TECHNICAL MEMORANDUM

TO: Craig Murray, PE, General Manager, Carpinteria Sanitary District
CC: Robert McDonald, PE, General Manager, Carpinteria Valley Water District
PREPARED BY: Erica Wolski, PE; Elisa Lee, PE; Eric Zeigler
DATE: August 24, 2022
RE: Ocean Plan Compliance Assessment for the Carpinteria Advanced Purification Project

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1. INTRODUCTION

Carpinteria Valley Water District (CVWD) has partnered with the Carpinteria Sanitary District (CSD) to develop the Carpinteria Advanced Purification Project (CAPP), in which recycled water will be produced on-site at the CSD Wastewater Treatment Plant (WWTP) with the proposed Advanced Water Purification Facility (AWPF), conveyed through a purified water conveyance system, and then injected into the Carpinteria Valley Groundwater Basin using injection wells. The proposed AWPF will receive undisinfected secondary effluent from the Carpinteria WWTP as its source water.

The purpose of this technical memorandum is to provide an assessment of projected CSD WWTP effluent compliance with State Water Recourses Control Board (SWRCB) Ocean Plan objectives at the CSD WWTP effluent outfall following completion of the proposed CAPP project. This technical memorandum summarizes the assumptions, methods, results, and conclusions of the Ocean Plan compliance assessment.

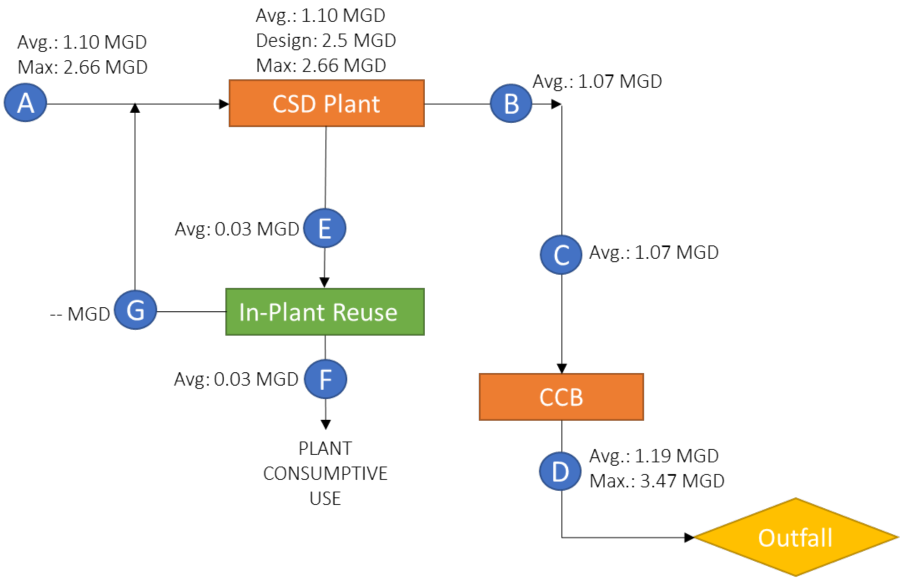
1.1 Existing CSD WWTP

The CSD WWTP is owned and operated by CSD. It is a secondary treated municipal wastewater plant with a dry weather design capacity of 2.5 MGD. The treatment process consists of mechanical screening, grit removal, primary clarification, aerated activated sludge tanks, secondary clarification, and chlorine disinfection. After chlorination, the effluent is de-chlorinated and discharged to the Pacific Ocean through a dedicated outfall. The effluent is fully nitrified, resulting in low ammonia concentrations and higher nitrate concentrations. The CSD WWTP is currently regulated by the Central Coast Regional Water Quality Control Board (RWQCB) under Order No. R3-2017-0032.

Average annual effluent water quality from the CSD WWTP from 2017 through 2021 is shown in **Appendix A.**

During the 2017 through 2021 period, the average annual influent flow was 1.10 MGD[1] with a maximum daily influent of 2.66 MGD[1] through 2.5 MGD design capacity of the WWTP. The average maximum effluent flow was 1.19 MGD[2] with a maximum daily effluent flow of 3.47 MGD[2]. These variations in flow from influent to effluent reflect flow equalization throughout the treatment processes. **Figure 1-1** presents a schematic of the existing CSD WWTP.

Figure 1-1: Simplified Flow Schematic of Existing CSD WWTP



1.1.1 Existing CSD Outfall

The CSD WWTP currently discharges effluent through a single 24-inch diameter concrete coated, welded steel outfall at a depth of 21 to 24 feet below mean sea level. The alignment of the outfall is shown in **Figure 1-2.** The outfall is approximately 1,600 feet long from the CSD WWTP surge chamber to the outfall terminus cap. There are 16 4-inch

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[1] CSD WWTP 2017-2021 data for M-INF reporting location, 24-hour period
[2] CSD WWTP 2017-2021 data for M-001A reporting location, instantaneous maximum

diameter ports with duckbill valves spaced evenly every 6-feet along the last 93 feet of the outfall pipe, as well as one 4-inch diameter port with a duckbill valve on the flanged end of the pipe. Each of the 16 ports consists of a 4-inch diameter pipe riser (18- to 24-inces in length) followed by a 90-degree elbow with the duckbill valve attached. The diffuser ports are alternately arranged with 8 on the east side and 8 on the west side of the outfall pipe. The duckbill valves were installed in June 2020. Prior to then, the 16 4-inch diameter diffuser ports along the last 93 feet of the outfall pipe included of a 4-inch diameter pipe riser terminating with a 90-degree elbow with a downward discharge trajectory of 30-degree from the horizontal. Also, the end of the pipe had one 4-inch diameter open port.

Figure 1-2: CSD WWTP Ocean Outfall Pipeline

Table 1-1: Historical CSD WWTP Effluent Average Daily Flows from 2017 to 2021

Month	WWTP Effluent Average Daily Flows (MGD)					
	2017	2018	2019	2020	2021	Monthly Average
January	1.37	N/A[2]	1.28	1.24	1.23	1.24
February	1.78	N/A[2]	1.50	1.18	1.21	1.35
March	1.33	1.23	1.41	1.29	1.20	1.29
April	1.24	1.17	1.25	1.35	1.17	1.23
May	1.14	1.12	1.22	1.23	1.15	1.17
June	1.13	1.11	1.23	1.20	1.17	1.17
July	1.18	1.17	1.24	1.21	1.13	1.19
August	N/A[1]	1.13	1.24	1.21	1.07	1.16
September	1.09	1.13	1.17	1.21	1.02	1.12
October	1.06	1.07	1.14	1.17	1.05	1.10
November	1.05	1.07	1.14	1.17	1.07	1.10
December	N/A[2]	1.07	1.30	1.17	1.24	1.15
Annual Average	**1.24**	**1.12**	**1.26**	**1.22**	**1.14**	**1.19**

Notes:

1. No flow data was available.
2. Flow data was omitted due to city-wide evacuations that occurred during this time.

1.2 Proposed CAPP Capacity

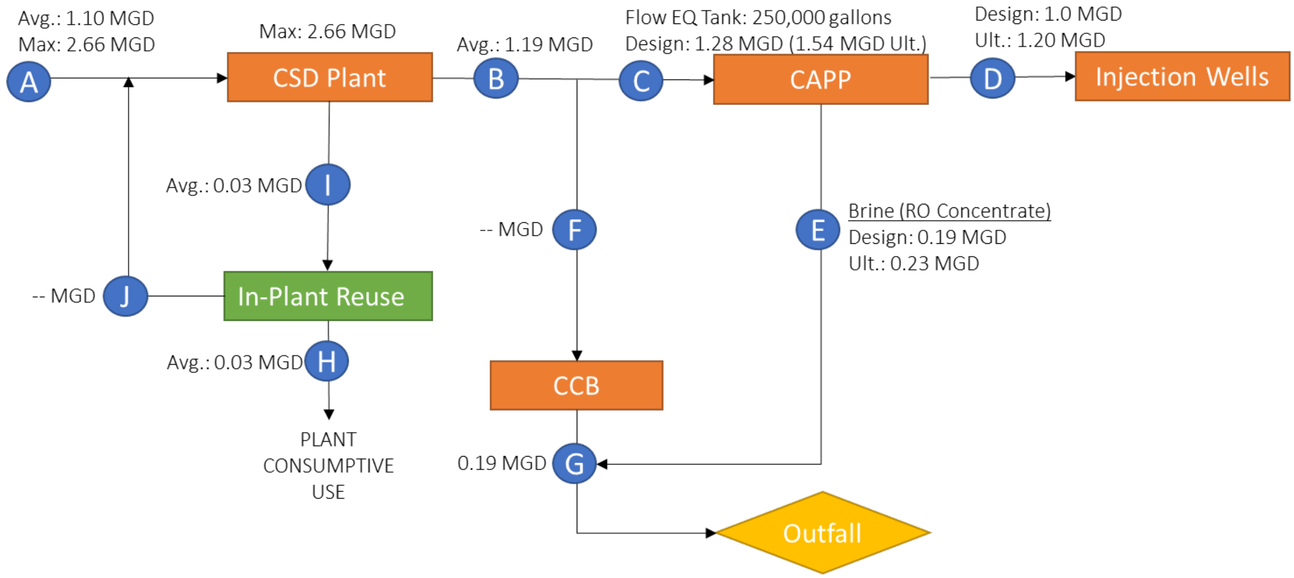
The 2016 Facilities Plan established an initial production capacity of 1.0 MGD for the AWPF based on the CSD WWTP average daily flow of 1.2 MGD at the time that report was developed. However, an examination of CSD WWTP flows from 2017 through 2021 showed daily flows to be less than 1.2 MGD during dry weather conditions, when rainfall is negligible (**Table 1-1**).

The 2019 CAPP AWT Final PDR refined the proposed AWPF to have an initial capacity of 1.0 MGD requiring an influent flow of 1.28 MGD and an ultimate capacity 1.2 MGD requiring an influent flow of 1.54 MGD. A target initial production capacity of 1.0 MGD was maintained based on the projected increased annual yield and minimal increase in capital and operating costs. The AWPF processes were designed to produce initially between 0.90 to 1.0 MGD of purified water with an ultimate capacity of 1.2 MGD. However, the initial capacity referenced in subsequent sections will be the nominal capacity of 1.0 MGD.

As noted in Section 1-1, there is some flow normalization and equalization through the existing treatment processes. The proposed CAPP AWPF will add a 250,000 gallon flow equalization storage tank in order to maintain a continuous flow rate to the AWPF. The equalization tank is sized to provide enough operating volume to produce 1.0 MGD of product water, equivalent to approximately 1.28 MGD of secondary effluent fed to the AWPF. This 1.28 MGD value includes the UF backwash waste return flow of approximately 0.09 MGD (3,750 gph) and assumes 93% recovery of the UF system and 84% recovery of the RO system with 0.19 MGD of RO concentrate (brine) discharged to the ocean outfall. Therefore, the required WWTP secondary effluent base flow is approximately 1.19 MGD[1].

Figure 1-1 presents a schematic of the proposed CSD WWTP with AWPF.

Figure 1-3: Simplified Flow Schematic of CSD WWTP with Proposed CAPP Capacity



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[1] This assumes diurnal flow using hourly flow data from days where the WWTP effluent was between 1.15 MGD and 1.25 MGD. This flow range provides a representative diurnal curve for a WWTP daily flow of approximately 1.19 MGD.

1.2.1 CSD Outfall Hydraulics

Approximately 100% of the CSD WWTP secondary effluent will be diverted to the proposed AWPF, except during wet weather flows, resulting in a significant reduction of flow conveyed discharged through the outfall for much of the year. The reduced flow would affect system hydraulics such that some of the diffusers would not have any discharge, thus allowing seawater, sediment, and marine life to enter the outfall. To prevent the fouling of the interior of the outfall, CSD replaced the 16 existing 4-inch diameter diffuser ports in 2020 with soft rubber duckbill style valves as well as attaching a 4-inch diameter duckbill valve on the open port at the flanged end of the pipe. The open area of the duckbill style valves vary with flow rate and this response to flow effectively increases the ports' exit velocity in the lower part of the flow range. The greater exit velocity (i.e., jetting) tends to improve the dilution of effluent into the ambient receiving water. The duckbill valve's ability to close during periods of little to no flow through the outfall will inhibit entry of sediment or marine life into the diffuser. Both the increased exit velocity and closure capability of duckbill valves are desirable features for ocean outfall diffuser systems. A Near-Term Dilution Study, prepared by FlowScience (see **Appendix B**) was developed as part of the CAPP Environmental Impact Report.

A hydraulics evaluation was performed with the duckbill style valves installed on the outfall diffusers to ensure the valves do not compromise the flow capacity of the outfall. To summarize, the duckbill style valves do not compromise the 5.5 MGD rated capacity of the outfall. At non-peak flow conditions, the diffuser fitted with a duckbill valve requires a minor increase in static head of a few inches compared to the existing diffuser port nozzles. This is not an issue because sufficient hydraulic head is available in the CSD WWTP ocean outfall surge chamber. At peak flow rates, those above typical operating conditions, the duckbill valves are found to be more efficient than the existing port nozzles and offer a minor increase in flow capacity.

The CSD WWTP's undisinfected secondary effluent flow will be redirected as source water to the AWPF from the inlet to the existing chlorine contact basin, upstream of the sodium hypochlorite injection chamber.

The CAPP will not result in increased mass loading of pollutants from the CSD WWTP to the Pacific Ocean, except for limited chemicals added in the AWPF (e.g., antiscalant and disinfection chemicals). However, effluent pollutant concentrations may be up to six times higher than current conditions from RO concentrate – assuming 84% RO system recovery – when the AWPF is treating all or most of the available wastewater. Ammonia may be more than six times higher than current effluent concentrations, since it will be added upstream of the UF trains to form chloramines, which help limit biological fouling on the UF and RO membranes.

A partial shutdown of the RO system is required during periods when the CSD WWTP flow is below the target feed rate into the AWPF. Consequently, the initial AWPF production capacity was re-evaluated to determine the optimal target based on flow availability and annual yield.

The key AWPF RO system items of note are the percent recovery (84%) and maximum turndown (10%). A summary of the evaluation is provided in **Table 1-** and a summary of AWPF treatment design capacities are provided in **Table 1-3**.

Table 1-2: Evaluation of AWPF Initial Production Capacity

Parameter	Unit	Initial Capacity (Nominal)
		1.0 MGD
RO Turndown, maximum	%	-10
AWPF Production Capacity Range	MGD	0.90 to 1.0
RO System Recovery, design	%	84
Required WWTP Flow Range	MGD	1.07 to 1.19
No. of Days with a Partial RO System Shutdown(1)	days	95
Total Annual Yield(2)	AFY	1,048

Notes:

1. Based on 2015 to 2018 WWTP daily flow data. Assumes a partial RO shutdown is required when WWTP flow was less than the minimum required flow (e.g. 0.964 MGD or 1.07 MGD).
2. Assumes all WWTP flow up to the maximum required flow (e.g. 1.07 MGD or 1.19 MGD) is sent to the AWPF for purified water production. Assumes UF backwash and other process waste flows, excluding RO concentrate, are recirculated to the WWTP headworks.

Table 1-3: Summary of AWPF Treatment Design Capacities

Parameter	Unit	Initial Capacity	Ultimate Capacity
AWPF Production Capacity	MGD	1.00	1.20
AWPF Influent Flow(1)	MGD	1.28	1.54
UF System			
Feed	MGD	1.28	1.54
Recovery, minimum	%	93	93
Backwash Waste	MGD	0.09	0.11
Filtrate	MGD	1.19	1.43
RO System			
Feed	MGD	1.19	1.43
Recovery, minimum	%	84	84
RO Concentrate	MGD	0.19	0.23
Permeate	MGD	1.00	1.20
UV-Advanced Oxidation	MGD	1.00	1.20

Notes:

1. Assumes the UF backwash waste flow stream will be recycled to the WWTP headworks.

1.3 Historical CSD WWTP Effluent Quality

Historical CSD WWTP effluent water quality data collected from 2017 through 2021 have been compiled and are included as **Appendix A**. A summary of the number of results, percent detected, and maximum CSD WWTP effluent concentrations are presented in **Table 1-4**. Only constituents with at least one CSD WWTP effluent result reported above the analytical detection limit are listed in Table 1-4.

Table 1-4: Maximum CSD WWTP Effluent Concentrations (2017-2021)

Constituent	Number of Results	% Detected	Units	Maximum Effluent Concentration
Objectives for Protection of Marine Aquatic Life				
Arsenic, Total Recoverable	6	83%	µg/L	1.88
Cadmium, Total Recoverable	6	67%	µg/L	0.073
Chromium (VI)	5	100%	µg/L	0.386
Copper, Total Recoverable	6	100%	µg/L	21.7
Lead, Total Recoverable	5	100%	µg/L	0.642
Mercury, Total Recoverable	6	17%	µg/L	0.0037
Nickel, Total Recoverable	6	83%	µg/L	7.2
Selenium, Total Recoverable	6	83%	µg/L	4.75
Silver, Total Recoverable	5	80%	µg/L	0.223
Zinc, Total Recoverable	6	100%	µg/L	86.1
Ammonia, Total (as N)	63	40%	µg/L	7,750
Acute Toxicity	3	100%	TUa	0.4
Chronic Toxicity	21	100%	TUc	17.9
Objectives for Protection of Human Health - Noncarcinogens				
Antimony, Total Recoverable	6	83%	µg/L	1.92
Chromium (III)	5	100%	µg/L	2.96
Objectives for Protection of Human Health - Carcinogens				
Aldrin	6	17%	µg/L	0.00405
Bis (2-Ethylhexyl) Phthalate	5	40%	µg/L	0.92
Chlorodibromomethane	6	83%	µg/L	67.3
Chloroform	6	100%	µg/L	35.7
DDT	5	20%	µg/L	0.00186
Halomethanes, Sum	5	100%	µg/L	180

1.4 Objective of Technical Memorandum

This analysis considers the worst-case for the various ocean discharge scenarios (i.e., prior to dilution through ocean mixing) for the proposed CAPP project. FlowScience ocean discharge modeling (**Appendix B**) and the results of the water quality analysis were then used to assess if the proposed CAPP project is expected to consistently meet the Ocean Plan water quality objectives set by the SWRCB. This technical memorandum summarizes the assumptions, methods, results, and conclusions of the Ocean Plan compliance assessment for the CAPP project.

2. METHODOLOGY FOR OCEAN PLAN COMPLIANCE

2.1 Methodology for Determination of Discharge Water Quality

Woodard & Curran characterized water quality and flow of the secondary effluent that will comprise the AWTF influent. Using these data, the future worst-case water quality of the ocean discharge was estimated, and the results evaluated to determine whether the proposed CAPP project complies with the Ocean Plan. This section describes the methodology used to perform this evaluation.

Water quality data for the existing CSD ocean outfall discharge from 2017 through 2021 were downloaded from CIWQS (see **Table 1-4**). These data are used to estimate the future water quality of the ocean outfall discharge under the proposed CAPP project.

2.1.1 CAPP Brine

Projected CAPP brine quality is conservatively estimated by applying an RO concentration factor of 6 to maximum CSD WWTP effluent concentrations from 2017 through 2021. Application of the RO concentration factor to or the maximum (i.e., worst-case) concentrations of constituents historically detected in CSD WWTP effluent are presented in **Table 2-1**. The RO concentration factor was applied to all constituents that have historically been detected in the CSD WWTP effluent. However, projected CAPP brine concentrations with the RO concentration factor applied might be overly conservative and not representative for non-conservative pollutants.

Table 2-1: Projected Maximum CAPP Brine Concentrations

Constituent	Units	Historical Maximum Effluent Concentration	Projected Maximum Concentration (1)
Objectives for Protection of Marine Aquatic Life			
Arsenic, Total Recoverable	µg/L	1.88	11.3
Cadmium, Total Recoverable	µg/L	0.073	0.438
Chromium (VI)	µg/L	0.386	2.32
Copper, Total Recoverable	µg/L	21.7	130
Lead, Total Recoverable	µg/L	0.642	3.85
Mercury, Total Recoverable	µg/L	0.0037	0.0222
Nickel, Total Recoverable	µg/L	7.2	43.2
Selenium, Total Recoverable	µg/L	4.75	28.5
Silver, Total Recoverable	µg/L	0.223	1.34
Zinc, Total Recoverable	µg/L	86.1	517
Ammonia, Total (as N)	µg/L	7750	46,500
Objectives for Protection of Human Health - Noncarcinogens			
Antimony, Total Recoverable	µg/L	1.92	11.5
Chromium (III)	µg/L	2.96	17.8
Objectives for Protection of Human Health - Carcinogens			
Aldrin	µg/L	0.00405	0.0243
Bis (2-Ethylhexyl) Phthalate	µg/L	0.92	5.52
Chlorodibromomethane	µg/L	67.3	404
Chloroform	µg/L	35.7	214
DDT	µg/L	0.00186	0.0112
Halomethanes, Sum	µg/L	180	1,082

Note: (1) Projected concentrations estimated might not be representative of concentrations for non-conservative pollutants.

2.1.2 Ocean Discharge Concentrations

The projected CAPP brine concentrations presented in **Table 2-1** are conservatively based on the discharge of 100% CAPP brine and does not consider scenarios where effluent brine concentrations could be reduced by blending with CSD WWTP secondary effluent prior to discharge. This 100% brine discharge scenario models the maximum influence of RO brine on the overall discharge (worst-case) and is representative of conditions when recycled water demands are the highest, typically during summer months.

3. OCEAN PLAN COMPLIANCE RESULTS

3.1 California Ocean Plan

The SWRCB's 2019 California Ocean Plan (Ocean Plan) sets forth water quality objectives for ocean discharges. These water quality objectives were established to preserve ocean water quality for beneficial uses to protect both human and marine health.

3.2 Ocean Modeling Results

The current CSD WWTP NPDES permit (adopted by the Regional Water Board September 21, 2017) applies a minimum initial dilution factor of 93:1 (seawater:effluent) to water quality based effluent limitations. Predicted minimum probable dilution (D_m) for multiple discharge scenarios were modeled by FlowScience, with results presented in a March 28, 2019 report (**Appendix B**). The most applicable modeled scenario assumes a modified diffuser configuration, as described previously in this memorandum, an effluent discharge flow rate of 0.3 MGD. All discharge scenarios were modeled for both cold and warm season discharges. With an effluent flow rate of 0.3 MGD during the cool and warm seasons provides minimum probably dilution factors of 220 and 200, respectively.

3.3 Ocean Plan Compliance Results

To assess projected CAPP brine discharge compliance with Ocean Plan objectives, a comparison of the projected maximum CAPP brine concentrations with a minimum probable dilution factor of 200, to effluent limitations calculated using Ocean Plan criteria is presented in **Table 3-1**. The projected in-pipe concentration for each constituent was calculated for the modeled discharge scenario using the projected maximum CAPP brined concentrations presented in **Table 2-1** and the conservative (i.e., warm season) minimum probable dilution factor of 200, as identified by FlowScience. For this scenario, the resulting concentrations for each constituent were compared to limitations based on the lowest Ocean Plan objectives to assess compliance.

Table 3-1: Projected Maximum CAPP Brine Concentrations

Constituent	Units	Projected Maximum Concentration	Projected Maximum Concentration After Mixing	Most Stringent WQO	Is Projected Max Conc After Mixing > Most Stringent WQO?
Objectives for Protection of Marine Aquatic Life					
Arsenic, Total Recoverable	µg/L	11.3	3.04	8	N
Cadmium, Total Recoverable	µg/L	0.438	0.00219	1	N
Chromium (VI)	µg/L	2.32	0.0116	2	N
Copper, Total Recoverable	µg/L	130	2.64	3	N
Lead, Total Recoverable	µg/L	3.85	0.0193	2	N
Mercury, Total Recoverable	µg/L	0.0222	0.000609	0.04	N
Nickel, Total Recoverable	µg/L	43.2	0.216	5	N
Selenium, Total Recoverable	µg/L	28.5	0.143	15	N
Silver, Total Recoverable	µg/L	1.34	0.166	0.7	N
Zinc, Total Recoverable	µg/L	517	10.5	20	N
Ammonia, Total (as N)	µg/L	46,500	233	600	N
Objectives for Protection of Human Health – Noncarcinogens					
Antimony, Total Recoverable	µg/L	11.5	0.0576	1,200	N
Chromium (III)	µg/L	17.8	0.0888	190,000	N
Objectives for Protection of Human Health – Carcinogens					
Aldrin	µg/L	0.0243	0.000122	0.000022	**Y**
Bis (2-Ethylhexyl) Phthalate	µg/L	5.52	0.0276	3.5	N
Chlorodibromomethane	µg/L	404	2.02	8.6	N
Chloroform	µg/L	214	1.07	130	N
DDT	µg/L	0.0112	0.0000558	0.00017	N
Halomethanes, Sum	µg/L	1082	5.41	130	N

4. ASSUMPTIONS

During each step of this evaluation, Woodard & Curran considered multiple scenarios and potential approaches. Throughout the process, conservative assumptions were selected. Below is a list of conservative assumptions used in the evaluation of CAPP brine compliance with Ocean Plan objectives.

- The most recent five years of CSD WWTP effluent were reviewed
- Only maximum detected CSD WWTP effluent concentrations were used
- The RO concertation factor was applied to all concentrations, including non-conservative pollutants to estimate CAPP brine concentrations
- A CAPP brine discharge flow of 0.3 MGD was used
- The assessment is based on the discharge of 100% CAPP brine without blending with secondary effluent
- Projected maximum CAPP brine concentrations were compared to effluent limitations based on Ocean Plan water quality objectives, regardless of a “reasonable potential” finding triggering the need for a limitation
- The warm season minimum dilution factor was used to determine Ocean Plan compliance
- Compliance was assessed using the most stringent Ocean Plan objectives

5. CONCLUSIONS

As noted in **Table 3-1**, projected CAPP brine concentrations for all constituents, after modeled initial mixing with seawater, are below the lowest Ocean Plan water quality objectives, with the exception of Aldrin. It should be noted that Aldrin was only reported above the method detection limit in one of six samples collected within the data period (2017-2021). Further, it should be noted that the single detected Aldrin result was qualified as detected but not quantifiable because the result was reported below the analytical practical quantitation limit. Given that there are no unqualified Aldrin results from the data period, Aldrin is a non-conservative pollutant, and the EPA banned all uses of the insecticide Aldrin in 1987, Woodard & Curran considers the single qualified Aldrin result as an outlier that should not be used to assess projected compliance with Ocean Plan objectives.

Based on the results of the conservative evaluation presented in this technical memorandum, CAPP brine can be discharged through a modified diffuser in compliance with Ocean Plan water quality objectives.

APPENDIX A: Historical Carpinteria Sanitary District Wastewater Treatment Plant Effluent Water Quality Data (2017-2021)

Constituent	Number of Results	% Detected	Units	Maximum Effluent Concentration
Objectives for Protection of Marine Aquatic Life				
Arsenic, Total Recoverable	6	83%	µg/L	1.88
Cadmium, Total Recoverable	6	67%	µg/L	0.073
Chromium (VI)	5	100%	µg/L	0.386
Copper, Total Recoverable	6	100%	µg/L	21.7
Lead, Total Recoverable	5	100%	µg/L	0.642
Mercury, Total Recoverable	6	17%	µg/L	0.0037
Nickel, Total Recoverable	6	83%	µg/L	7.2
Selenium, Total Recoverable	6	83%	µg/L	4.75
Silver, Total Recoverable	5	80%	µg/L	0.223
Zinc, Total Recoverable	6	100%	µg/L	86.1
Cyanide, Total (as CN)	6	0%	µg/L	All ND
Chlorine, Total Residual	1993	100%	µg/L	2540
Ammonia, Total (as N)	63	40%	µg/L	7750
Phenols, Non-chlorinated	5	0%	µg/L	All ND
Phenols, Chlorinated	5	0%	µg/L	All ND
Acute Toxicity	3	100%	TUa	0.4
Chronic Toxicity	21	100%	TUc	17.86
Endosulfans, Sum	5	0%	µg/L	All ND
Endrin	6	0%	µg/L	All ND
HCH	5	0%	µg/L	All ND
Radioactivity (pCi/L) - Alpha	6	100%	pCi/L	10.7
Radioactivity (pCi/L) - Beta	6	100%	pCi/L	33.1
Objectives for Protection of Human Health - Noncarcinogens				
Acrolein	5	0%	µg/L	All ND
Antimony, Total Recoverable	6	83%	µg/L	1.92
Bis (2-Chloroethoxy) Methane	5	0%	µg/L	All ND
Bis (2-Chloroisopropyl) Ether	5	0%	µg/L	All ND
Chlorobenzene	6	0%	µg/L	All ND
Chromium (III)	5	100%	µg/L	2.96
Di-n-butyl Phthalate	5	0%	µg/L	All ND
Dichlorobenzenes, Sum	6	0%	µg/L	All ND
Diethyl Phthalate	5	0%	µg/L	All ND
Dimethyl Phthalate	5	0%	µg/L	All ND
4,6-Dinitro-2-methylphenol	5	0%	µg/L	All ND
2,4-Dinitrophenol	5	0%	µg/L	All ND
Ethylbenzene	6	0%	µg/L	All ND
Fluoranthene	5	0%	µg/L	All ND
Hexachlorocyclopentadiene	6	0%	µg/L	All ND
Nitrobenzene	5	0%	µg/L	All ND
Thallium, Total Recoverable	6	0%	µg/L	All ND
Toluene	5	0%	µg/L	All ND
Tributyltin (TBT)	5	0%	µg/L	All ND
1,1,1-Trichloroethane	6	0%	µg/L	All ND
Objectives for Protection of Human Health - Carcinogens				

Constituent	Number of Results	% Detected	Units	Maximum Effluent Concentration
Acrylonitrile	5	0%	µg/L	All ND
Aldrin	6	17%	µg/L	0.00405
Benzene	6	0%	µg/L	All ND
Benzidine	5	0%	µg/L	All ND
Beryllium, Total Recoverable	6	0%	µg/L	All ND
Bis (2-Chloroethyl) Ether	5	0%	µg/L	All ND
Bis (2-Ethylhexyl) Phthalate	5	40%	µg/L	0.92
Carbon Tetrachloride	6	0%	µg/L	All ND
Chlordane	6	0%	µg/L	All ND
Chlorodibromomethane	6	83%	µg/L	67.3
Chloroform	6	100%	µg/L	35.7
DDT	5	20%	µg/L	0.00186
1,4-Dichlorobenzene	6	0%	µg/L	All ND
3,3-Dichlorobenzidine	5	0%	µg/L	All ND
1,2-Dichloroethane	6	0%	µg/L	All ND
1,1-Dichloroethylene	6	0%	µg/L	All ND
Dichlorobromomethane	0	No Data Available		
Dichloromethane	6	0%	µg/L	All ND
1,3-Dichloropropylenes, Sum	6	0%	µg/L	All ND
Dieldrin	6	0%	µg/L	All ND
2,4-Dinitrotoluene	5	0%	µg/L	All ND
1,2-Diphenylhydrazine	5	0%	µg/L	All ND
Halomethanes, Sum	5	100%	µg/L	180.4
Heptachlor	6	0%	µg/L	All ND
Heptachlor Epoxide	6	0%	µg/L	All ND
Hexachlorobenzene	6	0%	µg/L	All ND
Hexachlorobutadiene	6	0%	µg/L	All ND
Hexachloroethane	5	0%	µg/L	All ND
Isophorone	5	0%	µg/L	All ND
N-Nitrosodimethylamine	5	0%	µg/L	All ND
N-Nitrosodi-n-Propylamine	5	0%	µg/L	All ND
N-Nitrosodiphenylamine	5	0%	µg/L	All ND
Polynuclear Aromatic Hydrocarbons (PAHs)	5	0%	µg/L	All ND
Polychlorinated Biphenyls (PCBs), Sum	6	0%	µg/L	All ND
TCDD Equivalents	6	0%	µg/L	All ND
1,1,2,2-Tetrachloroethane	6	0%	µg/L	All ND
Tetrachloroethene	6	0%	µg/L	All ND
Toxaphene	6	0%	µg/L	All ND
Trichloroethene	6	0%	µg/L	All ND
1,1,2-Trichloroethane	6	0%	µg/L	All ND
2,4,6-Trichlorophenol	5	0%	µg/L	All ND
Vinyl Chloride	6	0%	µg/L	All ND

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DRAFT TECHNICAL MEMORANDUM

DATE: March 28, 2019

TO: Rosalyn Prickett
Woodard & Curran

FROM: Gang Zhao, Ph.D., P.E.
Kristen Bowman Kavanagh, P.E.
E. John List, Ph.D., P.E.

SUBJECT: Near-field dilution analysis of the Carpinteria Valley Water District IPR Project
FSI 174080

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1. INTRODUCTION

As part of the Carpinteria Valley Water District's Indirect Potable Reuse (IPR) project, Flow Science Incorporated (Flow Science) was retained by Woodard & Curran to analyze the near-field dilution of the IPR project brine effluent that is proposed to be discharged to the Pacific Ocean. The IPR project includes plans to build an advanced water purification facility (AWPF), which will provide advanced treatment for the effluent from the Carpinteria Sanitary District (CSD) wastewater treatment plant (WWTP). The highly treated effluent would then be injected into the Carpinteria Valley Groundwater Basin for reuse. The AWPF will produce a maximum of approximately 0.3 mgd of brine effluent, which will be discharged through the CSD ocean outfall. In addition, preliminary design work has been started to modify the diffuser of the CSD ocean outfall. Dilution of the effluent discharged from both the current and the proposed new outfall diffuser needs to be analyzed to evaluate the performance of the proposed diffuser modification.

This technical memorandum summarizes the analyses Flow Science completed for the near-field dilution of the selected discharge scenarios of the IPR project and describes the input data and methods Flow Science used to analyze the selected scenarios.

2. ANALYSIS INPUT DATA

2.1 DIFFUSER CONFIGURATION

The existing CSD ocean outfall has a diffuser located approximately 800 ft offshore in the Santa Barbara Channel (see Figure 1). The diffuser has 17 discharge ports. Eight 4-inch ports discharge effluent from one side of the diffuser and eight 4-inch ports discharge from the opposite side of the diffuser in an alternating pattern. In addition, there is one 8-inch port in the end flange of the diffuser. The ports are spaced 6 ft apart and are located approximately 22 feet below mean sea level. Figure 2 shows a typical section of the current diffuser.

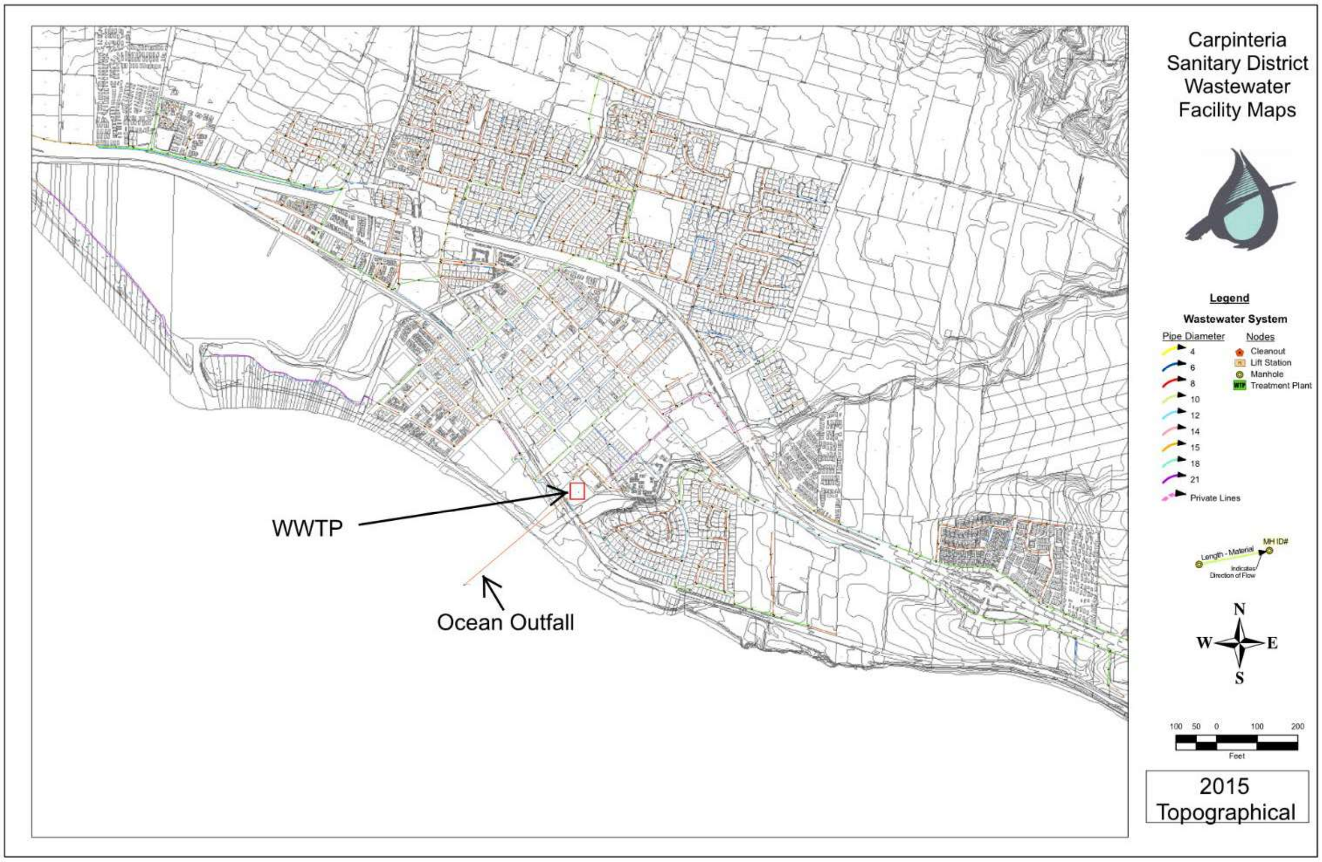

Figure 1. Location of CSD ocean outfall

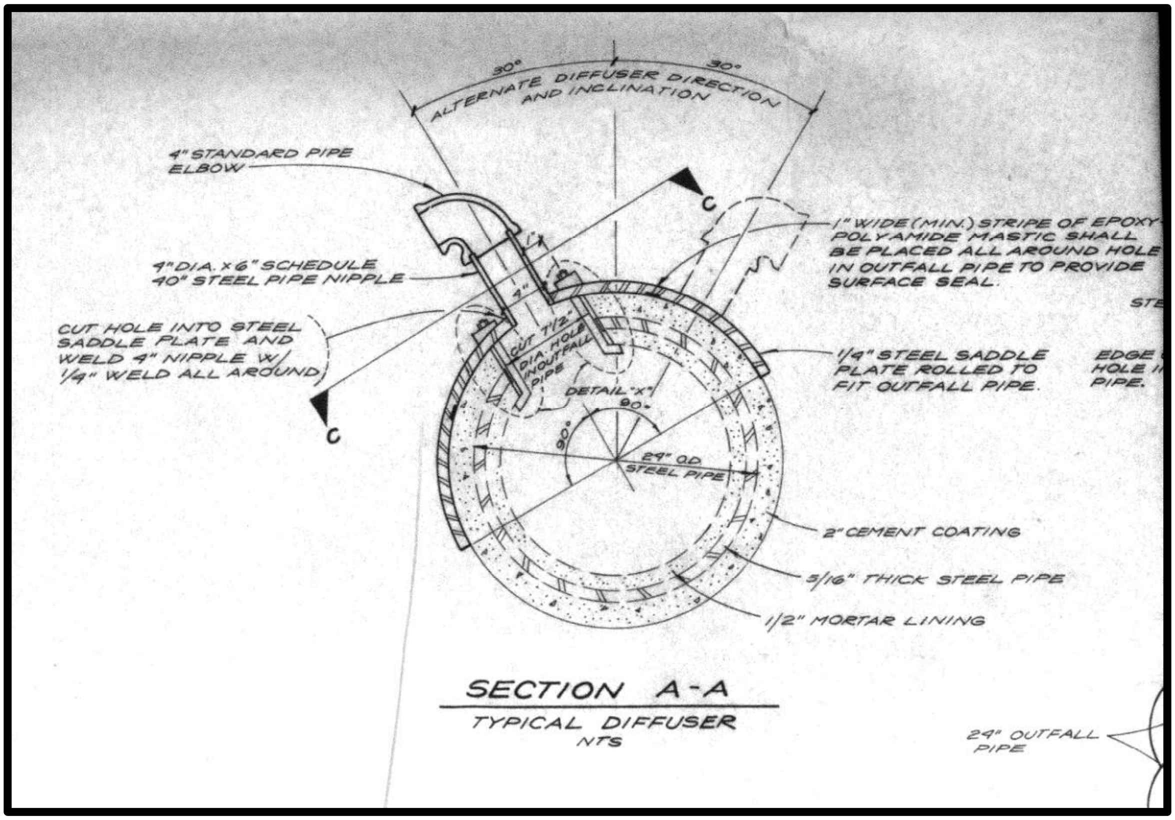

Figure 2. Typical diffuser section (currently in place)

Preliminary design work is underway to modify the current diffuser. The modified diffuser will have 17 ports fitted with Tideflex "duckbill" check valves, and effluent will be discharged horizontally (*i.e.*, with a 0º port vertical angle). The preliminary design calls for 16 ports to be fitted with 4-inch duckbill check valves, while the end port will be fitted with a single 8-inch duckbill check valve. The opening area of the "duckbill" check valves depends on the discharge flow rate. For the discharge flow rates modeled in this analysis, the opening area of the valve was determined by Woodard & Curran from data provided by the valve manufacturer, and an effective port diameter was derived to provide the same opening area. Key parameters of the current diffuser and the proposed new diffuser are summarized in Table 1. Due to model limitations, the end port of the new diffuser was represented as a 4-inch diffuser check valve, rather than an 8-inch diffuser check valve. The end port of the existing diffuser was not included in the model, consistent with previous modeling efforts.

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Table 1. Current versus modified diffuser configuration for the model input

Parameter	Current Diffuser	New Diffuser
Depth of diffuser ports	22 feet below MSL	22 feet below MSL
Number of open ports	16	17
Port spacing	6 feet	6 feet
Port diameter	4 inches	Depends on flow rate
Port vertical angle	-30°	0

2.2 DISCHARGE CHARACTERISTICS

A range of discharge scenarios with various discharge flow rates, effluent salinity, and discharge seasons were selected for this analysis. The selected discharge scenarios are summarized in Table 2. Effluent temperature was determined based on data of effluent temperature for 2013-2018. For the cool season, the effluent temperature is the average of the first quarter effluent temperature; for the warm season, the average temperature for the months July to October, the four months with the highest average effluent temperature, is selected as the effluent temperature. The first two scenarios in Table 2 are for the current diffuser configuration, and the remainders are for the modified diffuser. All scenarios in Table 2 were analyzed for a stagnant (no current) receiving water condition, consistent with the California Ocean Plan (2015). Temperature and salinity data were used to calculate densities of the effluent and ambient water, which are important parameters in dilution analyses.

Three flow rates were modeled, as follows:

- **2.5 MGD** represents the average dry weather flow capacity of the WWTP as listed in CSD’s NPDES Permit (Central Coast Regional Water Quality Control Board, NPDES NO. CA0047364). It is also larger than the maximum month wet weather flow rate of 1.8 MGD discharged to the Pacific Ocean, based on effluent flow data for 2009–2018.

- **1.5 MGD** represents the preliminary design dry weather flow capacity of the advanced treatment facility. Under normal operating conditions, advanced-treated water will be injected into the groundwater basin. However, there may be periods when the injection wells are off-line and all effluent is discharged to the Pacific Ocean. This represents such a scenario.

- **0.3 MGD** represents the design dry weather flow capacity of the advanced treatment facility. In this scenario, all WWTP effluent is receiving advanced treatment, and the outfall receives 100% RO concentrate. This scenario represents the worst-case condition for effluent water quality.

Table 2. Discharge scenarios analyzed

Scenario	Description of Discharge	Season	Effluent Flow (mgd)	Effluent Salinity (ppt)	Effluent Temp. (°F)	Port Diameter (in)	Port Angle
Current Diffuser Configuration							
1	ADWF Capacity	Warm	2.5	1.5	78	4	-30°
2	ADWF Capacity	Cool	2.5	1.5	69	4	-30°
Modified Diffuser Configuration							
3	ADWF Capacity	Warm	2.5	1.5	78	2.9	0°
4	ADWF Capacity	Cool	2.5	1.5	69	2.9	0°
5	Project Design Dry Weather Flow	Warm	1.5	1.5	78	2.6	0°
6	Project Design Dry Weather Flow	Cool	1.5	1.5	69	2.6	0°
7	RO Concentrate Dry Weather Flow	Warm	0.3	9	78	1.7	0°
8	RO Concentrate Dry Weather Flow	Cool	0.3	9	69	1.7	0°

2.3 RECEIVING WATER PROFILES

Salinity and temperature data over the entire depth of the receiving water column for all typical seasonal conditions are needed in computing the effluent dilution. Receiving water profile data are not available at the CSD outfall diffuser. However, ocean profile data have been collected quarterly at the Goleta Sanitary District (GSD) ocean outfall, which is approximately 16 miles to the west of the CSD outfall. These ocean profile data are summarized in quarterly receiving water monitoring reports (Goleta Sanitary District, 2013-2017). The GSD's nearshore stations, K1 and K5, are located in relatively shallow water, and these two stations are farther away from the GSD outfall than other nearshore stations. Data from stations K1 and K5 are less affected by the GSD outfall effluent than data collected at other nearshore stations. Thus data collected at stations K1 and K5 were used to represent the receiving water conditions at the CSD outfall.

The GSD ocean profile data from the first quarter of 2013 through the second quarter of 2017 were examined to determine typical ocean conditions. Data for the first quarter of 2016 and after the second quarter of 2017 are not available. The ocean temperature data were grouped by quarter and are presented in Figures 3 through 6, and the quarterly ocean salinity data are presented in Figures 7 through 10. Note that the water depth at the CSD outfall is about 25 ft (8 meters). Therefore only the top 25 ft of ocean profile data were used in the dilution analysis.

The ocean temperature profiles in Figures 3 through 6 show that water temperature is nearly uniform over the top 25 ft (8 m) for the first quarter (cool season), while thermal stratification exists in various degrees for the other quarters. Note that most of the data for the fourth quarter were collected in the month of October, and the ocean water had not cooled down. Therefore the fourth quarter data do not represent cool seasonal conditions. For the first and second quarters, the observed ocean temperature was in the range of 12 ºC to 16.5 ºC; for the third and fourth quarters, the ocean temperature was in the range of 16 ºC to 22.5 ºC. The ocean salinity profiles presented in Figures 7 through 10 show that salinity is generally uniform over the top 25 ft (8 m) of water. The observed ocean salinity was in the range of 33 ppt to 33.7 ppt, and most salinity profiles centered around 33.5 ppt. Variations in salinity are small and without discernible seasonal patterns.

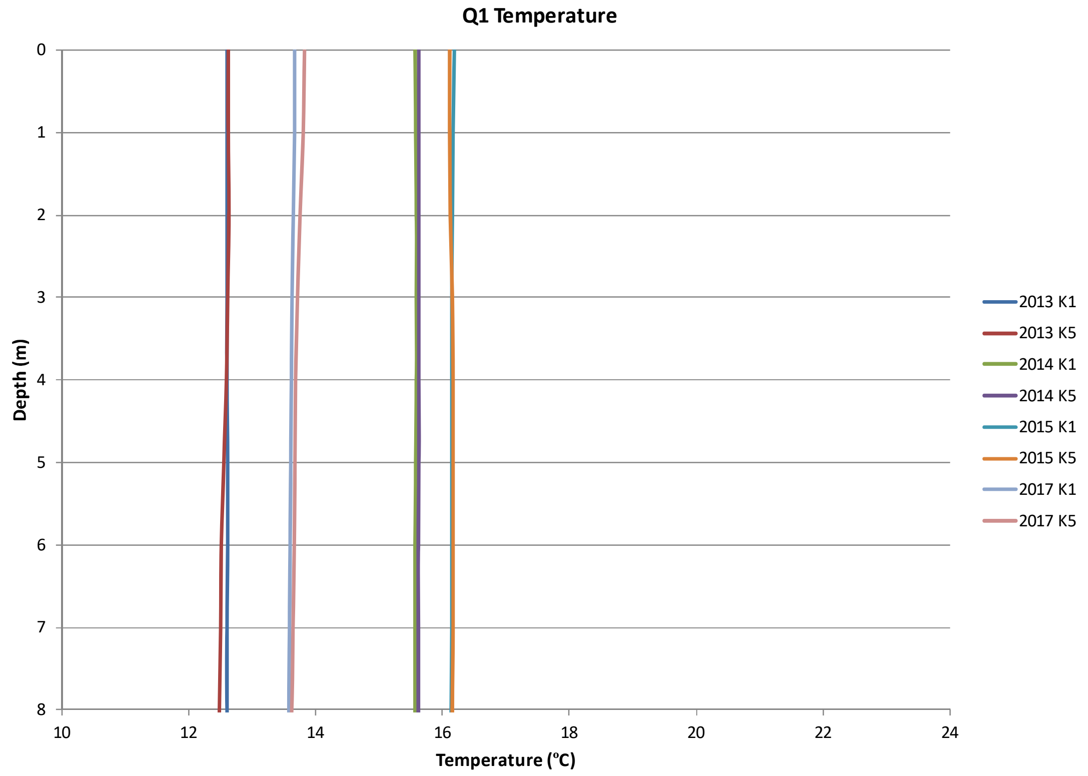

Figure 3. Ocean temperature data for the first quarter

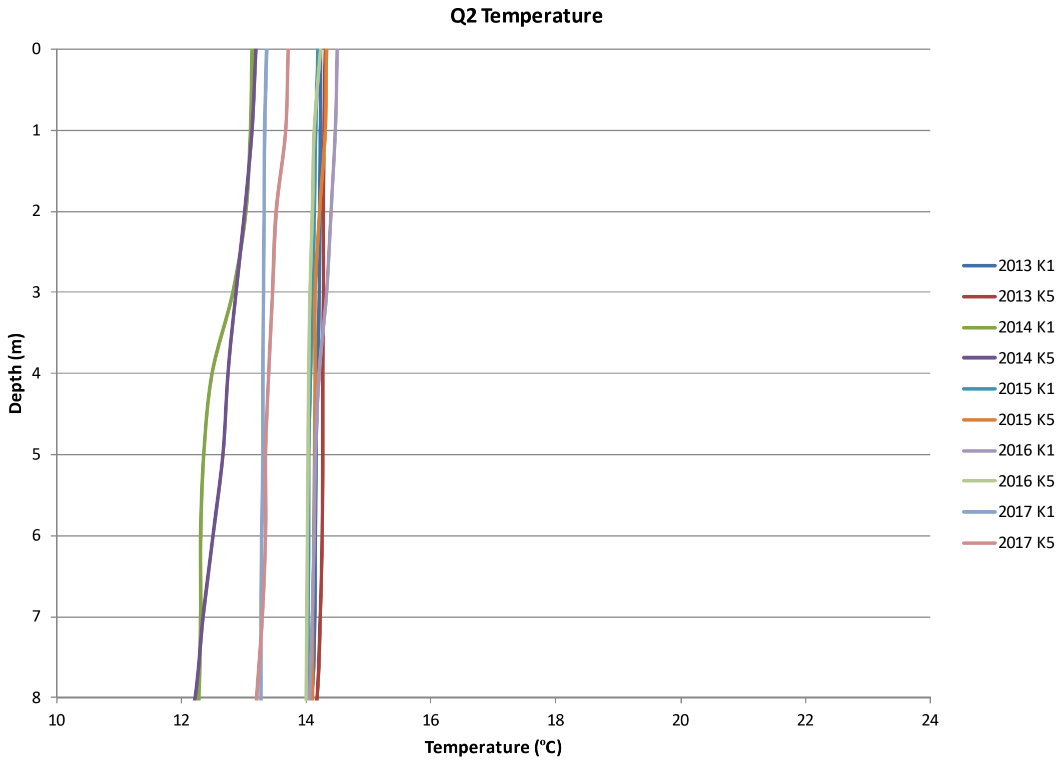

Figure 4. Ocean temperature data for the second quarter

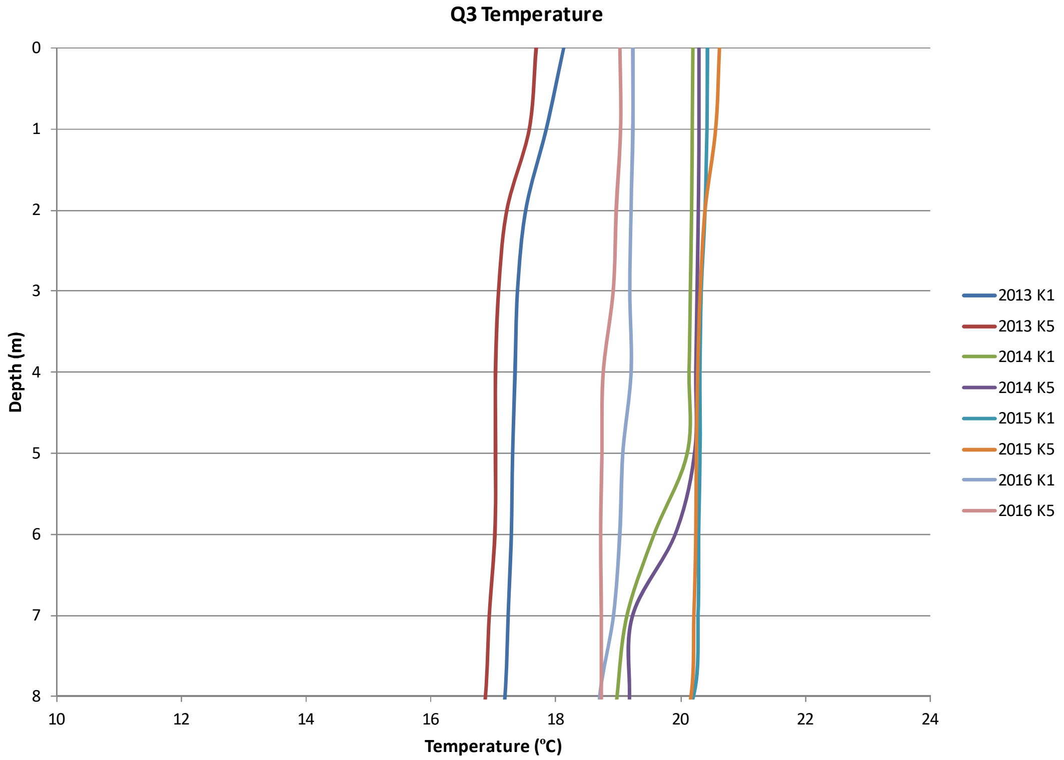

Figure 5. Ocean temperature data for the third quarter

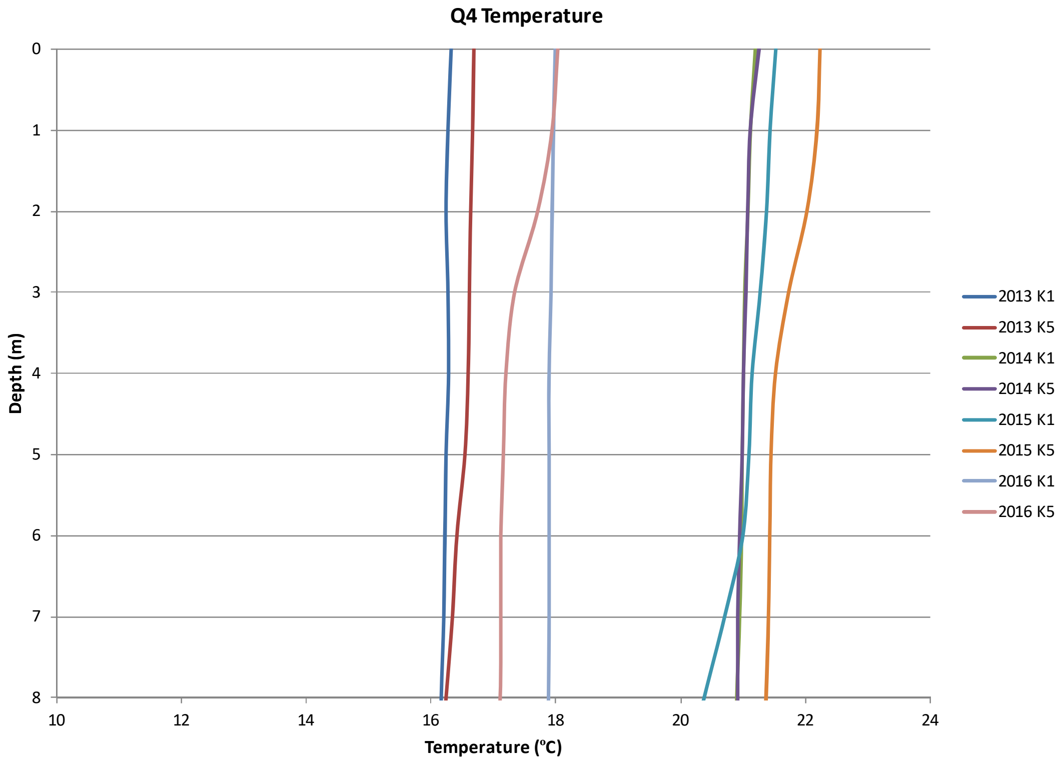

Figure 6. Ocean temperature data for the fourth quarter

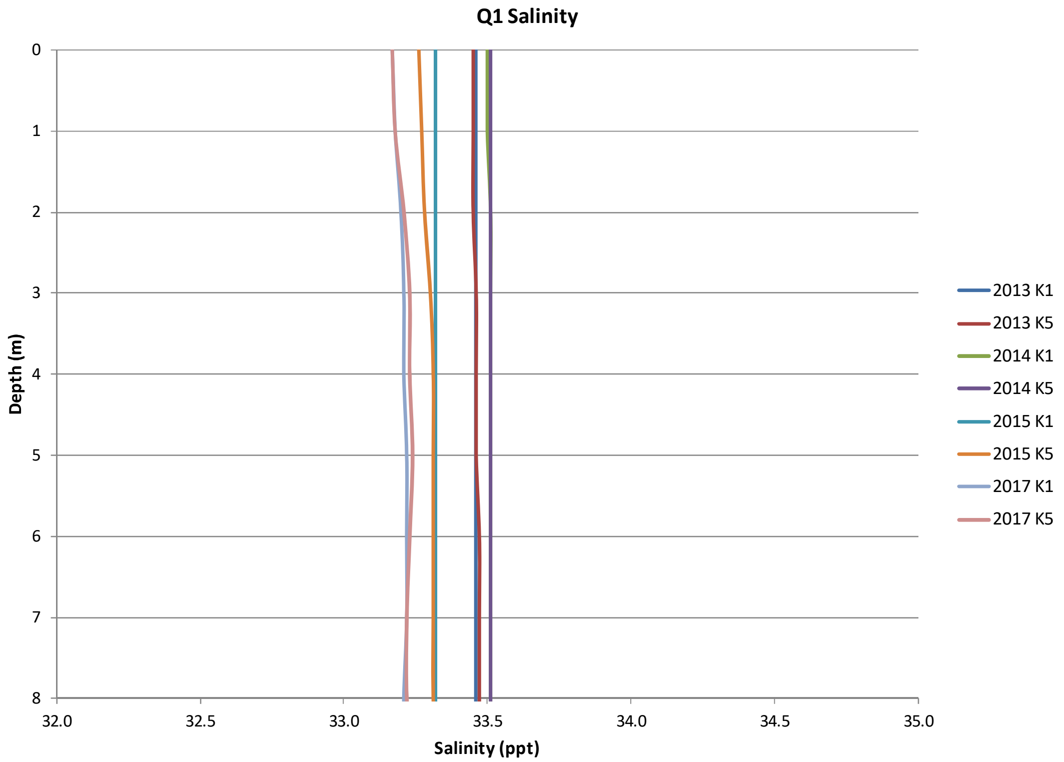

Figure 7. Ocean salinity data for the first quarter

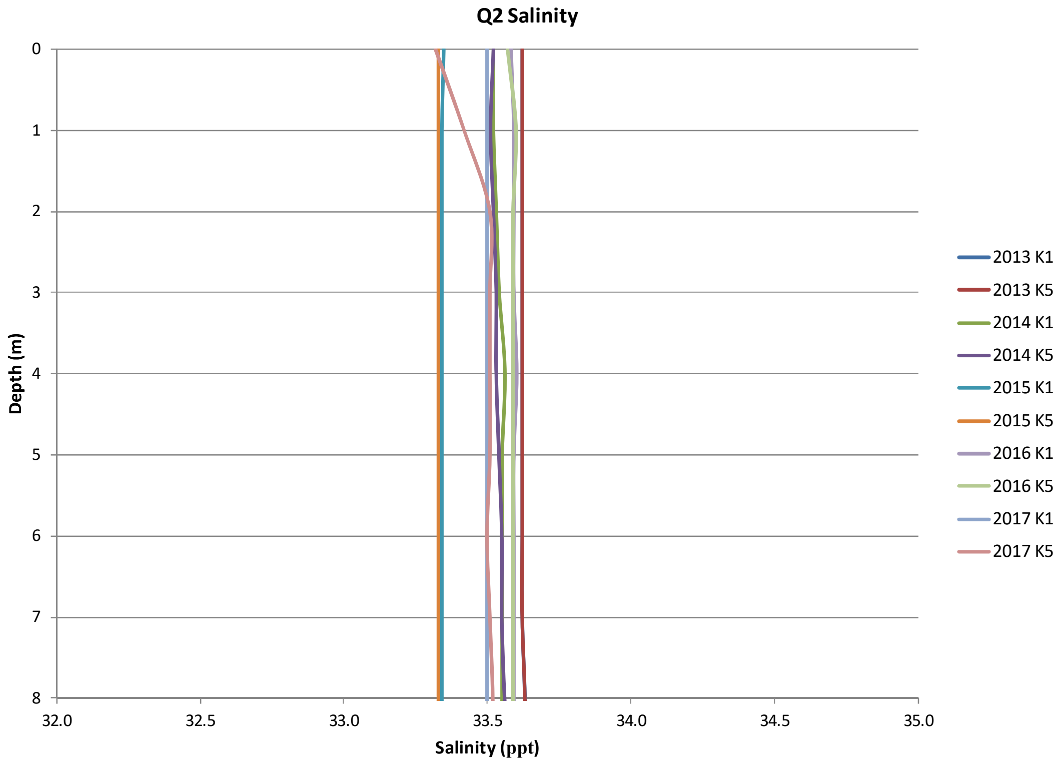

Figure 8. Ocean salinity data for the second quarter

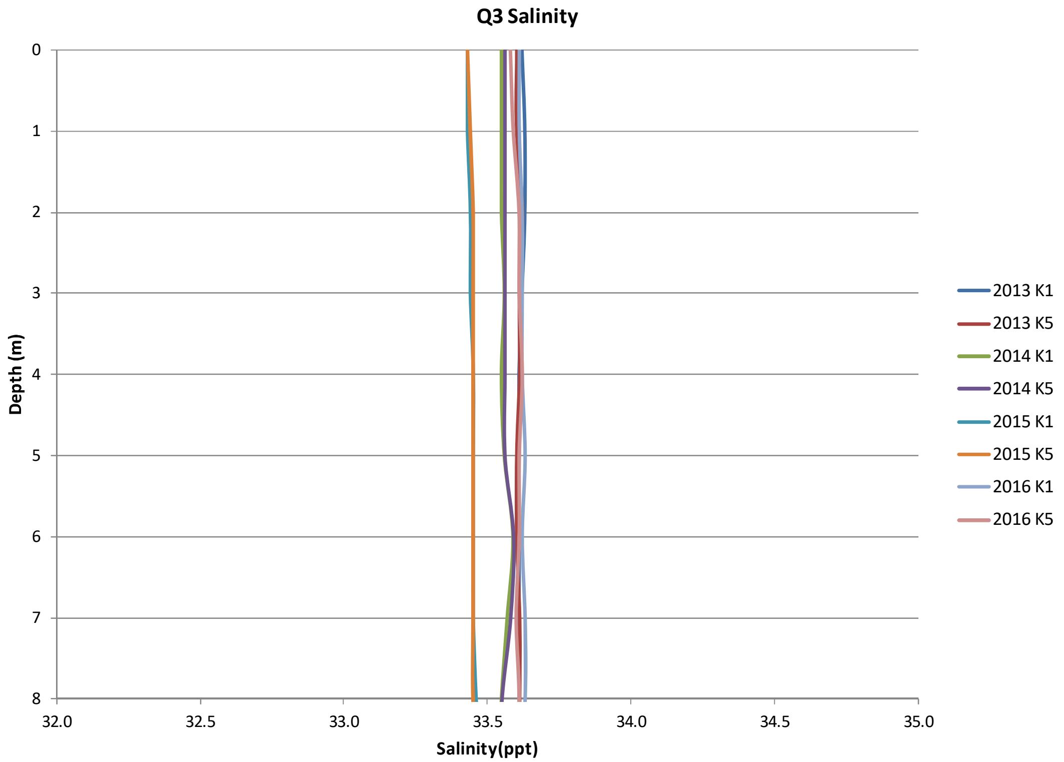

Figure 9. Ocean salinity data for the third quarter

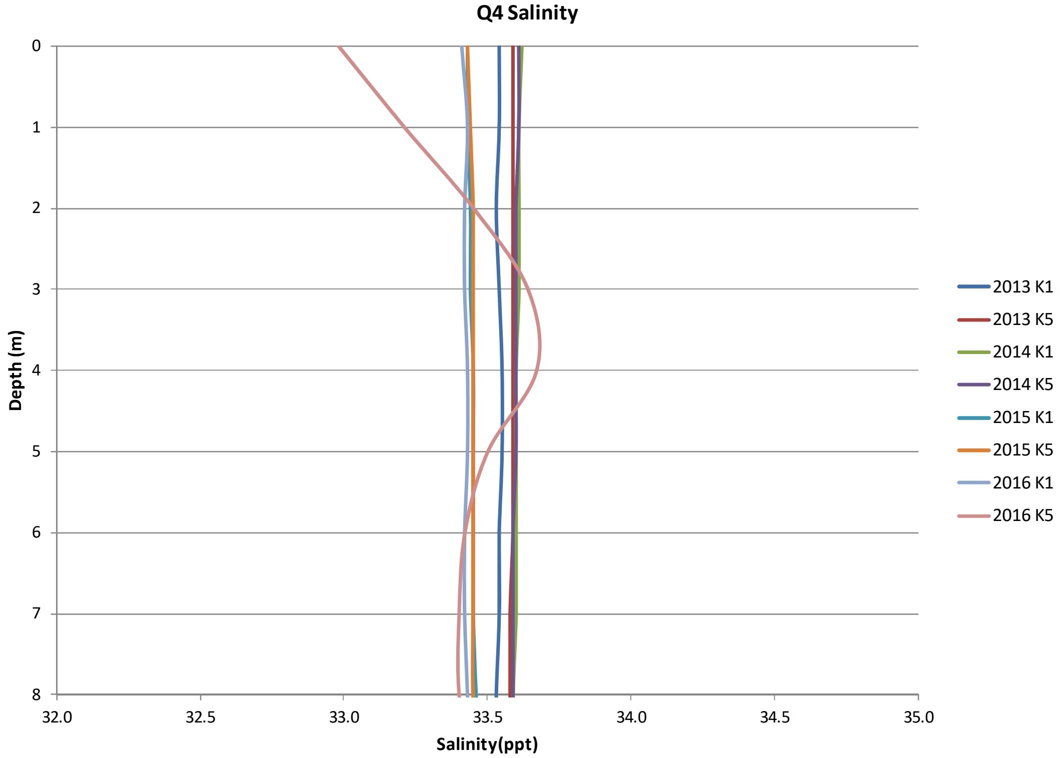

Figure 10. Ocean salinity data for the fourth quarter

For the cool season (first quarter), the data indicate that density stratification is negligible, and the difference in density is small among data collected from different years. Test model runs show that the profile at Station K5 collected in the first quarter of 2013 led to the lowest cool season effluent dilution. For the warm season, the profile at Station K5 collected in the fourth quarter of 2015 shows strong density stratification, which leads to the lowest warm season effluent dilution. These two profiles were selected to represent the cool and warm seasons in this analysis. The top 25 ft (8 meters) of the selected profiles are displayed in Table 3 and shown in Figure 11.

Table 3. Ocean temperature and salinity profiles used for dilution analysis

Depth (m)	Cool Season Station K5, Q1 2013		Warm Season Station K5, Q4 2015	
	Temp. (°C)	Salinity (ppt)	Temp. (°C)	Salinity (ppt)
0	12.63	33.45	22.23	33.43
1	12.63	33.45	22.18	33.44
2	12.64	33.45	22.02	33.45

Depth (m)	Cool Season Station K5, Q1 2013		Warm Season Station K5, Q4 2015	
	Temp. (°C)	Salinity (ppt)	Temp. (°C)	Salinity (ppt)
3	12.62	33.46	21.73	33.45
4	12.6	33.46	21.52	33.45
5	12.56	33.46	21.45	33.45
6	12.52	33.47	21.43	33.45
7	12.51	33.47	21.41	33.45
8	12.49	33.47	21.37	33.45

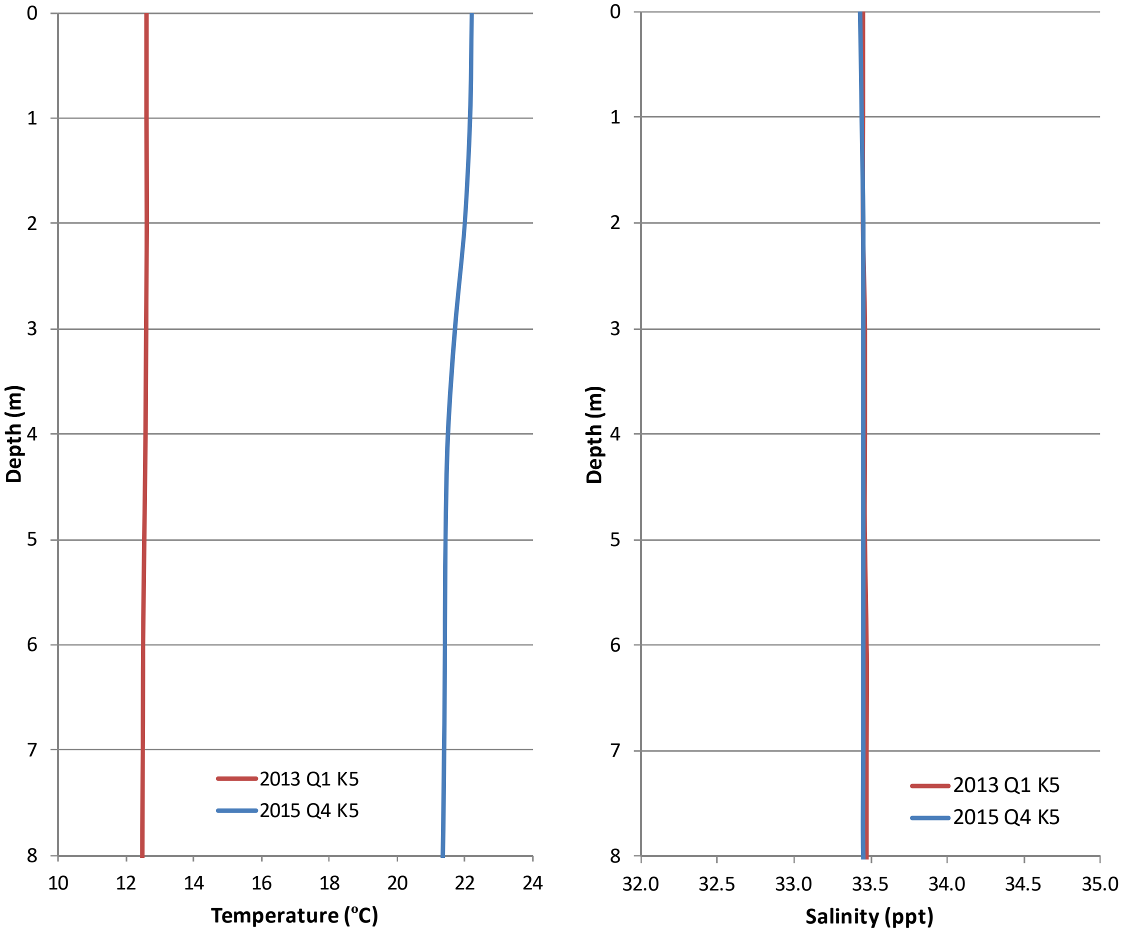

Figure 11. Selected ocean temperature and salinity profiles

Dilution analyses for ocean outfalls are typically used to characterize "worst case," stagnant (no current) receiving water conditions, and stagnant conditions are typically used as the basis for developing NPDES permit conditions. For these reasons, Flow Science has conducted the dilution analyses presented in this report for a zero-current, stagnant receiving water condition and regards this as a "worst case" condition.

3. DILUTION ANALYSIS METHOD

The analysis performed by Flow Science is a near-field dilution analysis, in which the dilution of the discharged effluent is computed within the "Zone of Initial Dilution" or ZID. The ZID is defined as the zone immediately adjacent to a discharge where momentum and buoyancy-driven mixing produces rapid dilution of the discharge. In this analysis, the ZID ends at the point where the effluent plume reaches the water surface.

Visual Plumes is a mixing zone computer model to simulate effluent discharged into a receiving water body that was developed from a joint effort led by the United States Environmental Protection Agency (U.S. EPA). Visual Plumes can simulate both single and merging submerged plumes, and stratified ambient flow can be specified by the user. The UM3 model — part of the EPA Visual Plumes diffuser modeling package — was used to simulate the effluent plume in this analysis. Note that the Visual Plumes model is not capable of simulating diffuser ports discharging effluent in alternating directions, which is how the CSD diffuser discharges effluent. In this analysis, it is assumed that all ports of the CSD diffuser discharge effluent in the same direction. This is a conservative assumption because it reduces the spacing between ports, leading to early merging of the plumes from individual ports and a lower computed dilution of the effluent.

4. DILUTION ANALYSIS RESULTS

The dilution analysis results presented in this report represent the point where the plumes just reached the sea surface. Horizontal spreading of the plumes at the sea surface was not included in this analysis. Results for the selected scenarios are presented in Table 4. The values of dilution in Table 4 are the ratio of the total volume of water within the plume to the volume of the effluent discharged through the diffuser. For example, a dilution value of 10 means the plume contains 9 parts of ocean water and 1 part of the effluent. When the effluent is discharged from the diffuser ports, it has an initial momentum which has a component in the horizontal direction. This initial momentum moves the plume away from the diffuser ports in the horizontal direction as the plume rises in the water column. When the plume reaches the sea surface, the centerline of the plume will be at some horizontal distance away from the diffuser ports. This horizontal distance of the plume centerline from the diffuser ports is also presented in Table 4.

The results in Table 4 indicate that dilution during the warm season is slightly lower than for the cool season. Comparison of the results at a 2.5 mgd effluent discharge flow rate for the current diffuser configuration (Scenarios 1 and 2) versus the new modified diffuser (Scenarios 3 and 4) indicate that the modified diffuser configuration could increase dilution by approximately 10%. For the modified diffuser, when the effluent discharge rate was reduced from 2.5 mgd to 1.5 mgd, the average dilution increased from 74 and 75 to 93 and 97 for the warm and cool seasons, respectively. When the effluent was changed to 0.3 mgd of the RO brine, the average dilution increased to 200 and 220 for the warm and cool seasons, respectively.

Both the average dilution of the effluent and the dilution at the plume centerline are presented in Table 4. For a discharge with an approved ZID, the effluent plume is required to meet water quality standards at the boundary of the ZID, and water quality standards can be exceeded within the ZID. The centerline of a plume is usually within the ZID. Therefore, the average dilution of the effluent is more appropriate for representing the effluent dilution of a discharge with a ZID.

Table 4. Dilution analysis results for selected scenarios

Scenario	Effluent discharge flow rate (mgd)	Season	Effluent salinity (ppt)	Effluent temp. (°F)	Average Dilution	Centerline Dilution	Horizontal distance from port (ft)
Current Diffuser Configuration							
1	2.5	Warm	1.5	78	67	36	8
2	2.5	Cool	1.5	69	68	36	8
Modified Diffuser Configuration							
3	2.5	Warm	1.5	78	74	41	12
4	2.5	Cool	1.5	69	75	41	11
5	1.5	Warm	1.5	78	93	50	9
6	1.5	Cool	1.5	69	97	51	9
7	0.3	Warm	9	78	200	111	4
8	0.3	Cool	9	69	220	114	4

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