply and industrial supply beneficial uses. Consequently, human health is being protected through adoption of new objectives, TMDLs, and other mechanisms to protect aquatic life. Based on current and anticipated future regulations, the CWF would not cause such pesticides to reach levels of concern for municipal and industrial supply beneficial uses in the San Joaquin River.***

Mr. Granberg's testimony identified the general constituent class "pesticides" as having the potential to result in injury to the City, associated with its water supply diverted from the San Joaquin River, due to implementation of CWF [Exhibit STKN-010, pg. 11, ln. 1]. Pesticides regulated in drinking water with primary MCLs are listed in **Table 15** along with their respective MCLs, other applicable federal or state numeric receiving water quality criteria/objectives, and the status of the pesticide use within California.

Many of the pesticides listed in Table 15 have been phased-out of use, some since the 1980s and others as recently as the 2000s. The pesticides with MCLs that have been phased out of use include: alachlor, carbofuran, chlordane, dalapon, dibromochloropropane, dinoseb, endrin, hexachlorobenzene, lindane, methoxychlor, molinate, oxamyl, pentachlorophenol, picloram, toxaphene, and 2,3,5-TP (silvex). Of these pesticides, alachlor, carbofuran, chlordane, dibromochloropropane, endrin, lindane, methoxychlor, molinate, and toxaphene were not detected in the source water data sets for the Sacramento River, San Joaquin River, and San Francisco Bay compiled for the screening analysis conducted in support of the CWF EIR/EIS water quality assessment (see Section 3.3.7 for more discussion regarding the screening analysis). The pesticides with no data—dalapon, dinoseb, hexachlorobenzene, oxamyl, pentachlorophenol, picloram, and silvex—have not been registered for use in California or have been banned for at least ten years, some for more than thirty years. Thus, a shifting in the source waters at the City's WTP intake from Sacramento River water to more San Joaquin River water, or vice versa, due to the CWF, would not be expected to contribute to drinking water MCLs for these pesticides being exceeded in the City's drinking water supply.

Pesticides with MCLs (in Table 15) with current registered uses include atrazine, bentazon, 2,4-D, diquat, endothall, ethylene dibromide, glyphosate, heptachlor, heptachlor epoxide, simazine, and thiobencarb. Of these pesticides, atrazine, 2,4-D, ethylene dibromide, heptachlor, simazine and thiobencarb were not detected in the source water data sets for the Sacramento River, San Joaquin River, and San Francisco Bay compiled for the screening analysis conducted in support of the CWF EIR/EIS water quality assessment. Because heptachlor use is limited to fire ant control in transformers, it is expected that heptachlor epoxide, a breakdown byproduct of heptachlor, is similarly at non-detect levels in Delta source waters. It is further noted that heptachlor and thiobencarb are regulated to a receiving water quality criterion/objective that is much lower than the drinking water MCL. Thus, a shifting in the source waters at the City's intake from Sacramento River water to more San Joaquin River water, or vice versa, due to the CWF would not be expected to contribute to drinking water MCLs for these pesticides being exceeded in the City's drinking water supply.

Pesticides with no data compiled for the EIR/EIS, which are still registered for current use in California, include bentazon, diquat, endothall, and glyphosate. Bentazon has a half-life of 24 hours in water because it is readily broken down in sunlight (EXTOXNET 1996), thus a change in source water fractions due to the CWF at the City's drinking water diversion location would not be expected to contribute to increased frequency of the drinking water MCL exceedance for this pesticide. In a report evaluating updated public health goals, the Office of Environmental Health Hazard Assessment (OEHHA) noted that diquat adsorbs strongly to soil and when used as an aquatic herbicide, residues decline rapidly, with a half-life of generally less than 48 hours. Thus, a change in sources water to include more or less San Joaquin River water due to the CWF is not expected to contribute to exceedances of diquat MCLs in the City's drinking water supply. Endothall is an aquatic herbicide whose half-life is typically less than 10 days (Cornell Cooperative Extension 2012), and thus changing source water fractions at the City's diversion location under the CWF would not be expected to contribute to exceeding the MCL for this pesticide. Glyphosate is an herbicide widely used in agriculture, forestry, and on lawns and gardens (NPIC 2015). Because of its prevalent use throughout both the Sacramento and San Joaquin river watersheds, it is not expected that one source-water would have a higher concentration of glyphosate such that changing source water fractions in the San Joaquin River at the City's WTP intake location would cause the MCL to be exceeded in the City's raw drinking water supply.

There are other pesticides that do not have drinking water MCLs that have been used or are presently used in the Central Valley, for example, chlorpyrifos and diazinon. A total maximum daily load (TMDL) has been developed to address chlorpyrifos and diazinon impairments in the Delta, Sacramento River, and San Joaquin River. While these pesticides are toxic to both aquatic life and humans, aquatic life beneficial uses have been identified as the most sensitive, thus the TMDL consists of acute and chronic aquatic life objectives. Thus, while there are no MCLs for these pesticides, human health is being protected through adoption of objectives for protection of aquatic life. Product registrations for most urban (non-agricultural) uses of diazinon and chlorpyrifos were cancelled by the USEPA in 2004 and 2000, respectively. Because these pesticides are no longer sold for urban residential use their concentrations have decreased rapidly in municipal wastewater treatment plant and municipal stormwater discharges. Agricultural applications are the primary sources of diazinon and chlorpyrifos to the Delta waterways. Water quality has improved in Delta waterways through successful efforts to reduce pesticide discharges including the cancellation of non-agricultural uses and a substantial reduction in the use of diazinon and chlorpyrifos as the agricultural sector transitioned to different pesticides, such as pyrethroids (USEPA and Central Valley Water Board 2015). These trends are occurring now, without the CWF, and would be expected to continue into the future. Thus, the CWF would not contribute to adverse conditions for chlorpyrifos and diazinon at the City's drinking water diversion location.

The Central Valley Water Board, through its pesticide TMDL and Basin Plan amendment process, is developing new water quality objectives for additional pesticides, including oxyfluorfen, prometryn, simazine, trifluralin, and fipronil (Central Valley Water Board 2017). Like chlorpyrifos and diazinon, the focus of criteria development for these pesticides has been protection of aquatic life beneficial uses because they are the beneficial uses most sensitive to the presence of these pesticides in ambient waters. Thus, while there are no MCLs for these pesticides, protection of human health is being protected through adoption of objectives for protection of aquatic life.

Into the future, there are likely to be continuing shifts in pesticide use, with some existing products being phased out, water quality criteria being developed for some, and new pesticides being introduced to replace those being phased out. These actions will take place independent of the implementation of the CWF. Thus, the CWF would not contribute to adverse conditions for existing and future pesticides at the City's drinking water diversion location.

Table 15. Pesticides with drinking water MCLs and their use status in California.

Pesticide	Drinking Water MCL (µg/L)	Other Criterion/ Objective (Basis) (µg/L)	Result from EIR/EIS Screening Analysis	Use Status
Phased Out of Use				
Alachlor	2	—	ND (0.05 µg/L)	Not registered use in CA since 2008 (DPR 2017)
Carbofuran	18	—	ND (0.5 µg/L)	No residential uses registered; banned in U.S. for food crops in 2009 (OEHHA 2017a); last product registration in CA expired in 2011 (OEHHA 2016)
Chlordane	0.1	0.00057 (CTR HH)	ND (0.05 µg/L)	Banned in U.S. in 1988 (ATSDR 1995a).
Dalapon	200	Non-detect (Basin Plan)	—	No longer contained in any registered pesticide products; all uses effectively cancelled in 1999(OEHHA 2009)
Dibromochloropropane (1,2-Dibromo-3-chloropropane)	0.2	—	ND (0.5 µg/L)	No longer produced or used agriculturally in the U.S. since 1985 (OEHHA 2017b)
Dinoseb	7	Non-detect (Basin Plan)	—	Banned for agricultural uses in U.S. in1986; no registered uses in CA (OEHHA 2017d).
Endrin	2	0.036 (CTR AQ CCC)	ND (0.01 µg/L)	Not been produced or sold for general use in the U.S. since 1986 (ATSDR 1997; OEHHA 2017f)
Hexachlorobenzene	1	0.00075 (CTR HH)	—	Used in the U.S. until 1984; has not been commercially produced in the U.S. since the late 1970s. (ATSDR 2015)
Lindane	0.2	0.019 (CTR HH)	ND (0.01 µg/L)	Banned in CA in 2002 (Ca. Health and Safety Code section 111246)
Methoxychlor	30	Non-detect (Basin Plan)	Below MCL (max = 0.09 µg/L)	Banned in U.S. in 2003 (OEHAA 2017g)
Molinate	20	—	ND (0.5 µg/L)	Banned in U.S. in 2009 (OEHAA 2017h)
Oxamyl	50	—	—	Not registered for use in CA since 1998 (DPR 2017)
Pentachlorophenol	1	0.28 (CTR HH)	—	Not registered for use in CA since 2005 (OEHHA 2017i; DPR 2017)
Picloram	500	—	—	Not registered for use in CA since 1988 (OEHHA 2016)

Pesticide	Drinking Water MCL (µg/L)	Other Criterion/ Objective (Basis) (µg/L)	Result from EIR/EIS Screening Analysis	Use Status
Toxaphene	3	0.0002 (CTR AQ CCC)	ND (0.2 µg/L)	Most uses canceled in 1982; all uses banned in 1990 (ATSDR 2014)
2,4,5-TP (Silvex)	*50*	Non-detect (Basin Plan)	—	Banned for most uses in 1979 and altogether in U.S. since 1985 (OEHHA 2017j)
Active Registrations				
Atrazine	*1*	—	*ND* *(0.02 µg/L)*	*Active CA registration; federally restricted (only trained personnel can apply) (ATSDR 2003; DPR 2017)*
Bentazon	18	—	—	Active CA registrations (DPR 2017). Half-life of 24 hours in water.
2,4-D	*70*	—	*ND* *(0.25 µg/L)*	*Used as an herbicide (OEHHA 2017j)*
Diquat	20	—	—	Used as an aquatic and terrestrial herbicide and crop desiccant (OEHHA 2016). Adsorbs strongly to soil and when used as an aquatic herbicide, residues decline rapidly, with a half-life of generally less than 48 hours.
Endothall	100	—	—	Used as an herbicide for submerged aquatic vegetation (OEHHA 2017e; Cornell Cooperative Extension). Half-life is typically less than 10 days.
Ethylene dibromide (1,2-Dibromoethane)	*0.05*	—	*ND* *(0.5 µg/L)*	*Most of uses have been stopped by U.S. EPA since 1984; also used in leaded gasoline, which ended with phase-out of leaded gasoline in 1996. (ATSDR 1995; OEHHA 2017c)*
Glyphosate	700	—	—	Current use herbicide with active registrations (DPR 2017). Widely used in agriculture, forestry, and home lawn and gardens. Prevalent use in both Sacramento and San Joaquin watersheds.
Hepatchlor	*0.01*	*0.00021* *(CTR HH)*	*ND* *(0.01 µg/L)*	*Uses limited to fire ant control in power transformers in 1988 (ATSDR 2005). Regulated to a receiving water quality criterion/objective that is much lower than the drinking water MCL.*
Hepatchlor Epoxide	0.01	0.00010 (CTR HH)	—	Breakdown product of heptachlor 8(ATSDR 2005)
Simazine	*4*	—	*ND* *(0.02 µg/L)*	*Herbicide with active registrations in CA (DPR 2017)*

Pesticide	Drinking Water MCL (µg/L)	Other Criterion/ Objective (Basis) (µg/L)	Result from EIR/EIS Screening Analysis	Use Status
Thiobencarb	*70*	*1* *(Basin Plan)*	*ND* *(0.02 µg/L)*	*Limited to use for rice crops (U.S. EPA 2014). Regulated to a receiving water quality criterion/objective that is much lower than the drinking water MCL.*

Notes:

Basin Plan = Central Valley Water Board (Region 5) Water Quality Control Plan for the Sacramento River and San Joaquin River Basins.

CTR HH = California Toxics Rule human health criterion for the protection from consumption of water and organisms

CTR AQ CCC = California Toxics Rule freshwater aquatic life continuous criterion concentration.

ND = not detected above analytical reporting limit; lowest reporting limit shown in parentheses.

Pesticides in italics were not detected in the source water data sets for the Sacramento River, San Joaquin River, and San Francisco Bay compiled for the screening analysis conducted in support of the CWF EIR/EIS water quality assessment.

Bold = Registered for current use in California, but no data available and thus compiled for the EIR/EIS screening analysis.

3.3.7 Other Toxins

Robert Granberg, [STKN-10, p.10:ln.20–p.11:ln.3] Bill Jennings, [CALSPA-2-Revised-2, pp. 7–10], and G. Fred Lee [CSPA-6rev, p. 3, ln. 19–20] indicate that other toxins are a concern for some locations in the Delta. Furthermore, Jennings [CALSPA-2-Revised-2, p.7–10] and Lee [CSPA-6rev, pp. 3, ln. 12–14, 19–20] stated that a reduction in Sacramento River water flows into the Delta would result in an increase in San Joaquin River water quality constituents.

A constituent "screening analysis" was performed in the EIR/EIS as the first portion of the overall analysis of water quality effects of implementing any of the BDCP/CWF alternatives (Draft EIR/EIS, Chapter 8, Section 8.4.2.1; Final EIR/EIS, Chapter 8, Section 8.3.2.1; Draft and Final EIR/EIS, Appendix C). The overall purpose of the screening analysis was to assess a large number of water quality constituents for their potential to adversely affect water quality in the Delta and the SWP/CVP Export Service Area based on changes in Delta hydrodynamics (i.e., mixing of source waters) driven by to the alternatives being assessed, including the CWF. The screening analysis used a step-wise evaluation procedure. First, the screening analysis determined which constituents had no potential to cause a significant impact to water quality and, thus, did not warrant further assessment. This determination could be reached, for example, if the constituent was never detected in any of the major sources waters, or it was detected in one or more source water but at concentrations substantially lower than adopted criteria/objectives and average concentrations among the three major source waters was very similar. Then, the analysis identified a list of "constituents of concern" that were further analyzed as part of assessing their potential water quality related impacts.

In total, the screening analysis considered 182 constituents (or classes of constituents), many of which were toxic pollutants. These constituents were all of the constituents that were monitored for in the source waters to the Delta in several publically available databases at the time the analysis was performed. The analysis resulted in the following findings. Of the 182 constituents, 110 were determined to have no potential to be adversely affected by the alternatives to an extent to which adverse environmental effects could occur. Historical data for these constituents showed no exceedances of water quality objectives/criteria in the major Delta source waters (i.e., Sacramento River, San Joaquin River and bay water), constituents were not on the State's Clean Water Act Section 303(d) list in the affected environment, were not of concern based on professional judgment or EIR/EIS scoping comments, and had no potential for substantial long-term water quality degradation (because concentrations in the primary source waters were nearly the same and/or substantially lower than criteria/objectives or other threshold effect levels). Consequently, no further analyses were performed for these 110 constituents. Conversely, further analysis was determined to be necessary for 72 constituents. Of these, 15 were addressed further in the Screening Analysis itself because they did not warrant BDCP/CWF alternative-specific analyses. None of these constituents were found to have the potential to cause an adverse impact to water quality due to the alternatives, including the CWF. One constituent – temperature – was primarily addressed in Chapter 11, *Fish and Aquatic Resources.* The remaining 56 constituents were fully assessed in Chapter 8, *Water Quality*, of the EIR/EIS.

The water quality assessment in Chapter 8 of the EIR/EIS included both quantitative assessments, utilizing DSM2 modeling output, and qualitative assessments. For the quantitative assessments, when the NAA and CWF scenarios were modeled with DSM2 and mass-balance assessments were conducted (by multiplying long-term average source water constituent concentrations by flow fractions to determine concentrations at specific locations), the decrease in lower Sacramento River water and increase in San Joaquin River water at certain Delta locations and water quality differences of those waters were accounted for in the assessment.

In this way, the best available information was used to assess all potential toxicants that could pose a concern for the City's WTP intake location, as well as elsewhere in the affected environment. Of the 182 constituents analyzed, no adverse water quality impact was identified for any toxic pollutant due to project operations, as described in both the RDEIR/SDEIS and the Final EIR/EIS.

3.3.8 Temperature

In Mr. Granberg's written testimony (Exhibit STKM-010, p. 12), he states: "*To the extent diversions from the North Delta reduce cold water flow into the Delta, and increase river temperatures, the Project also could increase algal production.*"

See Exhibit DWR-653 for an assessment of the CWF effects on water temperatures in the Delta and how such temperature effects could, in turn, affect harmful algal blooms in the Delta. The conclusion is that the small differences in water temperature between the CWF and NAA modeled for various locations across the Delta would not substantially increase the frequency or magnitude of cyanobacteria blooms within the Delta.

3.3.9 Microcystis

For an assessment of CWF effects on *Microcystis* blooms in the Delta, see Exhibit DWR-653. In addition, information pertaining to how the CWF would affect daily maximum channel velocity in lower San Joaquin River at the City of Stockton's WTP intake location and how, in turn, such effects on channel velocity would be expected to affect *Microcystis* blooms in the river at this location is provided below.

Figure 43 through **Figure 56** and **Table 16** show daily maximum (odd numbered figures) and absolute velocity modeled on a 15-minute time step (even numbered figures) for the lower San Joaquin River at Empire Tract, near the City of Stockton's drinking water diversion location. Daily maximum velocity would range between approximately 1.0 ft/s and 2.0 ft/s during all times for all months of the May through November period of the year, when *Microcystis* blooms can occur in the Delta. The City's diversion location is not an area of the Delta that has historically experienced problem-level *Microcystis* blooms or problem-level blooms of other cyanobacteria. This is largely because it is located on the mainstem San Joaquin River, where channel velocities and turbulence are too great to support large cyanobacteria blooms. Studies have shown that flow velocities of 0.2–1.0 ft/s disrupted *Microcystis* blooms and shifted the dominant phytoplankton species to green algae and diatoms (Li et al. 2013, Zhang et al. 2015). Daily maximum velocities at this location for the CWF and NAA would always be at or above

1.0 ft/s based on modeling output. Moreover, the frequency with which any given daily maximum velocity level would be exceeded would be similar or greater for the CWF, relative to the NAA.

The frequency with which any given absolute channel velocity (regardless of direction in the channel) would occur for each month of the May through November period would be nearly identical for the CWF and the NAA at this river location. Modeling shows that the probability of the absolute river velocity near the City's WTP intake being at levels below 1.0 ft/s would be identical for the CWF and the NAA.

Based on the hydrodynamic conditions that would occur in the San Joaquin River near the City's WTP intake location, one would not expect cyanobacteria to outcompete diatoms and green algae at this location for either the CWF or NAA scenarios. As such, the frequency and magnitude of cyanobacteria blooms in this river reach for the CWF are not expected to change notably relative to historical conditions, and would not be made worse relative to the NAA, due to channel hydrodynamics for the CWF.

As discussed in Exhibit DWR-653, the CWF would not increase water temperature in the Delta, including at the City's WTP intake location, by magnitude that would result in thermal conditions more conducive to *Microcystis* or other cyanobacteria blooms at this location, relative to the NAA. In addition, the CWF would have negligible, if any, effects on water column irradiance in the San Joaquin River near the City's intake location. Finally, relatively small increases in nutrients due to the CWF would not be expected to increase the frequency, magnitude, or duration of cyanoHAB in the Delta, relative to that which would occur for the NAA.

Collectively, the key drivers of *Microcystis* and other cyanobacteria blooms would not be changed sufficiently by the CWF near the City's WTP intake location on the San Joaquin River to cause more frequent or larger magnitude *Microcystis* or other cyanobacteria blooms in this river reach, relative to the NAA.

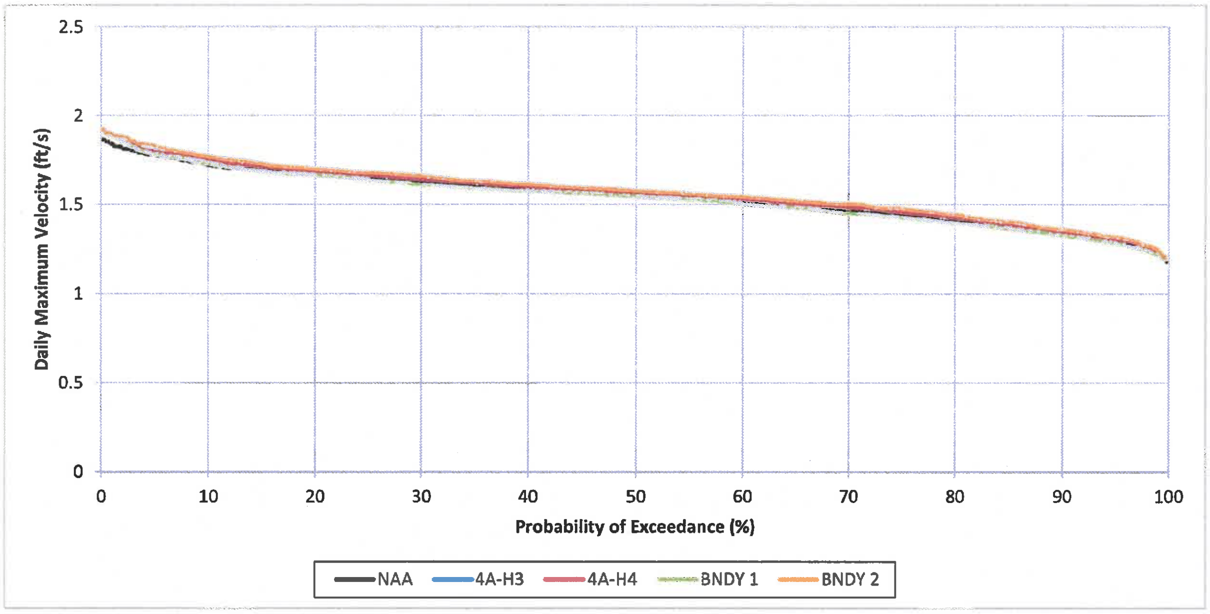

Figure 43. Probability of exceedance of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location for May of the 1976–1991 period of record modeled.

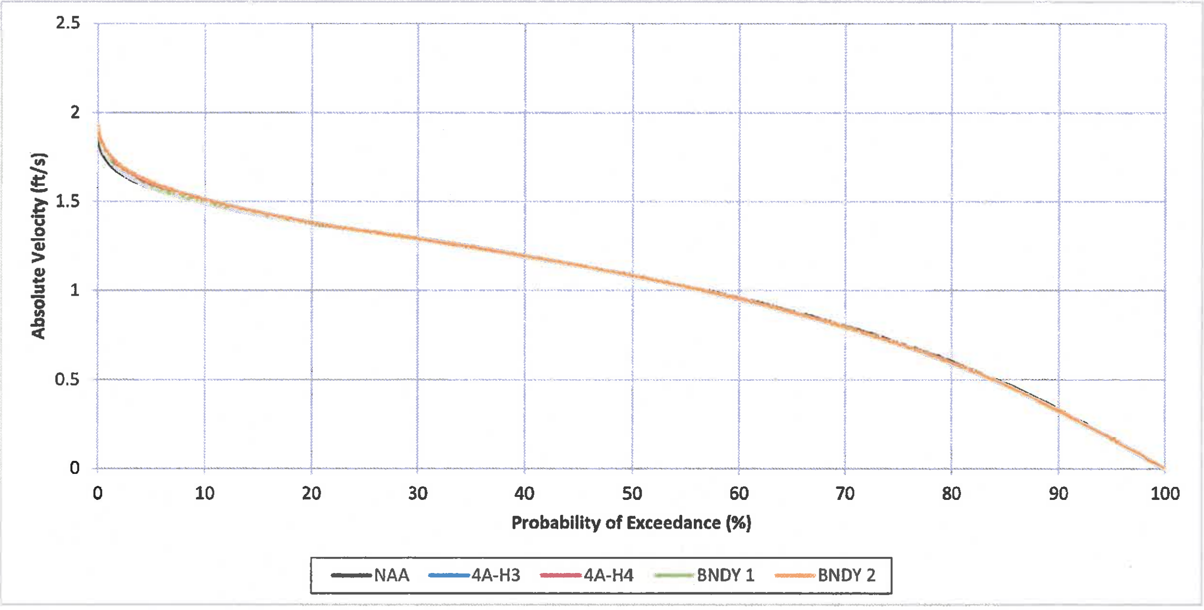

Figure 44. Probability of exceedance of absolute values of daily velocities, on a 15-minute time-step, in the San Joaquin River near the City of Stockton's drinking water diversion location for May of the 1976–1991 period of record modeled.

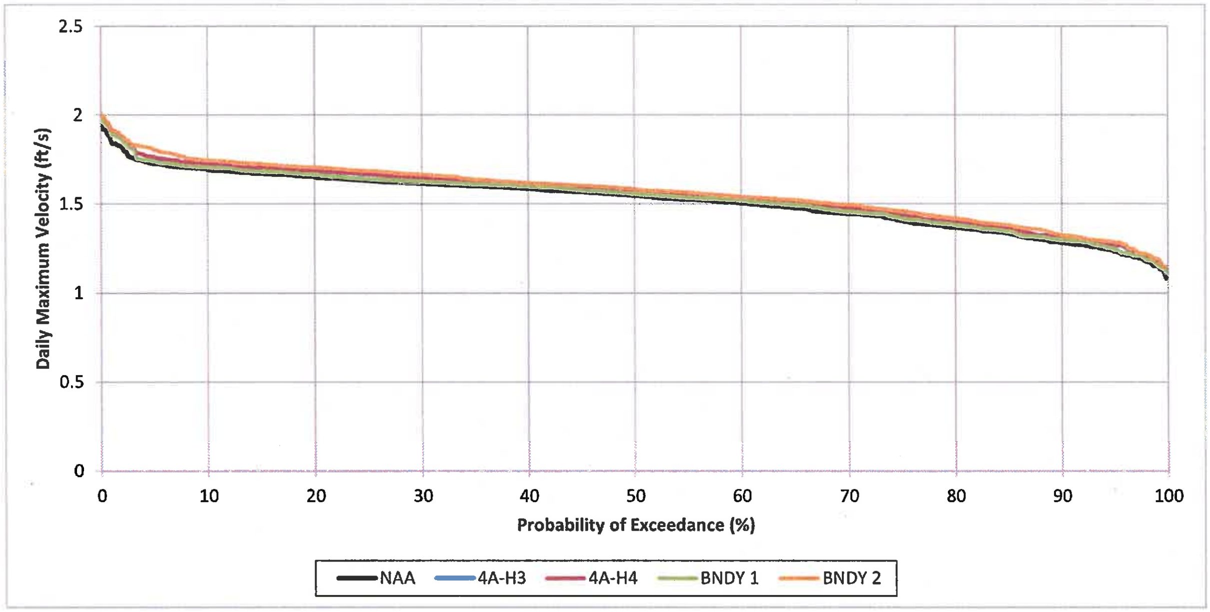

Figure 45. Probability of exceedance of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location for June of the 1976–1991 period of record modeled.

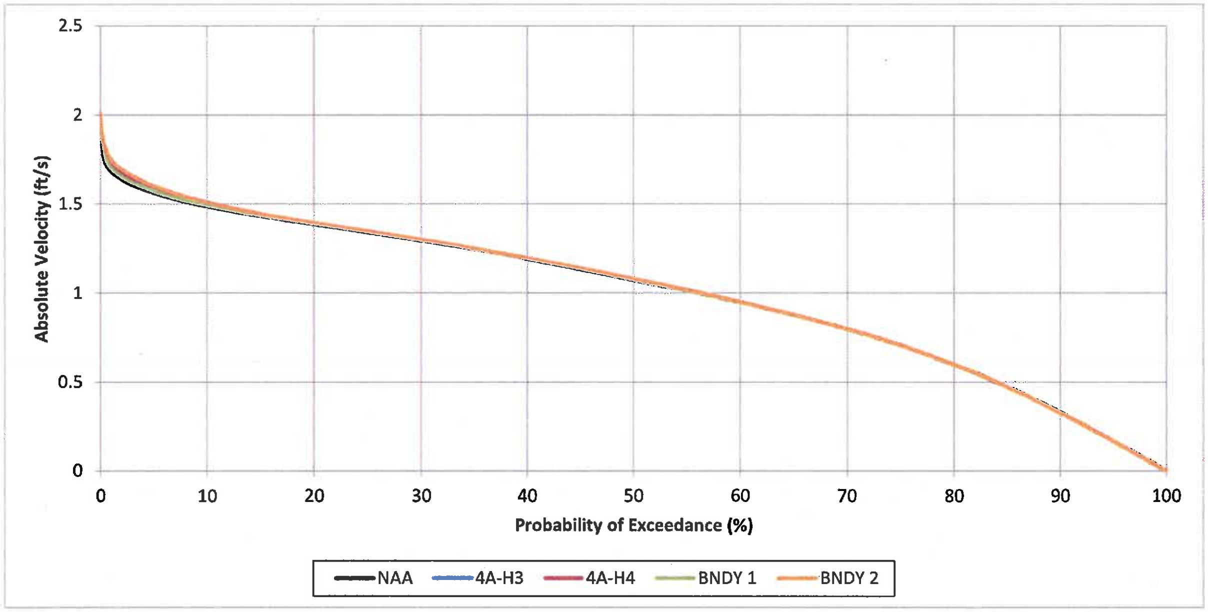

Figure 46. Probability of exceedance of absolute values of daily velocities, on a 15-minute time-step, in the San Joaquin River near the City of Stockton's drinking water diversion location for June of the 1976–1991 period of record modeled.

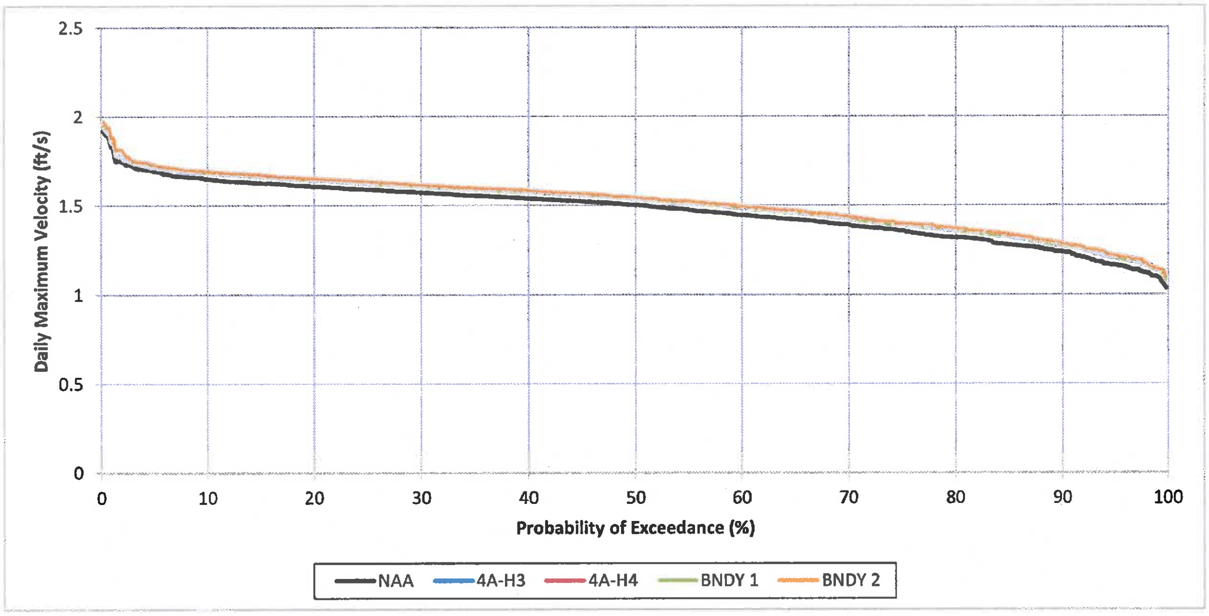

Figure 47. Probability of exceedance of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location for July of the 1976–1991 period of record modeled.

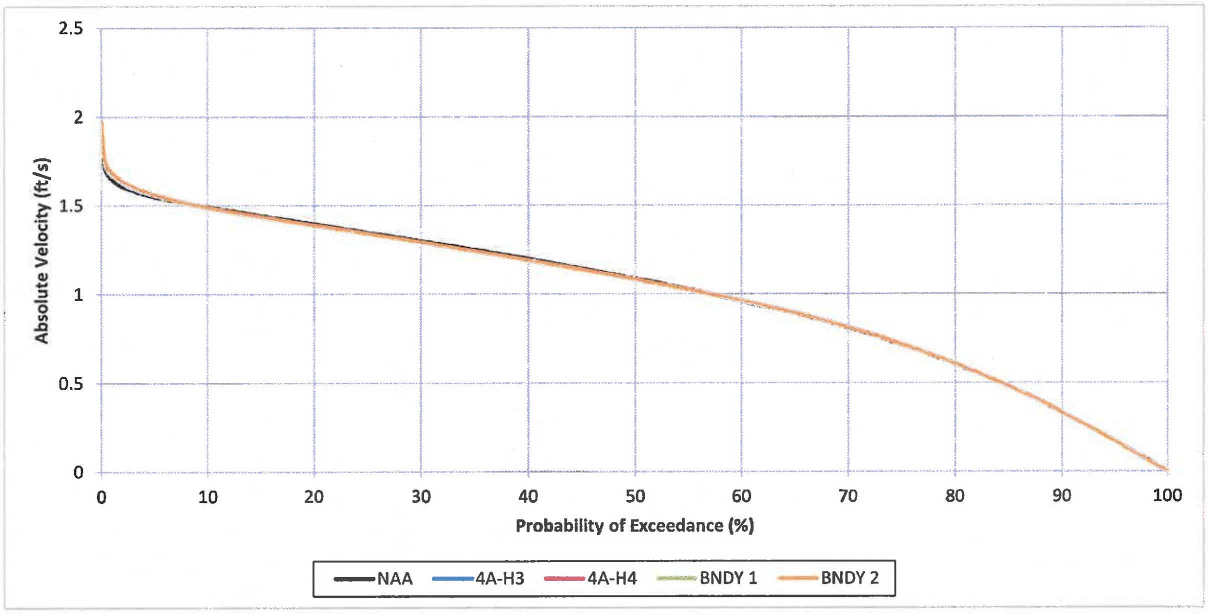

Figure 48. Probability of exceedance of absolute values of daily velocities, on a 15-minute time-step, in the San Joaquin River near the City of Stockton's drinking water diversion location for July of the 1976–1991 period of record modeled.

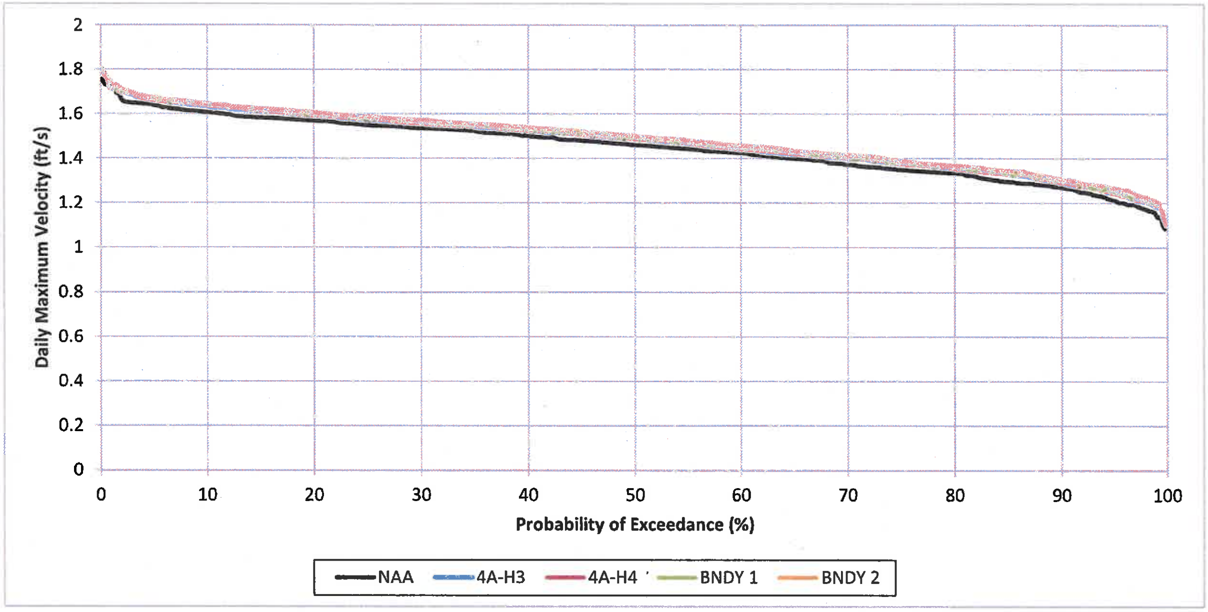

Figure 49. Probability of exceedance of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location for August of the 1976–1991 period of record modeled.

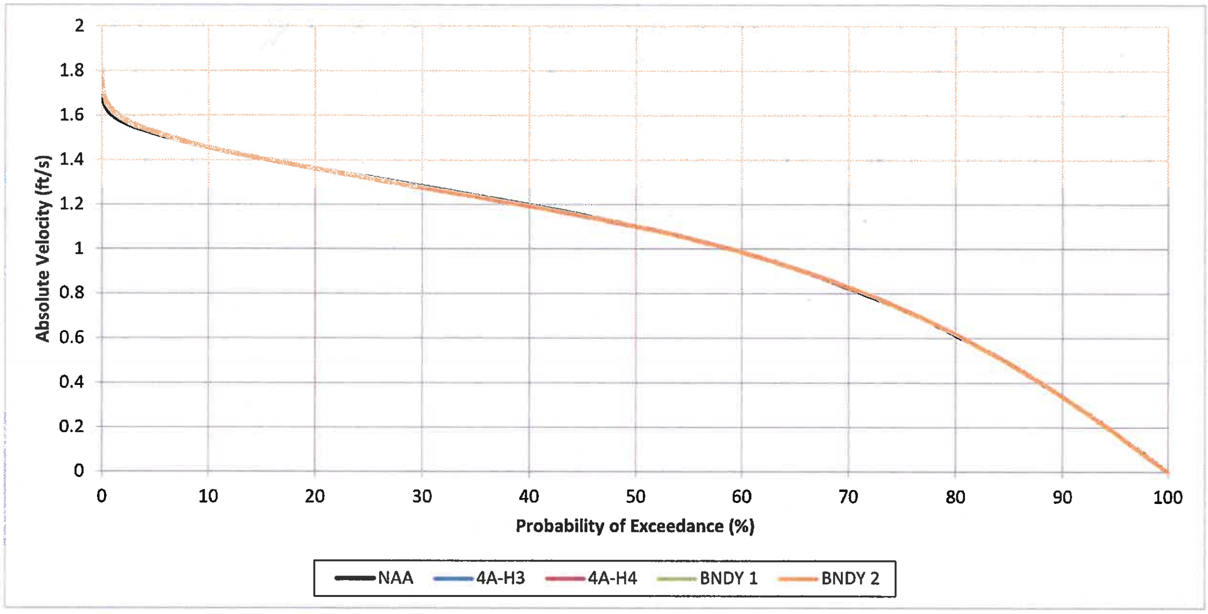

Figure 50. Probability of exceedance of absolute values of daily velocities, on a 15-minute time-step, in the San Joaquin River near the City of Stockton's drinking water diversion location for August of the 1976–1991 period of record modeled.

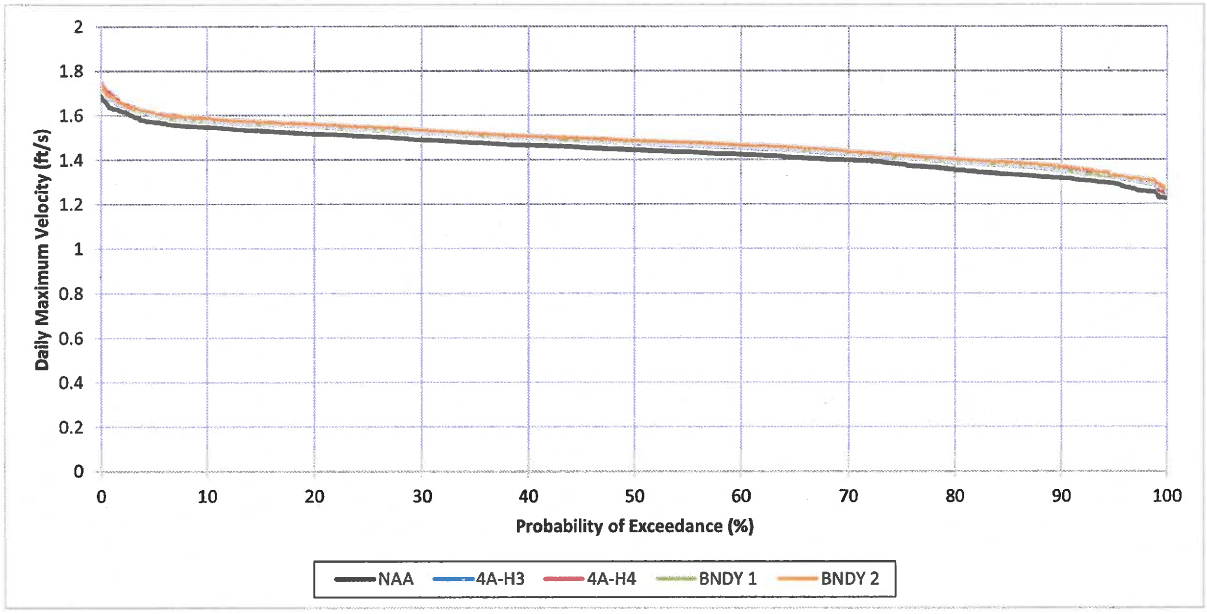

Figure 51. Probability of exceedance of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location for September of the 1976–1991 period of record modeled.

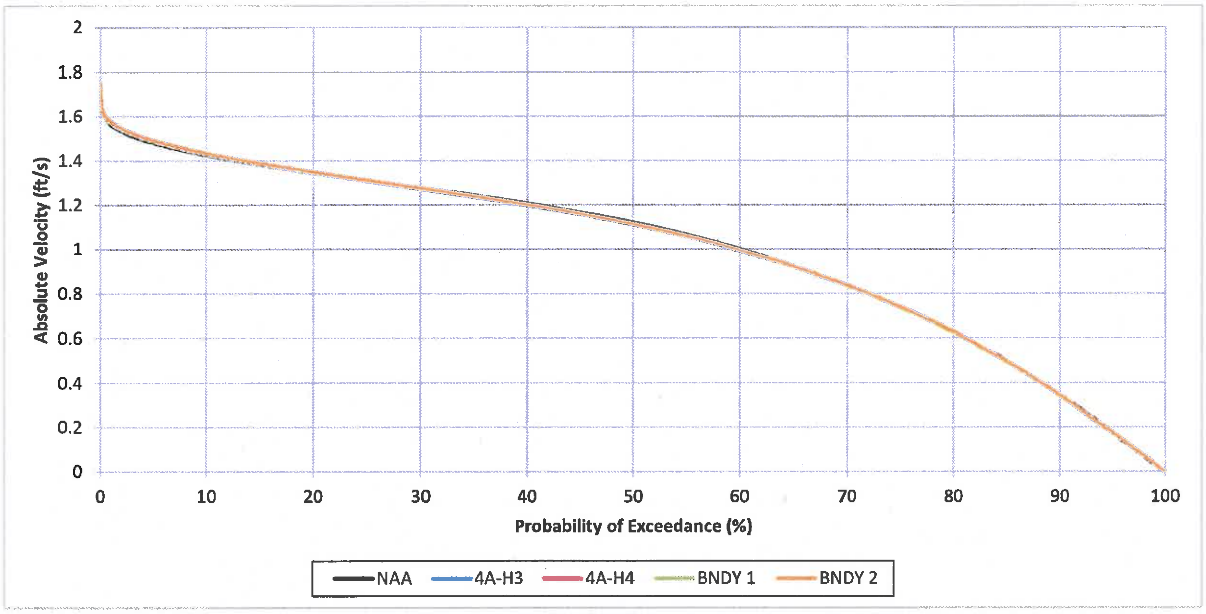

Figure 52. Probability of exceedance of absolute values of daily velocities, on a 15-minute time-step, in the San Joaquin River near the City of Stockton's drinking water diversion location for September of the 1976–1991 period of record modeled.

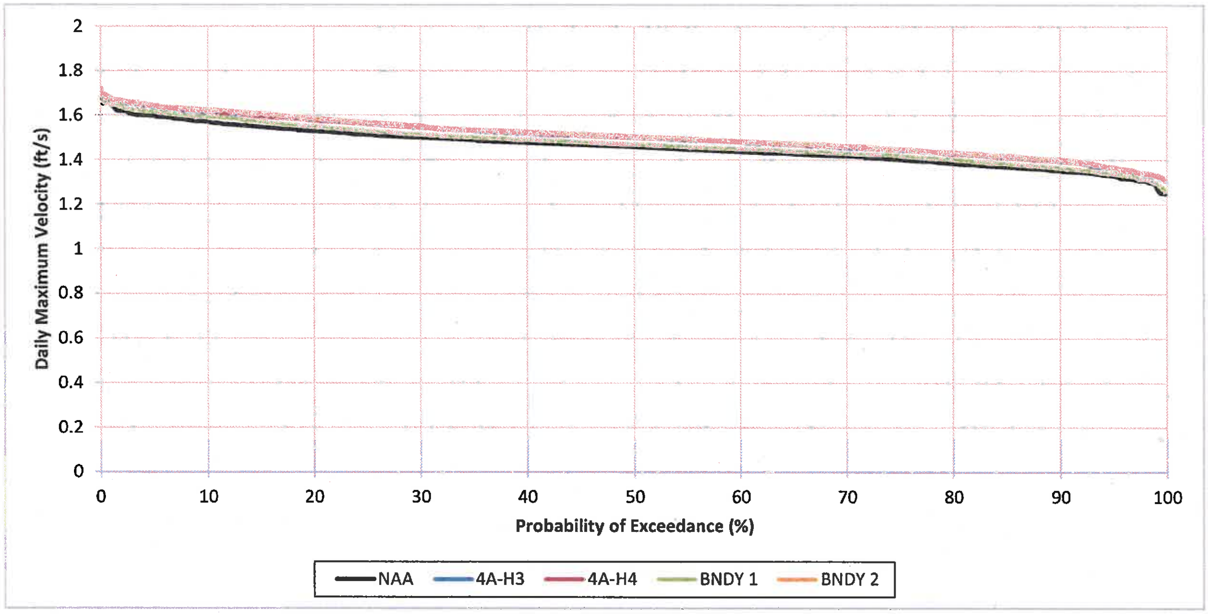

Figure 53. Probability of exceedance of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location for October of the 1976–1991 period of record modeled.

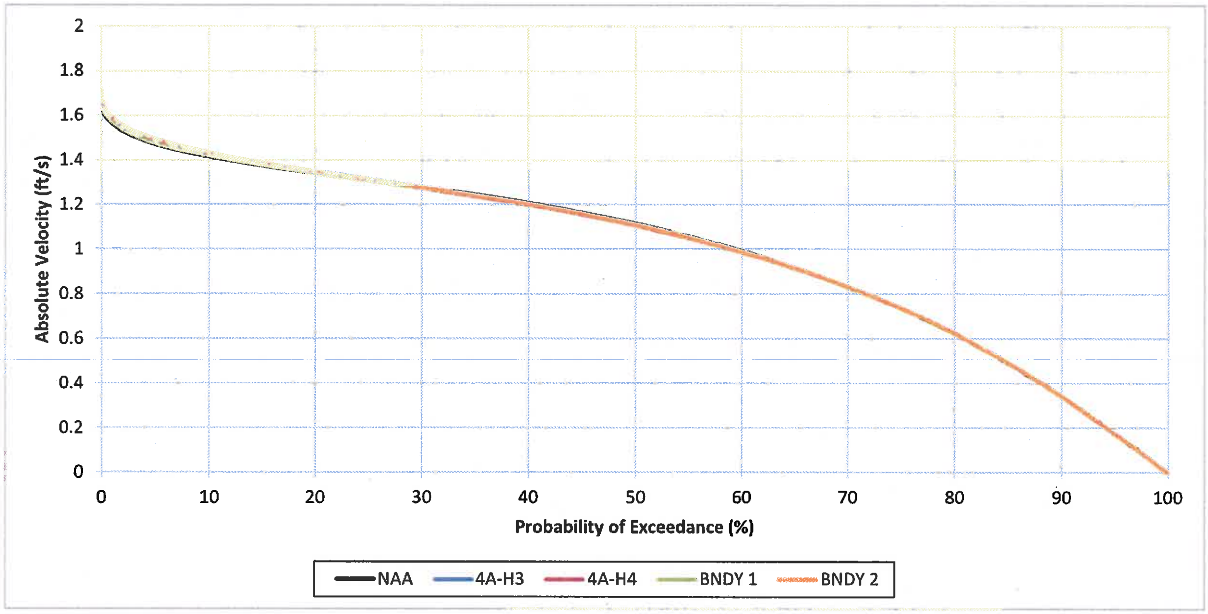

Figure 54. Probability of exceedance of absolute values of daily velocities, on a 15-minute time-step, in the San Joaquin River near the City of Stockton's drinking water diversion location for October of the 1976–1991 period of record modeled.

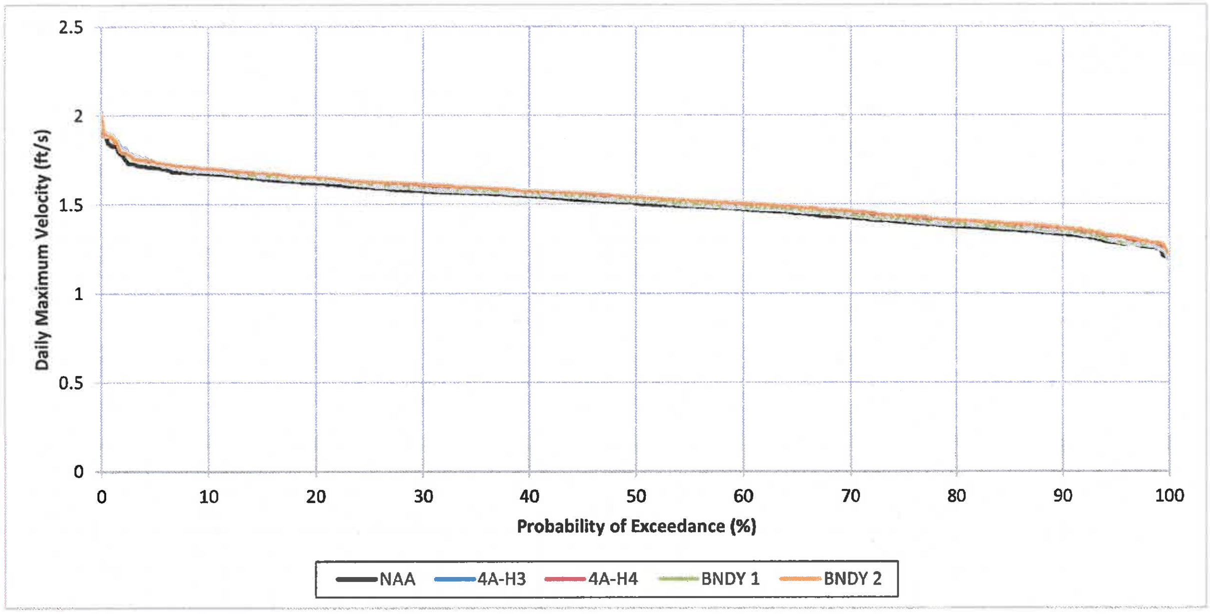

Figure 55. Probability of exceedance of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location for November of the 1976–1991 period of record modeled.

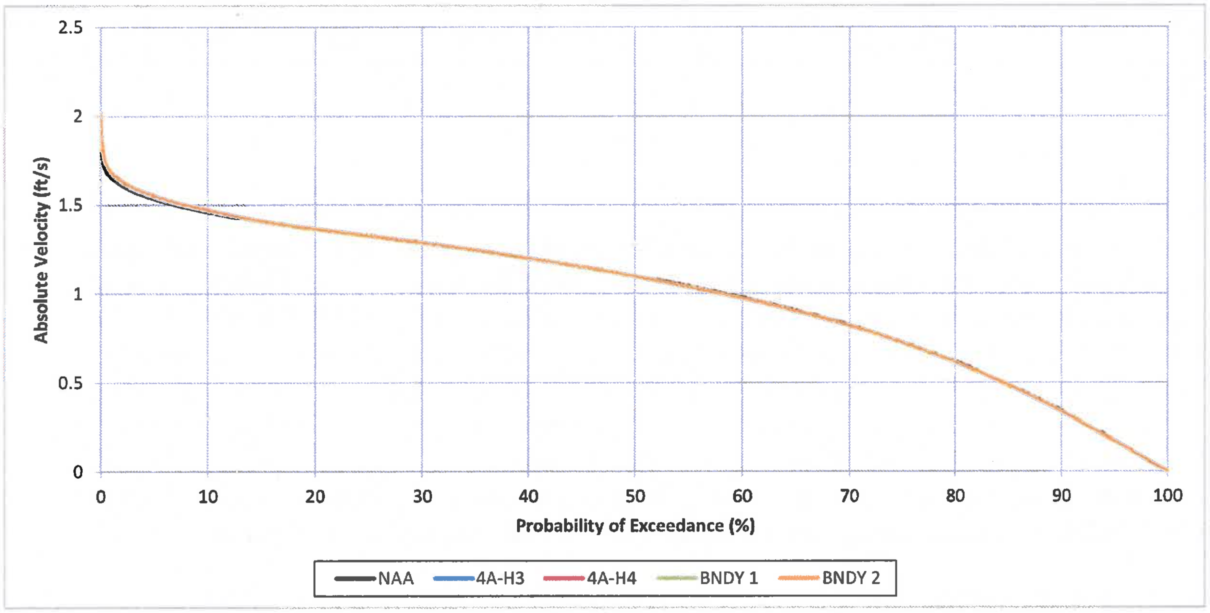

Figure 56. Probability of exceedance of absolute values of daily velocities, on a 15-minute time-step, in the San Joaquin River near the City of Stockton's drinking water diversion location for November of the 1976–1991 period of record modeled.

Table 16. Period average of daily maximum velocity in the San Joaquin River near the City of Stockton's drinking water diversion location.

Month	All Years (1976-1991) Drought (1987-1991)	Period Average of Daily Maximum River Velocity (ft/s)				
		NAA	4H3	4H4	B1	B2
May	All	1.55	1.56	1.56	1.54	1.58
	Drought	1.51	1.51	1.51	1.50	1.52
June	All	1.52	1.55	1.55	1.53	1.57
	Drought	1.50	1.51	1.51	1.51	1.52
July	All	1.47	1.51	1.51	1.51	1.52
	Drought	1.47	1.50	1.50	1.49	1.51
August	All	1.45	1.47	1.48	1.48	1.49
	Drought	1.47	1.46	1.46	1.46	1.48
September	All	1.44	1.47	1.48	1.47	1.48
	Drought	1.46	1.47	1.47	1.47	1.48
October	All	1.46	1.50	1.50	1.47	1.51
	Drought	1.47	1.49	1.49	1.47	1.50
November	All	1.50	1.53	1.53	1.52	1.54
	Drought	1.51	1.51	1.51	1.51	1.53
May through November	All	1.49	1.51	1.51	1.50	1.53
	Drought	1.48	1.49	1.49	1.49	1.51

3.3.10 Turbidity

Ms. Barrigan-Parrilla [Exhibit RTD-20, pg. 37, ln. 12–15] claims that CWF water quality impacts could include increased risk of turbidity from construction and operation that could result in increased treatment requirements at the City of Stockton's WTP. Turbidity was a parameter assessed in detail within Chapter 8, Water Quality, of the BDCP Draft EIR/EIS, BDCP/CWF RDEIR/SDEIS, and BDCP/CWF Final EIR/EIS for all project alternatives. Turbidity was assessed in a qualitative manner for the Delta and, thus, addressed the potential impacts at the City of Stockton's drinking water diversion location. The impact determination for all CWF alternatives was "less than significant" for CEQA purposes and "not adverse" for NEPA purposes for the Delta region. The water quality analysis conducted and presented in the CWF EIR/EIS has determined that an increase in turbidity would not be expected.

3.3.11 Mercury and Selenium

Ms. Barrigan-Parrilla [Exhibit RTD-20, pg. 37, ln. 12–15] claims that water quality impacts of the CWF could include increased risk of mercury, methylmercury, and selenium from construction and operation that could result in increased treatment requirements at the City of Stockton's WTP. Mercury and selenium impacts resulting from construction and operation of the CWF were addressed in Chapter 8, Water Quality, of the BDCP/CWF RDEIR/SDEIS and Final

EIR/EIS. The focus of the assessment was on how changes in mercury concentrations would result in changes in fish tissue concentrations, and how changes in selenium concentrations would result in changes in concentrations in whole-body fish, bird eggs, and fish fillets, because these beneficial uses are the most sensitive to the presence of, and changes to, these constituents in water. The drinking water MCL for mercury is 2 µg/L (there is no MCL for methylmercury), whereas the modeled annual average mercury concentrations at all Delta locations is less than 0.008 µg/L (Table Hg-1 in Appendix B of the BCDP/CWF RDEIR/SDEIS and Table I-17 in Appendix 8I, Mercury, of the BDCP/CWF Final EIR/EIS).

The drinking water MCL for selenium is 50 µg/L, whereas the modeled annual average selenium concentrations at all Delta locations is less than 1 µg/L (Table Se-1 in Appendix B of the BCDP/CWF RDEIR/SDEIS and Table M-33 in Appendix 8M, Selenium, of the BDCP/CWF Final EIR/EIS). The water quality analysis conducted and presented in the CWF EIR/EIS has determined that a significant increase in methylmercury and selenium would not be expected.

4 REFERENCES

Amy, G.L., Siddiqui, M., Ozekin, K., Zhu, H.W.,Wang, C. Empirical based models for predicting chlorination and ozonation byproducts: haloacetic acids, chloral hydrate, and bromate. USEPA 1998 EPA report CX 819579.

ATSDR (Agency for Toxic Substances and Disease Registry. 1995a. ToxFAQ: Chlordane. September. Available at: <https://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=354&tid=62>. Accessed on February 6, 2017.

———. 1995b. ToxFAQ: 1,2-Dibromoethane. Available at: <https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=131>. Accessed on February 6, 2017.

———. 1997. ToxFAQ: Endrin. Available at: <https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=616&tid=114>. Accessed on February 6, 2017.

———. 2003. ToxFAQ: Atrazine. September. Available at: <https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=854&tid=59>. Accessed on February 6, 2017.

———. 2005. ToxFAQ: Heptachlor and Heptachlor Epoxide. Available at: <https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=744&tid=135>. Accessed on February 6, 2017.

———. 2014. ToxFAQ: Toxaphene. Available at: <https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=547&tid=99>. Accessed February 6, 2017.

————. 2015. Tox FAQ: Hexachlorobenzene. Available at: <https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=626&tid=115>. Accessed on February 6, 2017.

Central Valley Water Board. 2017. Central Valley Pesticide TMDL and Basin Plan Amendment – Water Quality Criteria Method Development website. Available at: <http://www.swrcb.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/central_valley_pesticides/criteria_method/index.shtml>. Accessed February 8, 2017.

Cornell Cooperative Extension. 2012. Endothall FAQ. Available at: <http://ccetompkins.org/environment/aquatic-invasives/hydrilla/management-options/herbicides/endothall/endothall-faq>. Accessed on February 7, 2017.

DPR (Department of Pesticide Regulation). 2017. California Product/Label Database Queries & Lists. Available at: <http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods>. Accessed on February 6, 2017.

EXTOXNET. 1996. Pesticide Information Profile for Bentazon. Available at: <http://extoxnet.orst.edu/pips/bentazon.htm>. Accessed on February 7, 2017.

Li, F., Zhang, H., Zhu, Y., Yihua, Z., Ling, C. 2013. Effect of flow velocity on phytoplankton biomass and composition in a freshwater lake. Science of the total environment. 447:64-71.

NPIC (National Pesticide Information Center). 2015. Glyphosate General Fact Sheet. Available at: < http://npic.orst.edu/factsheets/glyphogen.html>. Accessed on February 6, 2017.

OEHHA (Office of Environmental Health Hazard Assessment). 2009. Memorandum: Update of PHG – Dalapon (2,2-Dichloropropanoic acid). Available at: <http://oehha.ca.gov/chemicals/dalapon>. Accessed on February 6, 2017.

————. 2016. Proposed Updated Public Health Goals for Chemicals in California Drinking Water: Carbofuran, Diquat, Endrin, Picloram, Thiobencarb—Draft. Prepared by Pesticide and Environmental Toxicology Branch. September.

————. 2017a. Chemical information website for Carbofuran. Available at: <http://oehha.ca.gov/chemicals/carbofuran>. Accessed on February 6, 2017.

————. 2017b Chemical information website for 1,2-Dibromo-3-chloropropane. Available at: <http://oehha.ca.gov/chemicals/12-dibromo-3-chloropropane>. Accessed on February 6, 2017.

————. 2017c Chemical information website for 1,2-Dibromomethane. Available at: <http://oehha.ca.gov/chemicals/12-dibromoethane>. Accessed on February 6, 2017.

————. 2017d. Chemical information website for Dinoseb. Available at: <http://oehha.ca.gov/chemicals/carbofuran>. Accessed on February 6, 2017.

————. 2017e. Chemical information website for Endothall. Available at: <http://oehha.ca.gov/chemicals/endothall>. Accessed on February 6, 2017.

————. 2017f. Chemical information website for Endrin. Available at: <http://oehha.ca.gov/chemicals/endrin>. Accessed on February 6, 2017.

————. 2017g. Chemical information website for Methoxychlor. Available at: <http://oehha.ca.gov/chemicals/methoxychlor>. Accessed on February 6, 2017.

————. 2017h. Chemical information website for Molinate. Available at: <http://oehha.ca.gov/chemicals/molinate>. Accessed on February 6, 2017.

————. 2017i. Chemical information website for Pentachlorophenol. Available at: <http://oehha.ca.gov/chemicals/pentachlorophenol>. Accessed on February 6, 2017.

————. 2017j. Chemical information website for Silvex. Available at: <http://oehha.ca.gov/chemicals/silvex>. Accessed on February 6, 2017.

————. 2017j. Chemical information website for 2,4-Dichlorophenoxyacetic Acid. Available at: <http://oehha.ca.gov/chemicals/24-dichlorophenoxyacetic-acid>. Accessed on February 6, 2017.

Sohn, J., Amy, G., Cho, J., Lee, Y., Yoon, Y. Disinfectant decay and disinfection by-products formation model development: chlorination and ozonation by-products.Water Res 2004;38:2461–78.

U.S . EPA (United States Environmental Protection Agency). 2014. Mandatory Pesticide Use Limitations for Thiobencarb Bulletins. Office of Pesticide Programs. November. Available at: <https://www.epa.gov/endangered-species/thiobencarb-use-limitations>. Accessed on February 6, 2017.

U.S. EPA (United States Environmental Protection Agency) and Central Valley Water Board. 2015. Water Quality Progress Report, Sacramento-San Joaquin Delta – Diazinon and Chlorpyrifos (Approved 2007). Last updated 6/15/2015. Available at: <https://www.epa.gov/sites/production/files/2015-07/documents/8-delta-opp-tmdl-implementation-report-2015-06-15.pdf>. Accessed on February 7, 2017.

Zhang, H., Chen, R., Li, F., Chen, L. 2015. Effect of flow rate on environmental variables and phytoplankton dynamics: results from field enclosures. Chinese J. of Oceanology and Limno. 33(2):430-43