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City of Oxnard

Public Works Integrated Master Plan

RECYCLED WATER

PROJECT MEMORANDUM 4.3
AWPF/OWTP OUTFALL REGULATORY CONSIDERATIONS

FINAL DRAFT
December 2015

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City of Oxnard

Public Works Integrated Master Plan

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1.0 PURPOSE OF REPORT

Patricia McGovern Engineers was contracted to analyze potential permit compliance at the City's Oxnard Wastewater Treatment Plant (OWTP) outfall as the Advanced Water Purification Facility (AWPF) is expanded and reverse osmosis concentrate is added back to the OWTP secondary effluent. Both water quality-based effluent limits and technology-based effluent limits were assessed and pollutants that have a potential to cause non-compliance as the AWPF is expanded were identified.

1.1 Project Memoranda (PMs) Used for Reference

The recommendations outlined in this PM are made in concert with recommendations and analyses from other related PMs:

- PM 2.1 – Water System – Background Summary.
- PM 3.1 – Wastewater System – Background Summary.
- PM 4.1 – Recycled Water System – Background Summary.
- PM 3.2 – Wastewater System – Flow and Load Projections.
- PM 3.7.1 – Wastewater System – Treatment Alternatives.

2.0 SUMMARY OF ANALYSES

2.1 Regulatory Considerations

This analysis defines the compliance issues and examines regulatory considerations and options for compliance. A Reasonable Potential Analysis (RPA) is conducted to determine potential pollutants of concern under the four major phases of AWPF expansion. The summary memo found in Appendix A provides further details of this analysis.

2.2 Compliance Strategies

This analysis further explores institutional / permitting and engineering / technical strategies for mitigating the potential impacts to compliance as a result of AWPF expansion. The summary memo found in Appendix B provides further details of this analysis.

3.0 FINDINGS

3.1 Results

The outfall analysis concluded that while there is no reasonable potential for compliance issues with Phase I of the AWPF, there is the potential for compliance issues if the AWPF is expanded to Phase II or Phase III. With the Phase II expansion, it is possible that effluent limits for ammonia (6-month median and daily maximum), chronic toxicity (daily maximum), BOD, and TSS will be exceeded. With the Phase III expansion it is possible that effluent limits for copper (6-month median), bis (2-ethylhexyl) phthalate (30-day average), and oil and grease will also be exceeded. Details regarding percent estimated non-compliance, allowable AWPF flows for each constituent, and the methods used for this analysis can be found in Appendix A.

Several alternative compliance strategies are explored further:

- Change point of compliance for BOD / TSS prior to the blended (secondary + RO concentrate) effluent.
- Modify the dilution ratio to greater than 98:1, which is current.
- Use mass-based limits versus concentration-based limits.
- Provide additional sources of dilution.
- Chemically enhance the OWTP primary treatment to achieve higher solids and metals removal.
- Consider adding nitrification to the secondary process.

3.2 Assumptions

As part of this analysis, it was assumed that 100 percent of the pollutants end up in the RO concentrate. While this may not always be the case, it was a conservative approach. This analysis also assumed that the recycled water flows are equalized. This is a reasonable assumption because equalizing flows is much cheaper than building AWPF capacity for peak flows that sits idle for the majority of the time.

3.3 Outfall Water Quality Sequencing Analysis

A draft of this analysis is included with this project memo submission (Appendix C). This report is currently under development and will be completed Phase 2 of this PWIMP effort. A draft is included to provide an understanding of the *OPTIMO®* model used and to describe the analyses currently underway.

3.4 Next Steps

Given the strategies listed above, the following is the prioritized list of strategies recommended for the City to pursue:

- No action.
- Change compliance point for BOD/TSS.
- Consider MBR for the OWTP.

Table 1 illustrates the maximum AWPF flows that would result in compliance given the above strategies. With all options, the City of Oxnard will need to work closely with Regional Board staff. A more detailed discussion of the options to address the findings of this outfall analysis can be found in Appendix A, and B, as noted.

Table 1 Potential Compliance Strategies for the AWPF / OWTP and Resulting Potential AWPF Maximum Capacities
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Regulatory Compliance Strategy	Maximum AWPF Capacity(1)
No Action	7.6 mgd
Change in compliance point for BOD/TSS	10.5 mgd
MBR	Full(2)

Notes:
(1) Capacity limited by ammonia toxicity of the blended effluent.
(2) Due to nitrification of the secondary effluent, ammonia toxicity is no longer the limiting constituent and the AWPF capacity would then only be limited by the secondary effluent quantity available.

APPENDIX A - REGULATORY CONSIDERATIONS ANALYSIS MEMO

CITY OF OXNARD

EXPANDING THE ADVANCED WATER PURIFICATION FACILITY

- REGULATORY CONSIDERATIONS -

Draft

June 10, 2015

Patricia McGovern Engineers

City of Oxnard
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EXECUTIVE SUMMARY

The Oxnard Advanced Water Purification Facility (AWPF) was built to treat secondary treated effluent from the Oxnard Wastewater Treatment Plant for purposes of reuse and groundwater recharge. The AWPF will treat secondary effluent through a microfiltration (MF), reverse osmosis (RO), and advanced oxidation process (AOP) treatment train, and is planned to be operational in three phases:

Phase I – 6.25 MGD,
Phase II – 12.5 MGD, and
Phase III – 18.75 MGD.

In order to identify parameters that may have discharge permit compliance issues as the AWPF is expanded, this memorandum addresses the following issues:

1) The concentration factor - 'worst-case' - The concentration factor is the value that the historical data can be multiplied by to estimate future effluent concentrations when the AWPF is expanded in Phase I, II and III.

2) Identification of toxic pollutants that exceed water quality objectives through a Reasonable Potential Analysis (RPA).

3) Estimated compliance with potential receiving water-quality based effluent limits for toxic pollutants that trigger 'Reasonable Potential', and estimated compliance with technology-based effluent limit for conventional pollutants (e.g. Biochemical Oxygen Demand and Total Suspended Solids).

4) Identification of the estimated maximum AWPF flow for each parameter that will not cause a compliance issue.

5) Finally, regulatory strategies to be in compliance with potential permit limits are explored, along with recommendations for future sampling and regulatory efforts.

In summary, the worst-case concentration factor is 6.67. This concentration factor occurs when flows through the treatment plant are insufficient to supply the AWPF demand; the entire flow is diverted to the AWPF and the entire effluent is 100 percent reverse osmosis concentrate. This is assumed to occur primarily in Phase III and in certain instances in Phase II. At these times, the effluent concentration of pollutants in the effluent when the AWPF is operating at Phase III will be 6.67 times greater than what their concentration would have been if the AWPF were not operating.

A reasonable potential analysis was conducted on Ocean Plan Table 1 pollutants. A reasonable potential analysis identifies pollutants that have a potential to exceed water quality objectives. A reasonable potential analysis is conducted every permit renewal cycle. If a pollutant does trigger reasonable potential, then an effluent limit is calculated and included in the permit. The two key factors in calculating reasonable potential are the historical effluent concentration data and dilution factor.

The reasonable potential analysis was conducted using historical effluent data from January 2010 through December 2014, concentrated with the concentration factors calculated for this analysis. In summary, the reasonable Potential Analysis found that none of the parameters would require a permit limit during Phase I of the AWPF. During Phase II and Phase III, several parameters are expected to trigger reasonable potential. Anticipated permit limits were calculated, and the estimated percent time of non-compliance based on historical data is presented in Table ES1.

Table ES1. Anticipated Non-compliance with Water Quality Based Effluent Limits

Pollutant – Averaging Period	Calculated Permit Limit	% Estimated Non-compliance
Phase II		
Ammonia - 6-month median	59.4 mg/L	75%
Ammonia – Daily maximum	237.6 mg/L	0.4%
Chronic Toxicity – Daily maximum *Using the current statistical method - NOEC*	99 TUc	0%
Chronic Toxicity – Daily maximum *Using the proposed statistical method - TST*	Pass or <50% effect	1.7%
Phase III		
Copper – 6-month median	101 ug/L	84%
Bis (2-ethylhexyl) phthalate – 30-day average	346.5 ug/L	5%
Ammonia - 6-month median	59.4 mg/L	100%
Ammonia – Daily maximum	237.6 mg/L	1.5%
Chronic Toxicity – Daily maximum *Using the current statistical method - NOEC*	99 TUc	0%
Chronic Toxicity – Daily maximum *Using the proposed statistical method – TST* (1)	Pass or <50% effect	1.7%

Notes:
(1) Using the 5.6% effluent dilution chronic toxicity test as a surrogate for a 6.21 Phase I concentration factor and 6.67 Phase III concentration factor.

Under the current chronic toxicity analytical and statistical methods outlined in Oxnard's NPDES permit, chronic toxicity would not trigger reasonable potential in Phase I, II, or III. The State Water Resourced Control Board is proposing a new statistical method called the Test of Significant Toxicity for evaluating compliance with chronic toxicity limits. The historical data was assessed using this statistical method to check for future compliance based on historical data. One data point was found to be non-compliant at the current effluent concentration. This same data point was found to be compliant at Phase I concentrations, yet non-compliant at a concentration factor of 5.6, or an AWPF flow of roughly 12 MGD.[1] Insufficient data exists at this time to make assessments of concentrations at flows greater than 12 MGD, which includes both Phase II (12.5 MGD) and Phase III (18.75 MGD) flows.

The permit also includes technology-based limits for conventional pollutants. No problems are anticipated in Phase I, yet as the AWPF expands to Phase II and Phase III there is increased chance of non-compliance, as shown in Table ES2. Daily settable solids and turbidity effluent data were also reviewed (with limited data). Concentrated values of these parameters are not anticipated to exceed limits in Phase I, Phase II, or Phase III.

Table ES 2. Estimated Non-Compliance with Technology-Based Effluent Limits

Pollutant/Standard	Estimated Non-compliance			
	PHASE II		PHASE III	
	Weekly	Monthly	Weekly	Monthly
BOD Concentration	41%	100%	100%	100%
BOD 85% Removal		17%		98%
TSS Concentration	1%	3%	50%	98%
TSS 85% Removal		0%		65%
Oil & Grease (1)	0%	0%	4%	100%

Notes:
(1) Based on this analysis, there was only one daily sample (of 1,826 samples) that exceeded the instantaneous limit of 75 mg/l for each of Phase I, II and III. Consequently, instantaneous non-compliance is not shown.

The maximum AWPF flow that would result in compliance with the water quality based effluent limits was estimated for all parameters. BOD limits the AWPF to approximately 7.6 MGD. One permit strategy is to move the compliance point for both BOD and TSS, secondary treatment technology based effluent limits, to the

[1] This may be due to problems conducting the test, and a test with a similarly inconsistent dose/response curve may be invalidated depending on how the Regional Water Board implements the TST in future permits.

secondary treatment effluent versus the combined flow. If this were to be a successful strategy, the maximum AWPF flow would be limited by compliance with the 6-month ammonia limit at 10.5 MGD.

Recommendations

It is recommended that all parameters that are identified as potential compliance issues be sampled at the secondary effluent, RO concentrate and combined secondary/AWPF flows. The assumption in this analysis is that 100% of the pollutant concentration ends up in the RO concentrate, although this may not always be the case and may be overly conservative. These samples will provide a clearer picture of the pollutant concentrations in the system.

It is recommended that both regulatory/institutional strategies and technical/engineering strategies be further explored. In terms of regulatory/institutional strategies, Oxnard should work with other dischargers in the State who are also running up against permit requirements as they increase their recycled water flows to promote Statewide policy changes. More specifically for Oxnard, moving the point of compliance for technology based secondary treatment standards would increase the allowable recycled water flow due to BOD and TSS limitations. Oxnard may also consider re-evaluating their dilution credit, which would increase the recycled water flows limited by Water Quality Based Effluent Limits such as ammonia. The dilution may increase, although a combination of complex factors makes this difficult to say until a dynamic modeling effort is undertaken. Prior to moving forward with this option, discussions and agreement with the Regional Water Quality Control Board on how the results would be interpreted is necessary.

CONCENTRATION FACTOR

AWPF flows will extract clean water from the effluent and leave the removed pollutants in the effluent, essentially 'concentrating' the effluent discharge. Concentration factors have been calculated to estimate effluent concentrations when the AWPF is operational. For example, a concentration factor of 1.5 would mean that the new effluent concentration is roughly 1.5 times the existing effluent concentration for each pollutant. The calculations conservatively assume that 100% of the pollutant is removed from the recycled water stream during the recycled water treatment train and left in the effluent for all pollutants except for BOD.

A concentration factor has been calculated for every averaging period (e.g. daily maximum, monthly average, etc.) that corresponds to the averaging period of an effluent limitation for each parameter. For example, the effluent limit for benzene is a 30-day average; therefore, the 30-day concentration factor should be used when calculating reasonable potential or expected compliance for toxicity.

The following section provides an overview of the current and anticipated flow regimes at the Oxnard Wastewater Treatment Plant when considering Phase I, Phase II, and Phase III of the AWPF, and identifies the concentration factor for each averaging period that has been calculated.

Flow Regimes

Phase I recycled water peak flows are planned to be 6.25 MGD. This demand requires an additional 1.10 MGD of flow for the RO process, which will be returned to the effluent as RO concentrate. Additionally, an additional 0.82 MGD is necessary for the Microfiltration (MF) process and will be returned to the headworks as MF backwash. Since the MF backwash is returned to the headworks, this flow 'recycles' itself, and only a total of 7.35 MGD of treatment plant influent flow is necessary to supply AWPF demands for Phase I.

The recycled water flows have been provided as a single value flows – Phase I = 6.25 MGD, Phase II = 12.5 MGD, and Phase III – 18.75 MGD. A critical assumption in this analysis is that the recycled water flows are equalized (i.e. the system runs continuously such that peak flows are both instantaneous and average daily flows). Although one would expect diurnal demands for recycled water use, it is assumed that extra flows can be diverted to groundwater injection. This is a reasonable assumption in that it is cheaper and more efficient to provide storage for recycled water to meet daily peak demands than build extra capacity in the recycled water treatment train and have the AWPF sit idle for most of the day.

Daily wastewater flow data was provided from January 1, 2009 through December 31, 2014, which was used to calculate concentration factors. In addition, hourly wastewater flows from August 2, 2014 through August 8, 2014 were used to identify hourly concentration factors. The contribution from brine flows from the Oxnard Water Campus Desalter is also considered.

The Oxnard Water Campus Desalter Contributions

The Oxnard Water Campus (OWC) Desalter contributes flow prior to the Oxnard WWTP headworks that is treated at the plant and then discharged through Oxnard's effluent pipeline. During the January 2009 through December 2014 data range, the OWC Desalter was not operational for approximately two and half years (from Fall of 2011 through mid-July, 2014). In the calculation of concentration factors, the lowest effluent flow is used to be conservative. With the OWC Desalter non-operational, concentration factors could be overestimated (i.e. too conservative).

The data was extensively reviewed; daily OWC Desalter flows were compared to daily effluent wastewater flows. The lowest flows for all of the averaging periods actually occurred when the Desalter was operational except for the 6-month median concentration factor.

For the purposes of this analysis, the OWC Desalter is assumed to contribute an insignificant amount of pollutants. How OWC Desalter flows are specifically considered for each averaging period is provided in the following sections.

Concentration Factor for Instantaneous Limits

An analysis of hourly wastewater flows for the period of 8/2/14 through 8/8/14 shows that during the early morning, flows during the dry weather sample period dipped to 9.6 MGD. Due to the fact that this is relatively short sampling period, a safety factor of 10% has been factored into the calculation of an instantaneous concentration factor. Consequently, the Phase I concentration factor is 4.02 (i.e. the new concentration is 4.02 times the existing concentration).

During Phase II and Phase III, there will be times when influent flows are not sufficient to supply the full demand for recycled water. During these conditions the effluent flow will be 100% concentrate. In Phase II and Phase III, the concentration factor is 6.67 (i.e. the new concentration is 6.67 times the existing concentration).

Concentration Factor for Maximum Daily Limits

Current effluent limits for pollutants such as chronic toxicity and copper have a maximum daily effluent limitation. The maximum daily effluent limit is the highest allowable daily discharge based on analyzing the composite of 24 hourly samples taken over a representative calendar day (e.g. midnight through 11:59 pm). Samples to determine compliance will be taken over the course of the entire day, not just during the low flow times. Therefore, daily flows (rather than hourly or instantaneous flows) are what will determine the concentration factor when considering reasonable potential and compliance.

The minimum average daily wastewater flow over the six years analyzed was 14.9 MGD. This data point was from a day that the OWC Desalter was operational. Since there are random days the OWC Desalter does not operate, it is reasonable to expect that there will be times the flow drops to this level. Assuming an AWPF

Phase I flow demand of 6.25 MGD on a day when effluent flows averaged 14.9 MGD, then the worst case scenario effluent flow is 8.65 MGD. This results in a Phase I maximum daily concentration factor of 1.72 (i.e. the new effluent concentration is 1.72 times the existing effluent concentration). For Phase II and Phase III the maximum daily concentration factor is 6.21 and 6.67, respectively.

Concentration Factor for 6-Month Median Limits

Current effluent limits for ammonia, metals, and other Table 1 Ocean Plan constituents (i.e. pollutants) have a 6-month median effluent limitation. The 6-month median effluent limit is the highest allowable moving median of all daily averages for any 180-day period. For the case of copper and other Table 1 Ocean Plan constituents, a 24-hour composite sample is taken once a quarter. Therefore, a 6-month median can be based on the average of two daily composite samples.

A rolling average of average monthly effluent wastewater flows over a 6-month period was calculated from January 1, 2009 through December 31, 2014. The lowest 6-month average of monthly wastewater flows in this time period is 19.5 MGD. This average flow occurred during a period when the OWC Desalter was non-operational. Evaluating the monthly flows if the OWC Desalter were operational during the entire data range, the lowest average monthly flow is estimated to be 21.2 MGD.[2] Conservatively assuming a consistent 6.25 MGD recycled water demand occurs during this flow period, the effluent flow would be 14.95 MGD, resulting in a Phase I 6-month median concentration factor of 1.42 (i.e. the new concentration would be 1.42 times the existing concentration). The Phase II and Phase III 6-month median concentration factors are 2.45 and 6.67, respectively.

Concentration Factor for Average Weekly and Average Monthly Limits

Effluent limits for Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) both have an average weekly and average monthly effluent limitation. The average weekly effluent limit is calculated as the average of all daily discharges measured during a calendar week. Similarly, the average monthly effluent limit is calculated as the average of all daily discharges during a calendar month. Both BOD and TSS are sampled daily based on analyzing the composite of 24 hourly samples taken over a representative calendar day (e.g. midnight through 11:59 pm).

Many Table 1 Ocean Plan pollutants have 30-day median limits. For most Table 1 pollutants, samples are taken once per month, quarter, or semiannually as a 24-hour composite. This means that one sample may be compared to a monthly limit.

[2] To compensate for this overestimation, an estimated effluent flow value was used. The daily OWC Desalter flows were subtracted from the daily effluent flows to obtain a wastewater flow. Then a representative OWC Desalter flow of 4.0 MGD was added back on to all daily wastewater flows from January 2009 through December 2014. To be conservative, this representative value is slightly below the average daily flow during the first two years of data when the OWC Desalter was fully operational.

The lowest rolling average monthly flow in the six-year period of flow data reviewed was 18.7 MGD. For an AWPF Phase I flow of 6.25 MGD, the effluent flow would be 12.45 MGD, resulting in a concentration factor of 1.50 (i.e. the new concentration would be 1.50 times the existing concentration). For Phase II and Phase III, the average monthly concentration factors would be 3.02 and 6.67, respectively.

The lowest rolling average weekly flow in the six-year period of flow data reviewed was 17.7 MGD. For an AWPF Phase I flow of 6.25 MGD, the effluent flow would be 11.45 MGD and the resulting Phase I average weekly concentration factor would be 1.55 (i.e. the new concentration would be 1.55 times the existing concentration). For Phase II and Phase III, the average weekly concentration factors would be 3.40 and 6.67, respectively.

Concentration Factors in Summary

A summary of the AWPF Phase I, Phase II, and Phase III concentration factors for each water quality objective averaging period is provided in Table 1. Although the lowest flow value in the data set provided is used, lower flow values may occur in the future. Therefore, when considering future compliance with potential effluent limits, the use of a safety factor should be considered.

Table 1. Summary of Concentration Factors with Phase I, II, and III AWPF Flows.

Water Quality Objective Averaging Period	Phase I Concentration Factor	Phase II Concentration Factor	Phase III Concentration Factor (1)
6-month Median	1.47	2.45	6.67
Monthly Average	1.50	3.02	6.67
Weekly Average	1.55	3.40	6.67
Maximum Daily	1.72	6.21	6.67
Hourly (Instantaneous Max)	4.02	6.67(1)	6.67

Note:
(1) Assumes available influent wastewater flow is less than AWPF capacity, and therefore the effluent is 100% concentrate.

REASONABLE POTENTIAL ANALYSIS

A Reasonable Potential Analysis (RPA) is an estimate of the potential for an effluent discharge to meet or exceed water quality standards. An RPA is conducted every five years during the NPDES permit renewal process on toxic pollutants in order to determine which pollutants shall have limits included in the permit.

The Oxnard Wastewater Treatment Plant discharges into the Pacific Ocean federal waters. Therefore, the method outlined in Appendix IV of the Water Quality Control Plan for Waters of California ("Ocean Plan") outlines the methodology for calculating reasonable potential. The factors in this method calculation include both 1) the historical effluent data and 2) the effluent dilution ratio.

When considering the historical effluent data, the concentration factors discussed previously were multiplied by each available data point from January 1, 2010 through December 31, 2014 for each toxic pollutant in Table 1 of the Ocean Plan (Appendix A) to obtain a 'concentrated' data set.

The dilution for Oxnard is 98:1. When considering dilution, the decreased flows due to the recycled water demands will change the effluent flow regime, and consequently the dilution ratio. Without a dynamic modeling effort, it is difficult to predict how a decreased effluent flow will influence the dilution because of the complex and competing factors involved. It is recommended that Oxnard conduct a modeling effort to assess the impacts of a decreased flow regime to the dilution ratio. As the dilution ratio increases, permit limits increase making compliance less challenging

Reasonable Potential Analysis Results

A reasonable potential analysis was conducted on the Table 1 Pollutants (Appendix A) according to the methodology outlined in Appendix VI of the Ocean Plan. The majority of the parameters in Table 1 were determined not to cause reasonable potential, or were inconclusive due to detection limits not being low enough to assess attainment. There were four parameters that require further discussion:

Copper: Ocean Plan Table 1 includes water quality objectives for copper expressed as 6-month median, daily maximum, and instantaneous maximum. In Phase III when all of the flows are diverted to the AWPF and the effluent is 100 percent concentrate, copper triggers reasonable potential (i.e. there would be a permit limit for copper), and based on historical data would be out of compliance with the 6-month median limit approximately 85 percent of the time. Copper does not trigger reasonable potential in either Phase I or Phase II.

Bis (2-ethylhexyl) phthalate: Ocean Plan Table 1 includes a water quality objective for bis (2-ethylhexyl) phthalate expressed as a 30-day average. In Phase III, at times when all of the flows are diverted to the AWPF and the effluent is 100 percent concentrate, bis (2-ethylhexyl) phthalate triggers reasonable potential (i.e. there would be a permit limit). Based on historical data, the bis (2-ethylhexyl) phthalate would be out of compliance with the limit one time out of the five years of data collected, or one out of 20 samples. Bis (2-ethylhexyl) phthalate is known to be a common laboratory contaminant.

Ammonia: Ocean Plan Table 1 includes water quality objectives for ammonia expressed as a 6-month median, daily maximum, and instantaneous maximum. Ammonia becomes an issue in Phase II when reasonable potential is triggered for both the 6-month median (0.6 mg/L) and daily maximum (2.4 mg/L) limits. Based on historical data and the concentration factors presented in Table 1, non-compliance would have occurred 75% of the time for the 6-month median limit and <1% of the time for the daily maximum limit, respectively. In Phase II the probability of non-compliance increases to 100% for the 6-month median limit and 2% of the daily maximum limit.

Chronic Toxicity: Ocean Plan Table 1 includes a water quality objective for chronic toxicity expressed as a daily maximum (1 Toxicity Unit, chronic or TUc). Chronic toxicity is not amendable to being 'concentrated' through a mass balance approach, as is the approach taken in a RPA. The best approach to estimate toxicity is to conduct bench-top or pilot-scale tests. In lieu of this data, an in-depth analysis of existing, available information has been conducted.

In summary, Oxnard data is not toxic. The nature of the current testing methods allows us to assess toxicity based on historical data up to an AWPF daily flow of approximately 12 MGD. Up to this flow, there would have been no compliance issues with toxicity for a concentrated effluent using current statistical methods, the No Observed Effects Concentration (NOEC). However, the toxicity testing landscape in California is rapidly changing, and by the next permit cycle, if not sooner, toxicity will be determined using a different statistical method called the Test of Significant Toxicity (TST). When the proposed statistical method (TST) is used, one data point in the historical data set is considered toxic.

Under the current statistical methodology, organisms are exposed at a number of effluent concentrations (0.56%, 1%, 1.8%, 3.2%, and 5.6%) to generate a dose/response curve. These concentrations equate to concentration factors. For this one "toxic" data point, the effluent was found to be toxic at both 1% and 5.6% effluent, or 1 and 5.6 concentration factors respectively. This same sample data was deemed not toxic for the 1.8% concentration, or what could equate to the Phase I concentration factor of 1.78.

The Phase II and Phase III concentration factors for a maximum daily limit are 6.21 and 6.67, respectively, and therefore, are not represented by the 5.6% tests that have already been conducted. A test at an effluent concentration of 6.21% and 6.67% would be needed to determine if the effluent is toxic at increased concentrations. It is recommended that Oxnard request that its contract lab run tests at the analogous higher concentration.

COMPLIANCE WITH ANTICIPATED PERMIT LIMITS

Compliance with Ocean Plan Table 1 Pollutants

For Ocean Plan Table 1 pollutants, water quality based effluent limits (WQBELs) are calculated for parameters that have triggered reasonable potential. The calculated permit limit and the percent of time it is anticipated to be out of compliance based on historical data is presented in Table 2.

Table 2. Calculated Permit Limit and Anticipated Non-compliance

Pollutant – Averaging Period	Calculated Permit Limit	% Estimated Non-compliance
Phase II		
Ammonia - 6-month median	59.4 ug/L	75% (176 of 235 samples)
Ammonia – Daily maximum	237.6 ug/L	0.4% (1 of 259 samples)
Chronic Toxicity – Daily maximum *Using the current statistical method - NOEC*	99 TUc	0%
Chronic Toxicity – Daily maximum *Using the proposed statistical method - TST*	Pass or <50% effect	1.7% (1 of 60 samples)
Phase III		
Copper – 6-month median	101 ug/L	84% (16 of 19 samples)
Bis (2-ethylhexyl) phthalate – 30-day average	346.5 ug/L	5% (1 of 20 samples)
Ammonia - 6-month median	59.4 ug/L	100% (235 of 235 samples)
Ammonia – Daily maximum	237.6 ug/L	1.5% (4 of 259 samples)
Chronic Toxicity – Daily maximum *Using the current statistical method - NOEC*	99 TUc	0%
Chronic Toxicity – Daily maximum *Using the proposed statistical method – TST (1)*	Pass or <50% effect	1.7% (1 of 60 samples)

Notes:
(1) Using the 5.6% effluent dilution test as a surrogate for a 6.21 Phase I concentration factor and 6.67 Phase III concentration factor.

An estimate of the maximum AWPF flow that would result in compliance with the water quality based effluent limits is provided in Table 3. These calculations are based on historical data. Although these flows are conservative, there will be times when the flows could be lower than historical flows. Therefore, a safety factor should be used if using these numbers for planning purposes.

Table 3. Estimated Maximum AWPF Flows Allowable in Order to Maintain Compliance with Water Quality Based Effluent Limits

Parameter	Flow (MGD)
Copper – 6-month median	15.3 MGD
Bis (2-ethylhexyl) phthalate – 30-day average	14.0 MGD
Ammonia - 6-month median	10.5 MGD
Ammonia – Daily maximum	12.5 MGD

Compliance with Conventional Pollutants

The Clean Water Act (CWA) requires all treatment plants to meet technology-based effluent limits, as outlined in Table 4. These limits are also included in the Oxnard Wastewater Treatment Plant NPDES permit.

Table 4. Technology Based Effluent Limits for Secondary Treatment Facilities

Parameter	Weekly (mg/L)	Monthly (mg/L)	Removal (%)
BOD	45	30	85%
TSS	45	30	85%

The concentrated historical record of BOD, TSS and soluble BOD (sBOD) data between January 1, 2010 and December 31, 2014 was concentrated using the previously described concentration factors and compared to these limits. BOD may be significantly removed in the microfiltration process, which would bring it back to the headworks for further removal at the plant, although this needs to be confirmed with field samples. For now, it was conservatively assumed that only soluble BOD will be concentrated and the microfiltration units will filter the particulate BOD and return it to the headworks, where it will eventually be adsorbed in the primary and secondary sludge. Therefore, only the soluble BOD (sBOD) in the AWPF concentrate was combined with the total BOD contributed by the (un-concentrated) secondary effluent to assess attainability with final outfall effluent regulatory limits.

Based on this analysis, final outfall effluent BOD and TSS are not likely to pose compliance problems during Phase I, although as AWPF capacity is increased in Phase II and Phase III, compliance issues are anticipated (Table 5).

Table 5. Percent Non-Compliance with Technology-Based Effluent Limits

Pollutant/Standard	Percent Non-Compliance					
	PHASE I		PHASE II		PHASE III	
	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly
BOD Concentration	0%	0%	41%	100%	100%	100%
BOD 85% Removal		0%		17%		98%
TSS Concentration	0%	0%	1%	3%	50%	98%
TSS 85% Removal		0%		0%		65%

An estimate of the maximum AWPF flow that would result in compliance with the CWA technology based effluent limits is provided in Table 6. These calculations are based on historical data. Although these flows are conservative, there will be times when the flows could be lower than historical flows. Therefore, a safety factor should be used if using these numbers for planning purposes.

Table 6. Estimated Maximum AWPF Flows Allowable in Order to Maintain Compliance with CWA Technology Based Permit Limits

Parameter	Weekly	Monthly	85% Removal
BOD	7.6 MGD	8.0 MGD	11.6 MGD
TSS	10.7 MGD	11.34 MGD	13.8 MGD

According to the Ocean Plan, Publically Owned Treatment Works (POTWs) must meet additional technology-based effluent limits (TBELs) for oils and grease (O&G), settable solids, and turbidity, as presented in Table 7. Daily O&G effluent data from January 1, 2010 through December 31, 2014 were assessed against the monthly, weekly, and instantaneous limit using the applicable averages and concentration factors. Based on this analysis, there was only one daily sample (of 1,826 samples) that exceeded the instantaneous limit of 75 mg/l for each of Phase I, II and III. Aside from this one data point, no compliance issues are anticipated in Phase I and Phase II. However, in Phase III when there will be times when all of the flow is diverted to AWPF and the effluent is 100 percent concentrate, O&G concentrations will exceed both the weekly and the monthly limits approximately 4% and 100%, respectively.

Table 7. Technology Based Effluent Limits* for POTWs Based on the Ocean Plan

Parameter	Monthly	Weekly	Instantaneous Max
Oil & Grease (mg/L)	25	40	75
Settable Solids (ml/L)	1.0	1.5	3.0
Turbidity (NTU)	75	100	225

*Note: Only applicable parameters presented

O&G would not be a compliance issue up to an AWPF flow of approximately 16.0 MGD for the 6-month median limit and 14.5 MGD for the daily limit (based on historical data and disregarding one outlier in the 1,826 data set), as presented in Table 8. Again, although these flows are conservative, there will be times when the flows could be lower than historical flows. Therefore, a safety factor should be used if using these numbers for planning purposes.

Table 8. Estimated Maximum AWPF Flows Allowable in Order to Maintain Compliance with Ocean Plan Technology Based Permit Limits

Parameter	Weekly	Monthly
O&G	14.5 MGD	13.5 MGD

Daily settable solids and turbidity effluent data were reviewed for the year 2013, which for the purposes of this analysis has been considered to be representative. Concentrated values of these parameters are not anticipated to exceed limits in Phase I, Phase II, or Phase III.

Regulatory Compliance Strategy Considerations

Compliance issues are not anticipated in Phase I of the AWPF, which is currently in operation. The Oxnard permit is up for renewal in July 2018. Phase II of the AWPF is planned for operation to begin in 2020. This leaves time for permit strategies to be further explored and developed in order to negotiate with the RWQCB prior to future permit renewals.

First, it is recommended that all parameters that are identified as potential compliance issues be sampled at the secondary effluent, RO concentrate and combined secondary/RO concentrate flows. The assumption in this analysis is that 100% of the pollutant ends up in the RO concentrate, although this may not always be the case and may be overly conservative. These samples will provide a clearer picture of the pollutant concentrations in the system.

Although the effluent is generally not toxic, one sample would have been out of compliance at the current flows under the proposed statistical method. This sample would not have been out of compliance in Phase I concentrations. There is insufficient data to identify whether the effluent will be toxic in Phase II and Phase

III concentrations. Therefore, it is recommended that additional test be conducted at effluent concentrations of 6.21% and 6.67%, for Phase II and Phase III, respectively.

Other dischargers in California will be facing the same permit restrictions that Oxnard will be facing. Oxnard should work with other agencies to promote a statewide policy change that promotes recycled water while mitigating some of these issues.

As dilution increases, water quality-based effluent permit limits increase and consequently, non-compliance with those permit limits decreases. Dilution will change as you change the volume of the effluent flow. As the effluent flow is decreased (i.e. increase AWPF flows), the dilution will likely increase, although a combination of complex factors makes this difficult to say for certain until a dynamic modeling effort is undertaken. The estimated dilution necessary for compliance with water quality based effluent limits is provided in Table 9. A dilution modeling effort of the Oxnard effluent dilution may prove useful.

Table 9. Estimated Dilution Necessary for Compliance with Permit Limits

Pollutant – Averaging Period	Dilution	Calculated Permit Limit
Phase II		
Ammonia - 6-month median	121	83 ug/L
Ammonia – Daily maximum	100	242 ug/L
Phase III		
Copper – 6-month median	184	187 ug/L
Bis (2-ethylhexyl) phthalate – 30-day average	164	578 ug/L
Ammonia - 6-month median	331	199 ug/L
Ammonia – Daily maximum	108	262 ug/L

Dilutions are modeled based on averaging periods. Regional Water Quality Control Boards typically use the lowest reasonable dilution as the dilution for determining reasonable potential and compliance for all water quality objectives, regardless of the averaging period of the limitation. This is a conservative approach. For example, when determining reasonable potential for a pollutant with a 6-month median water quality objective, using a 6-month median dilution ratio would be most appropriate.

Another option to explore is the use of mass-based permit limits, rather than concentration based. The mass of pollutants going into the receiving waters will not change, even as concentrations increase. Therefore, there is no net change in environmental impacts outside the mixing zone, although there is a net environmental benefit when considering the potable water offsets supplied by the AWPF.

Dilution and the use of mass-based permit limits are only pertinent to water quality-based effluent limits, and not technology-based permit limits for parameters such as BOD and TSS. Clean Water Act secondary treatment standards (i.e. for BOD and TSS) apply to all POTWs and are a measure of the effectiveness of secondary treatment. These limits only apply to the secondary treated flows rather than the combined secondary and concentrate flows. Therefore, the point of compliance for BOD and TSS should be moved to the secondary effluent. The result would be compliance with the BOD and TSS standards. This would require specific language in the permit to identify different compliance points for the different permit limits.

Ocean Plan technology based effluent limits are not specific to secondary treatment, yet rather to individual discharges. Therefore, the standards for O&G may be applied to the concentrate or the combined flow. Either way, O&G effluent will need to be carefully discussed with Regional Board staff. First, it is recommended that O&G samples be taken in the secondary effluent, concentrate, and combined flow of the currently operating AWPF to better understand the characteristics of O&G through the system. The current assumption is that 100% ends up in the RO concentrate, which may be overly conservative. A certain percentage could be recirculating back through the MF waste and disposed of through the solids.

Appendix A

Table 1 Water Quality Objectives from the 2012 California Ocean Plan

TABLE 1 (formerly TABLE B)
WATER QUALITY OBJECTIVES

	Units of Measurement	Limiting Concentrations: 6-Month Median	Daily Maximum	Instantaneous Maximum
OBJECTIVES FOR PROTECTION OF MARINE AQUATIC LIFE				
Arsenic	µg/L	8.	32.	80.
Cadmium	µg/L	1.	4.	10.
Chromium (Hexavalent) (see below, a)	µg/L	2.	8.	20.
Copper	µg/L	3.	12.	30.
Lead	µg/L	2.	8.	20.
Mercury	µg/L	0.04	0.16	0.4
Nickel	µg/L	5.	20.	50.
Selenium	µg/L	15.	60.	150.
Silver	µg/L	0.7	2.8	7.
Zinc	µg/L	20.	80.	200.
Cyanide (see below, b)	µg/L	1.	4.	10.
Total Chlorine Residual (For intermittent chlorine sources see below, c)	µg/L	2.	8.	60.
Ammonia (expressed as nitrogen)	µg/L	600.	2400.	6000.
Acute* Toxicity	TUa	N/A	0.3	N/A
Chronic* Toxicity	TUc	N/A	1.	N/A
Phenolic Compounds (non-chlorinated)	µg/L	30.	120.	300.
Chlorinated Phenolics	µg/L	1.	4.	10.
Endosulfan	µg/L	0.009	0.018	0.027
Endrin	µg/L	0.002	0.004	0.006
HCH*	µg/L	0.004	0.008	0.012
Radioactivity	Not to exceed limits specified in Title 17, Division 1, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30253 of the California Code of Regulations. Reference to Section 30253 is prospective, including future changes to any incorporated provisions of federal law, as the changes take effect.			

* See Appendix I for definition of terms.

2012 Ocean Plan

TABLE 1 (formerly TABLE B) Continued

Chemical	30-day Average (µg/L) Decimal Notation	Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – NONCARCINOGENS		
acrolein	220.	2.2×10^{2}
antimony	1,200.	1.2×10^{3}
bis(2-chloroethoxy) methane	4.4	4.4×10^{0}
bis(2-chloroisopropyl) ether	1,200.	1.2×10^{3}
chlorobenzene	570.	5.7×10^{2}
chromium (III)	190,000.	1.9×10^{5}
di-n-butyl phthalate	3,500.	3.5×10^{3}
dichlorobenzenes*	5,100.	5.1×10^{3}
diethyl phthalate	33,000.	3.3×10^{4}
dimethyl phthalate	820,000.	8.2×10^{5}
4,6-dinitro-2-methylphenol	220.	2.2×10^{2}
2,4-dinitrophenol	4.0	4.0×10^{0}
ethylbenzene	4,100.	4.1×10^{3}
fluoranthene	15.	1.5×10^{1}
hexachlorocyclopentadiene	58.	5.8×10^{1}
nitrobenzene	4.9	4.9×10^{0}
thallium	2.	$2. \times 10^{0}$
toluene	85,000.	8.5×10^{4}
tributyltin	0.0014	1.4×10^{-3}
1,1,1-trichloroethane	540,000.	5.4×10^{5}
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
acrylonitrile	0.10	1.0×10^{-1}
aldrin	0.000022	2.2×10^{-5}
benzene	5.9	5.9×10^{0}
benzidine	0.000069	6.9×10^{-5}
beryllium	0.033	3.3×10^{-2}
bis(2-chloroethyl) ether	0.045	4.5×10^{-2}
bis(2-ethylhexyl) phthalate	3.5	3.5×10^{0}
carbon tetrachloride	0.90	9.0×10^{-1}
chlordane*	0.000023	2.3×10^{-5}
chlorodibromomethane	8.6	8.6×10^{0}

* See Appendix I for definition of terms.

TABLE 1 (formerly TABLE B) Continued

Chemical	30-day Average (µg/L) Decimal Notation	Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
chloroform	130.	1.3×10^{2}
DDT*	0.00017	1.7×10^{-4}
1,4-dichlorobenzene	18.	1.8×10^{1}
3,3'-dichlorobenzidine	0.0081	8.1×10^{-3}
1,2-dichloroethane	28.	2.8×10^{1}
1,1-dichloroethylene	0.9	9×10^{-1}
dichlorobromomethane	6.2	6.2×10^{0}
dichloromethane	450.	4.5×10^{2}
1,3-dichloropropene	8.9	8.9×10^{0}
dieldrin	0.00004	4.0×10^{-5}
2,4-dinitrotoluene	2.6	2.6×10^{0}
1,2-diphenylhydrazine	0.16	1.6×10^{-1}
halomethanes*	130.	1.3×10^{2}
heptachlor	0.00005	5×10^{-5}
heptachlor epoxide	0.00002	2×10^{-5}
hexachlorobenzene	0.00021	2.1×10^{-4}
hexachlorobutadiene	14.	1.4×10^{1}
hexachloroethane	2.5	2.5×10^{0}
isophorone	730.	7.3×10^{2}
N-nitrosodimethylamine	7.3	7.3×10^{0}
N-nitrosodi-N-propylamine	0.38	3.8×10^{-1}
N-nitrosodiphenylamine	2.5	2.5×10^{0}
PAHs*	0.0088	8.8×10^{-3}
PCBs*	0.000019	1.9×10^{-5}
TCDD equivalents*	0.0000000039	3.9×10^{-9}
1,1,2,2-tetrachloroethane	2.3	2.3×10^{0}
tetrachloroethylene	2.0	2.0×10^{0}
toxaphene	0.00021	2.1×10^{-4}
trichloroethylene	27.	2.7×10^{1}
1,1,2-trichloroethane	9.4	9.4×10^{0}
2,4,6-trichlorophenol	0.29	2.9×10^{-1}
vinyl chloride	36.	3.6×10^{1}

* See Appendix I for definition of terms.

Table 1 Notes:

a) Dischargers may at their option meet this objective as a total chromium objective.

b) If a discharger can demonstrate to the satisfaction of the Regional Water Board (subject to EPA approval) that an analytical method is available to reliably distinguish between strongly and weakly complexed cyanide, effluent limitations for cyanide may be met by the combined measurement of free cyanide, simple alkali metal cyanides, and weakly complexed organometallic cyanide complexes. In order for the analytical method to be acceptable, the recovery of free cyanide from metal complexes must be comparable to that achieved by the approved method in 40 CFR PART 136, as revised May 14, 1999.

c) Water quality objectives for total chlorine residual applying to intermittent discharges not exceeding two hours, shall be determined through the use of the following equation:

$$\log y = -0.43 (\log x) + 1.8$$

where: y = the water quality objective (in µg/L) to apply when chlorine is being discharged;
x = the duration of uninterrupted chlorine discharge in minutes.

E. Biological Characteristics

1. Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded*.

2. The natural taste, odor, and color of fish, shellfish*, or other marine resources used for human consumption shall not be altered.

3. The concentration of organic materials in fish, shellfish* or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.

F. Radioactivity

1. Discharge of radioactive waste* shall not degrade* marine life.

* See Appendix I for definition of terms.

APPENDIX B - COMPLIANCE STRATEGIES ANALYSIS MEMO

CITY OF OXNARD

EXPANDING THE ADVANCED WATER PURIFICATION FACILITY

- COMPLIANCE STRATEGIES -

Draft

June 10, 2015

Patricia McGovern Engineers

City of Oxnard
Expanding the Advanced Water Purification Facility
- Compliance Strategies -

OVERVIEW

The City of Oxnard operates an Advanced Water Purification Facility (AWPF) that consists of Microfiltration (MF), Reverse Osmosis (RO), and Advanced Oxidation Process (AOP). The AWPF will treat wastewater from the Oxnard Wastewater Treatment Plant in increasing phases as follows:

Phase I – 6.25 MGD,
Phase II – 12.5 MGD,
Phase III -18.5 MGD.

Concentrate from the MF process is directed back to the headworks of the wastewater treatment plant, while the RO concentrate is combined with the remaining secondary effluent and discharged through the effluent outfall.

AWPF flows extract clean water from the effluent and leave the removed pollutants in the effluent, essentially 'concentrating' the effluent discharge. As the flows from the AWPF increase, effluent concentrations increase. Subsequently, permit limits may be exceeded. An analysis was conducted to identify constituents that may concentrate to levels that exceed standards. Constituents identified in the analysis are presented in Table 1. An estimation of the flows produced by the AWPF at which each constituent may begin to cause a problem is also presented.

Table 1. Constituents that May Exceed Standards when Concentrated.

Constituent	Max Flow
BOD	7.6 MGD
TSS	10.7 MGD
Ammonia	10.5 MGD
O&G	13.5 MGD
Bis (2-ethylhexyl) phthalate, (Bis) [(1)]	14.0 MGD
Copper	15.3 MGD

Note:
1) Bis (2-ethylhexyl) phthalate, a notorious laboratory contaminant, had one 'hit' over the 5-year historical record. Although included, it is not a consistent, nor preventable, constituent of concern.

Compliance issues are not anticipated in Phase I of the AWPF, which is currently in operation. Phase II of the AWPF is planned for operation to begin in 2020. The recycled water flows that the AWPF is able to produce before exceeding standards is 7.6 MGD, limited by meeting BOD limits. A number of strategies, both institutional and technical have been identified to achieve compliance.

INSTITUTIONAL / PERMITTING STRATEGIES

Institutional and permitting strategies would include strategies that change the requirements in the NPDES permit, the way the permit is regulated, or the framework in which RO concentrate from treated wastewater is regulated. There are several large agencies in California that treat secondary treated effluent to advanced levels for recycling purposes. Due to the current drought conditions, the State encourages this practice. Unfortunately, there is no clear guidance that supports this practice in the current regulatory framework. Similar to Oxnard, many of these agencies find that they may be out of compliance with their NPDES permits as they increase recycled water flows. Oxnard may want to work with other dischargers to help implement statewide policy changes to mitigate these issues.

Any changes to the Oxnard effluent permit to accommodate increased AWPF flows would need to be further explored with the Regional Board, and likely the EPA Region IX. Compliance strategies require agreement with the Regional Board, and then final approval by the public in a public permit approval process. For some strategies, this can be a lengthy process with unreliable results, while other strategies are fairly straightforward.

Change the Point of Compliance for BOD/TSS

BOD and TSS limits are Technology Based Secondary Effluent Limits, meaning that they exist to ensure that the secondary treatment process is operating to sufficient standards. Therefore, the secondary effluent (rather than the secondary effluent combined with the RO concentrate) should be sampled to determine compliance with BOD and TSS secondary treatment standards.

If the point of compliance for BOD and TSS were moved to the secondary effluent, BOD and TSS would meet permit limits as the AWPF flows increased. The maximum allowable recycled water flows would then be limited by the AWPF's ability to meet ammonia standards, an increase of roughly 38% over the flows that are limited by BOD/TSS compliance, to 10.5 MGD.

In order to move the point of compliance for BOD and TSS, the permit would need to be amended, either at the next permit renewal in 2018 or through a permit reopener in the interim. This requires discussions with, and agreement by, the Los Angeles Regional Water Quality Control Board.

Modify the Dilution Ratio

Limits for ammonia, bis (2-ethylhexyl) phthalate, and copper are Water Quality Based Effluent Limits (WQBELS), meaning they exist to protect receiving waters. Dilution is a major factor in determining permit limits for WQBELs. The current dilution granted Oxnard's effluent flow is 98:1. If the dilution were to increase, permit limits would also increase (i.e. become easier to comply with). The estimated dilution necessary for compliance with permit limits for each constituent of concern is presented in Table 2.

Table 2. Estimated Dilution Necessary for Compliance with Permit Limits

Pollutant – Averaging Period	Dilution	Calculated Permit Limit
Phase II		
Ammonia - 6-month median	121	83 ug/L
Ammonia – Daily maximum	100	242 ug/L
Phase III		
Copper – 6-month median	184	187 ug/L
Bis (2-ethylhexyl) phthalate – 30-day average	164	578 ug/L
Ammonia - 6-month median	331	199 ug/L
Ammonia – Daily maximum	108	262 ug/L

An initial investigation into the basis of the 98:1 dilution was conducted. The Regional Board conducted an internal document review that found that they do not have any electronic documentation of an Oxnard dilution study. Regional Board staff[1] identified three potential outcomes if a more rigorous investigation were to be conducted on their part.

1) The results of a study conducted at a similar outfall were applied at Oxnard due to similarities, and a separate study was not necessary.
2) Oxnard staff provided the Regional Board with dilution results, yet never provided the actual study.
3) A paper copy of the dilution study exists in the Regional Board archives and was never digitized. A Freedom of Information Act request would be necessary to discover whether there is such a study.

A request to Oxnard staff produced parts of two documents[2] that discuss the outfall and dilution, both developed in the 1970s, yet neither of these reports refers to a dilution of 98:1. Further, Oxnard staff could not find any documentation referring to a dilution of 98:1.[3]

If a new dilution study were to be conducted, it is unclear whether the result would increase or decrease the current dilution value granted. A dilution study results in a number of dilution values that vary dependent on the averaging period and conditions identified. For instance, the dilution will vary seasonally, and be different for different averaging periods (maximum day, average month, etc.).

Prior to embarking on a new dilution study, discussions with the Regional Board staff would be necessary. The Regional Board would need to be open to revisiting

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[1] Communication with Elizabeth Erickson, LARWQCB, 4/6/15.

[2] *Upgrading Wastewater Treatment Plant & Ocean Disposal Facilities*; B&C, 1974; and *Application for Modification of the Requirements of Secondary Treatment Volume 1; CH2MHill*, 1979.

[3] Communication with Thien Ng, City of Oxnard, 4/15/15.

Oxnard's dilution. More importantly, the Regional Board would need to be open to interpreting the results of the dilution study. For example, in the San Francisco Bay Region, the Regional Board has indicated that they are open to granting larger dilutions (by selecting dilutions with different averaging periods) to accommodate recycled water flows.

Use Mass-based Limits versus Concentration-based Limits

The Clean Water Act allows for both concentration-based and mass-based effluent limits. As recycled water is increased, the concentrations of constituents in the effluent increase, yet the mass loadings will be the same. As such, applying mass-based limitations rather than concentration-based limits would be beneficial in terms of compliance. An underlying supporting basis for mass-based limits is that the combined AWPF/secondary effluent flow would provide an environmental benefit with the offset of potable water from the recycled water flows.

Again, the Regional Board would need to agree to use mass-based limits. They may consider mass-based limits on a parameter-specific basis. For example, pollutants such as copper are conservative, and the total loading may be more important than the concentration discharged. Additionally, EPA Region IX will also need to agree with a mass-based limit approach before relying on this strategy. In the San Francisco Bay, EPA Region IX intervened in the PCB Watershed Permit and forced the San Francisco Bay Regional Board to include concentration-based limits in addition to the mass discharge limits that were originally included.

In summary, moving the point of compliance for the constituents regulated under the secondary treatment standards (i.e. BOD/TSS) is relatively straightforward, and is the first step in increasing the AWPF flows. Moving the point of compliance would allow AWPF flows to increase to 10.5 MGD (rather than 7.6 MGD), when the flow will be limited by ammonia compliance.

For toxics such as ammonia and copper, a dilution increase or mass-based limits are potential strategies. Any of the strategies require discussion and agreement with the Regional Board, and then final approval by the public in a public permit approval process. At a minimum, Oxnard should engage with other agencies that are embarking on similar projects in the State and work with them to negotiate policies that support making accommodations in the regulatory framework.

ENGINEERING / TECHNICAL STRATEGIES

Engineering or technical strategies may include in-the-ground treatment processes, physical additions or changes to the system, etc. There may be large capital and operations and maintenance (O&M) costs, and long implementation time frames due to planning, design, and construction, while other technical strategies may be quick fixes.

Provide Additional Sources of Dilution

Concentrations in the effluent increase because clean water is diverted from the effluent flow, yet the pollutants remain in the effluent. The addition of clean water will dilute the effluent flow, thereby decreasing concentrations. The addition of RO concentrate from United Water desalter has been further evaluated as a possible source of clean water. Both water quality and flow from the United Water desalter were evaluated.

No constituents from the desalter RO concentrate were identified that would contribute to a non-compliance with standards. The desalter diluted all of the constituents identified in Table 1, except for TSS. Concentrations of TSS will increase when desalter flows are added to the effluent.

The United Water desalter will operate with 5 treatment trains, each of which will process roughly 5,000 acre-ft/year of influent flow. The initial flows will operate using just one train. It is assumed that flows from the desalter will be consistent (i.e. no diurnal or seasonal fluctuations). Both the low flow and the capacity flow scenarios were evaluated. With the exception of TSS, concentrations in the effluent decreased, but not significantly, at the low flow scenario. At capacity, all of the constituents of concern were no longer limiting the recycled water flows except for ammonia, BOD and TSS. Ammonia compliance went from limiting recycled water flow at approximately 10.5 MGD without the desalter flow, to limiting the flow at 13 MGD to 15 MGD, depending on United Water desalter influent water quality.

Chemical Addition to the Primaries

Chemically Enhanced Primary Treatment (CEPT) is the addition of chemicals (e.g. ferric chloride, aluminum sulfate) to the primary sedimentation tanks that 'clump' together solids via coagulation and flocculation so they settle out faster. The result is an increased removal of solids, including copper, BOD, TSS and O&G. Based on studies conducted, the removals are highly dependent on the influent concentrations; for copper the reported range is approximately 30-80% removal, a potential >200% increase traditional primary treatment.[4] Primary tanks can be easily modified to add this process.

Bench-scale tests would need to be conducted before removal efficiencies can be estimated, yet it is likely the case that CEPT addition would increase the AWPF flows due to BOD, TSS, O&G, and copper compliance limitations.

Membrane Bioreactor (MBR)

[4] Johnson, Pauline, Girinathannair, Padmanabhan, et al. *Enhanced Removal of Heavy Metals in Primary Treatment Using Coagulation and Flocculation*, WERF May 2008.

A membrane bioreactor (MBR) would replace the secondary treatment facilities. MBRs are a compact treatment process that combines suspended growth biological reactors with solids removal via filtration. The result is increased performance over traditional secondary treatment processes. All removals of constituents identified in Table 1 will be improved significantly with the application of MBR, although the anticipated resulting increase in AWPF flows requires an estimation of the increase in removals, which is out of the scope of this analysis.

SUMMARY

There are several strategies that can be taken to maximize the amount of recycled water flows that will be allowed without threat of violating the discharge permit. These strategies include both permitting/institutional and technical/engineering considerations. The following combination of strategies are discussed as options to maximum recycled water flow before an exceedance may occur:

1) No Action
2) Change Point of Compliance for BOD/TSS
3) Change Point of Compliance for BOD/TSS + Add United Water desalter permeate flows at capacity
4) MBR

The maximum recycled water flow that can occur before an exceedance may be expected when no further action is taken is presented in Figure 1. BOD concentrations limit the allowable recycled water flow first. A regulatory change in the permit that allows the point of compliance for BOD and TSS to be located after the secondary treatment facilities, yet prior to contributions from the RO permeate (or the United Water desalter in the next scenario), is presented in Figure 2. This allows the maximum recycled water flow to increase from around 7.6 MGD to approximately 10.5 MGD.

Figure 1. Maximum Recycled Water Flow With No Further Action

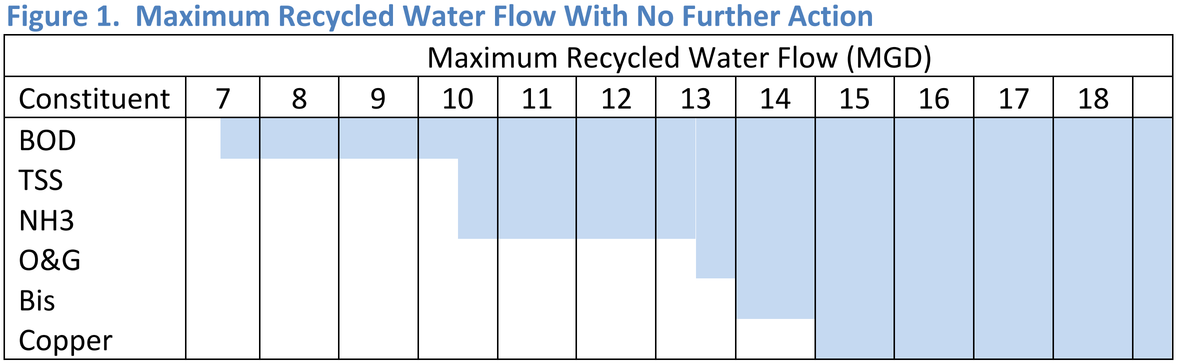

Figure 2. Maximum Recycled Water Flow + Change Point of Compliance

	Maximum Recycled Water Flow (MGD)											
Constituent	7	8	9	10	11	12	13	14	15	16	17	18
BOD												
TSS												
NH3												
O&G												
Bis												
Copper												

Adding in the United Water permeate contributions would allow the recycled water flows to increase even further, to approximately 13 MGD to 15 MGD, depending on the water quality of the influent to the United Water desalter (Figure 3). It is important to note that Figure 3 represents the United Water desalter contributions at capacity, and under the assumption that the desalter will run consistently while in operation.

Figure 3. Maximum Recycled Water Flow + Change Point of Compliance + United Water Permeate Contributions at Capacity

	Maximum Recycled Water Flow (MGD)											
Constituent	7	8	9	10	11	12	13	14	15	16	17	18
BOD												
TSS												
NH3 (1)												
O&G												
Bis												
Copper												

Note:
1) The maximum recycled water flow is shown as a range because it is dependent on the flows from the United Water permeate line, which are dependent on that system's influent water quality.

With the addition of MBR, the maximum recycle water flow will increase significantly, although the exact amounts are have not been evaluated.

APPENDIX C - OUTFALL WATER QUALITY SEQUENCING ANALYSIS

City of Oxnard, California

Integrated Water Resources Master Plan

Recycled Water System

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OUTFALL WATER QUALITY SEQUENCING ANALYSIS

2.1 INTRODUCTION

Note: *This report is under development and will be completed in the final submittal. A draft is provided here so that the reader has an understanding of the OPTIMO® model and what analyses are currently underway.*

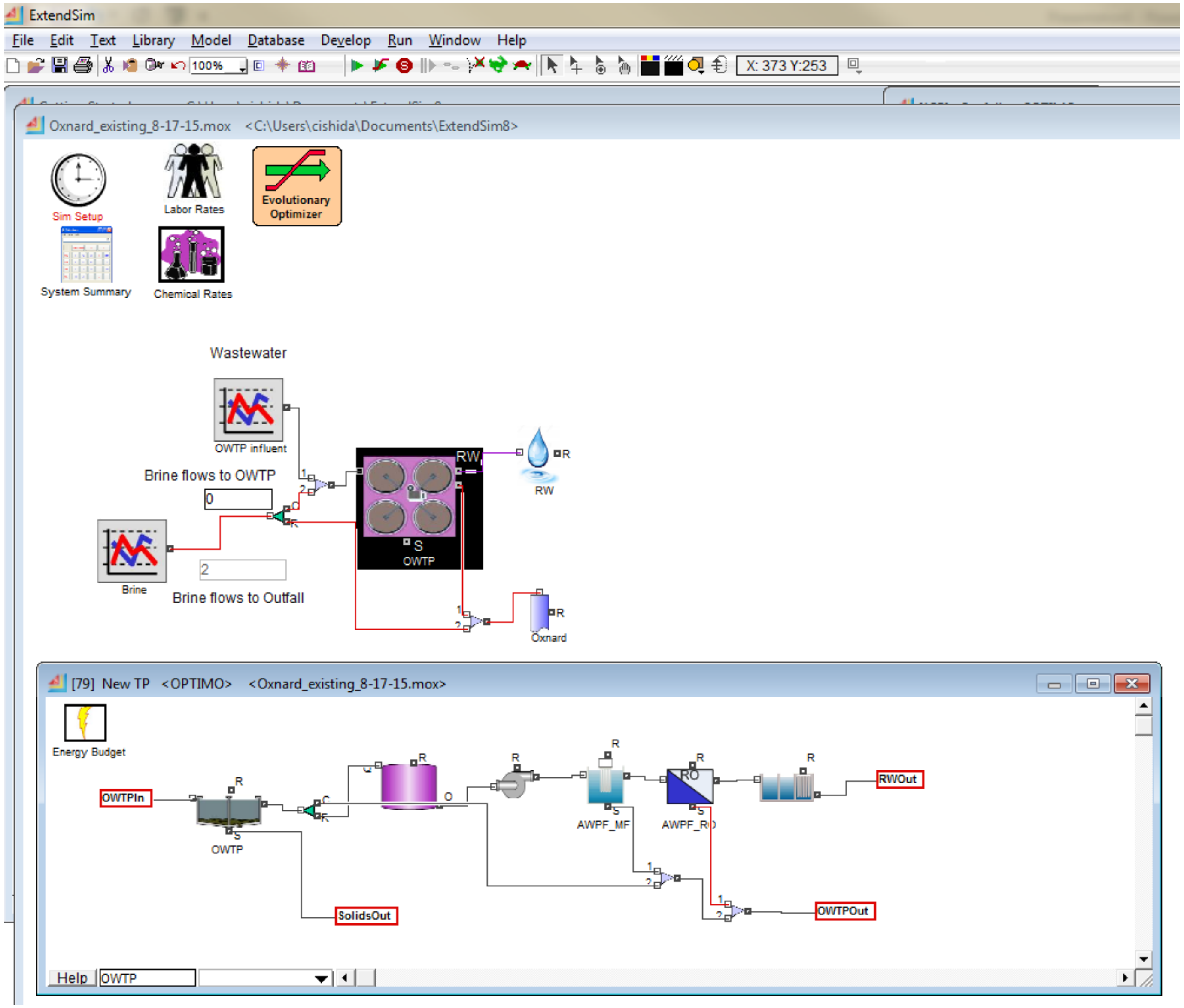
This report focuses on the *OPTIMO®* model that was utilized as part of the Public Works Integrated Master Plan (PWIMP). The purpose of the *OPTIMO®* model application is to examine the effects of changes to the Oxnard system on the discharge water quality to the outfall.

OPTIMO® is a flow and mass balance model that was applied to test different scenarios for the outfall water quality sequencing analysis. The model simulates water and wastewater flow routing, treatment (accounts for treatment capacity and removal rates), water and recycled water demands, and water quality constraints. The model is built on an object-oriented programming platform that allows for quick model scenario construction, similar to drawing a flow chart. The model can be used to test different flow routing regimes, increased treatment capacities, different levels of treatment, and different water quality criteria relatively quickly.

The primary strength of the model is that it is an integrated systems model that includes existing and planned components of the potable and recycled water and wastewater systems. This allows for "cause and effect" tests where different modifications to the potable water, recycled water, and/or wastewater systems can be implemented, and the resulting water quality at the outfall is evaluated. For these reasons, the *OPTIMO®* model was utilized to help the project team test different system configurations related to the outfall water quality sequencing analysis.

Figure 1 shows the Oxnard system as represented in the *OPTIMO®* model.

Figure 1. Oxnard system modeled in *OPTIMO*®.



Additional model features that were not utilized in this analysis, but are available for use in future analyses include tracking energy and chemical use, and operating cost optimization.

This Section describes:

- Model scenarios.
- Model components and inputs.
- Model results.
- Conclusions.

2.2 MODEL SCENARIOS

The *OPTIMO*® model was developed to assist the project team in addressing the questions and scenarios described in Table 1 relative to the effects on the outfall discharge water quality.

Table 1 Planning Questions and Model Scenarios Public Works Integrated Master Plan City of Oxnard

Planning Question	Phase/Year	Modeled System Description
How much reuse water can be produced?	Phase I	6.25 mgd AWPF Capacity
	Phase II	12.5 mgd AWPF Capacity
	Phase III	18.75 mgd AWPF Capacity
What is the maximum capacity of the concentrate collection line?	Phase I	Oxnard Desalter & EF Oxnard
	Phase II	
	Phase III	
Is there a benefit to rerouting the MF backwash to the outfall?	Phase I	6.25 mgd AWPF Capacity
	Phase II	12.5 mgd AWPF Capacity
	Phase III	18.75 mgd AWPF Capacity

2.3 MODEL COMPONENTS AND INPUTS

The Oxnard wastewater system was modeled as a simplified system in *OPTIMO®*, including:

- Water quality.
- Influent wastewater diurnal flow patterns.
- Brine flows from BS 1/6 desalter and other brine contributors.
- Wastewater secondary treatment at the OWTP.
- Advanced wastewater treatment at the AWPF, including MF backwash and RO concentrate flows.
- Recycled water demands.
- Storage.
- Discharge flows to the ocean outfall and water quality permit requirements.

The data inputs used to develop the aforementioned model components are described in the following sections.

2.3.1 Water quality parameters

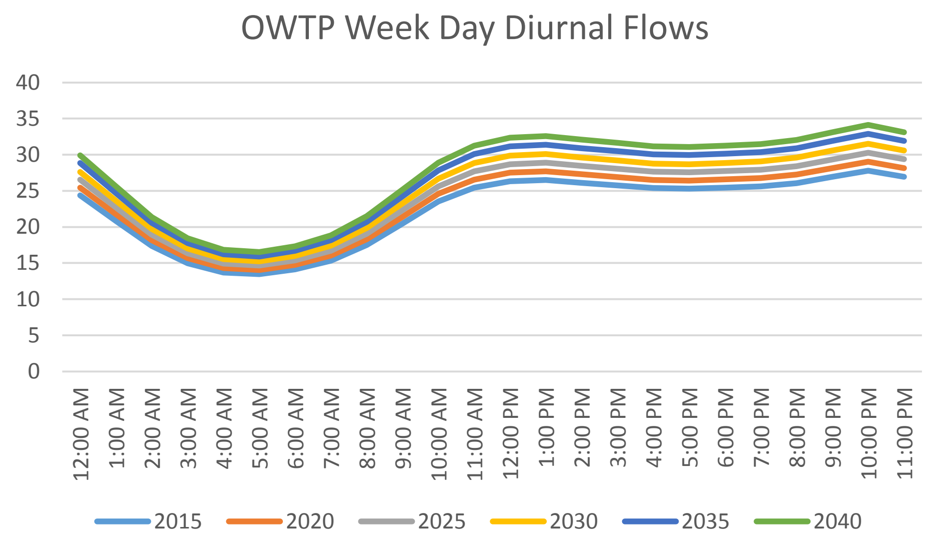
The following water quality parameters are tracked throughout the *OPTIMO®* model:

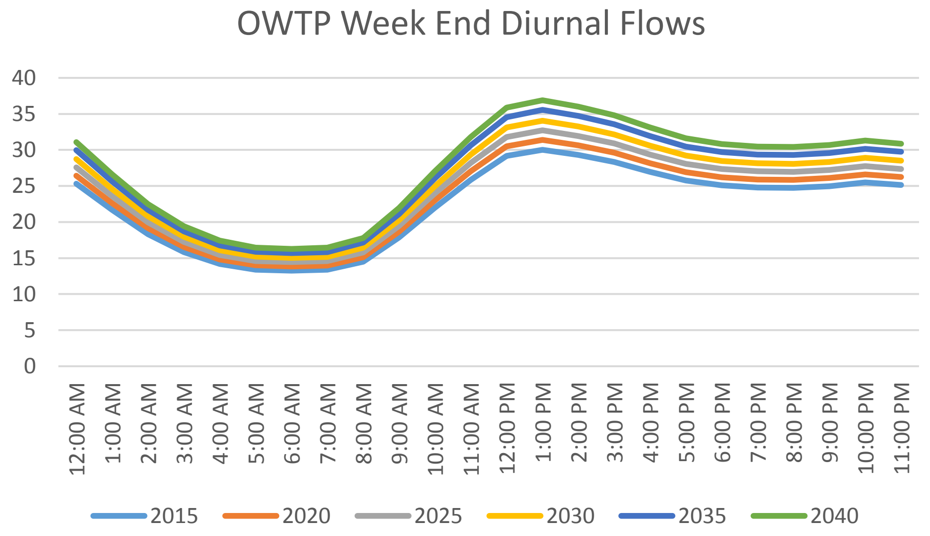
- TSS
- BOD
- NH3
- TDS
- Copper
- Bis (2-ethylhexyl) phthalate
- Nitrate
- O&G
- Toxicity
- Nanosilver
- sBOD

2.3.2 Wastewater diurnal flows and water quality

Wastewater diurnal flow patterns were developed for typical week day and weekends based on OWTP SCADA. ADWF projections described in PM 3.2 Flow and Load Projections and diurnal patterns were used to develop hourly flows as inputs to the *OPTIMO®* model. Figure 2 depicts the hourly flow patterns used for week days and weekends from 2015 through 2040.

Figure 2 OWTP week day and weekend diurnal patterns for 2015-2040





2.3.3 OWTP Secondary Treatment

Secondary treatment capacity was based on the capacity analysis completed in PM 3.4 Treatment Plant Performance and Capacity, and was assumed as 29.8 mgd for ADWF capacity.

Table 2 Removal Efficiencies at OWTP
Public Works Integrated Master Plan
City of Oxnard

Constituent	Removal Efficiency
Ammonia	16%
Bis (2-ethylhexyl) phthalate	
BOD	97%
sBOD	
Nanosilver	66
Nitrate	
Oil & Grease	
Total Copper	92%
Toxicity	
TDS	3.1%
TSS	98%

2.3.4 AWPF

Table 3 Removal Efficiencies for MF and RO
Public Works Integrated Master Plan
City of Oxnard

Constituent	MF Removal Efficiency (%)	RO Removal Efficiency (%)
Ammonia		
Bis (2-ethylhexyl) phthalate		
BOD		
sBOD		
Nanosilver		
Nitrate		
Oil & Grease		
Total Copper		
Toxicity		
TDS		
TSS		

2.3.5 Brine/Return flows and water quality

2.3.5.1 BS 1/6 Desalter

Table 4 Desalter Brine Water Quality
Public Works Integrated Master Plan
City of Oxnard

Constituent	Concentration (mg/L)
Ammonia	
Bis (2-ethylhexyl) phthalate	
BOD	
sBOD	
Nanosilver	
Nitrate	120
Oil & Grease	
Total Copper	
Total Silver	
Toxicity	
TDS	7800
TSS	

2.3.5.2 MF Backwash

2.3.5.3 RO Concentrate

2.3.6 Recycled Water Demands

Table 5 Recycled Water Demands Public Works Integrated Master Plan City of Oxnard			
Customer	**Phase I (Existing) Average Annual Demand (mgd)**	**Phase II (2015) Average Annual Demand (mgd)**	**Phase III (2027) Average Annual Demand (mgd)**
P&G		1.72	1.79
NewIndyPaper		0.61	0.61
RiverRidgeGC		1.38	1.38
RiverPkDev		0.13	0.13
Southland		0.61	0.61
Reiter		0.84	0.84
Houweling		0.61	0.61
Totals		**5.92**	**5.99**

Table 6 Recycled Water Quality Requirements Public Works Integrated Master Plan City of Oxnard	
Constituent	**Criteria (mg/L)**
Ammonia	
Bis (2-ethylhexyl) phthalate	
BOD	
sBOD	
Nanosilver	
Nitrate	
Oil & Grease	
Total Copper	
Total Silver	
Toxicity	
TDS	500
TSS	

2.3.7 Storage

The existing 5 million gallon (MG) secondary effluent equalization basin at the OWTP is included in the *OPTIMO*® model. For modeling purposes it is assumed that the basin is operated to fill and empty daily to equalize flows to the AWPF.

2.3.8 Ocean Outfall Discharge Limits

2.4 MODEL RESULTS

[In progress. To be included in final PM.]

2.5 CONCLUSIONS

[In progress. To be included in final PM.]