Volume 2: Appendices

OUTFALL LAND SECTION AND OOBS PIPING REHABILITATION

Draft Environmental Impact Report

Prepared for
Orange County
Sanitation District

December 2011

ESA

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Appendix A

Notice of Preparation and Comments on the NOP

ORANGE COUNTY SANITATION DISTRICT
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Costa Mesa Sanitary District
Midway City Sanitary District
Irvine Ranch Water District
County of Orange

Notice of Preparation

Date: August 8, 2011

To: Responsible and Trustee Agencies and Interested Parties

Subject: Notice of Preparation (NOP) of an Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation

Review Period: August 8 – September 8, 2011

The Orange County Sanitation District (Sanitation District) is the lead agency under the California Environmental Quality Act (CEQA) for the preparation of an Environmental Impact Report (EIR) for the proposed Outfall Land Section and Ocean Outfall Booster Pump Station (OOBS) Piping Rehabilitation (proposed Project). The proposed Project is located within the southeast corner of Sanitation District's Treatment Plant No. 2 (Plant 2) at 22212 Brookhurst Street, Huntington Beach. Additionally, there are two offsite locations: one site is in a vegetated area, along the western edge of Orange County bike path, between the south side of Plant 2 and Pacific Coast Highway (PCH), and the other site is on the south side of PCH, between the Huntington Beach Least Tern Preserve and the Santa Ana River, within Huntington State Beach.

Over the years, the Sanitation District has conducted several studies on the condition of its outfall systems and performed necessary repairs. To date the outfall system has only required minimal maintenance. However, a recent engineering report revealed that the steel bulkhead walls on the east and west sides of the Beach Box may be experiencing severe corrosion and may be structurally deficient. The engineering report recommended that the Beach Box be rehabilitated as soon as possible to avoid any potential risk of Beach Box failure. The recommended rehabilitation of the Beach Box is a key element of the proposed Project. Additionally, the Sanitation District outfall facilities are approximately forty years old and other repairs and internal / external inspections on the Long Outfall System are also needed at this time.

The proposed Project will consist of inspection, condition assessment, and rehabilitation of corroded components of the land section of the existing 120-inch diameter, primary five-mile outfall (Long Outfall) system extending from Surge Tower No. 2 (Surge Tower 2) within Plant 2 to the Beach Box located on Huntington State Beach. Specifically, the proposed Project includes five project elements that comprise the Long Outfall System rehabilitation: (1) rehabilitation of Surge Tower 2, (2) rehabilitation of the land Long Outfall, (3) abandonment of the Long Outfall metering ports and vaults, (4) replacement of the existing effluent flow meter on the Long Outfall and (5) rehabilitation of the Beach Box.

The EIR will evaluate two basic alternatives for rehabilitation the Long Outfall System.

Alternative 1 includes all five project elements and adds the installation of a temporary bypass structure immediately downstream of the Beach Box. The purpose of this structure is to allow the rehabilitation of the Beach Box without diverting treated effluent into the Short Outfall to discharge to the ocean. The Bypass structure would consist of two 60-inch (5-foot) overhead pipes which would be connected to the Short and Long Outfalls land sections.

Alternative 2 includes all five project elements and the use of the Short Outfall System to minimize the duration of the project construction activities. This Alternative would divert flow from the Long Outfall upstream of Surge Tower 2 to the 1-mile Short Outfall for discharge to the ocean for the duration of the inspection and rehabilitation activities.

The EIR will evaluate the potential for the discharge of treated effluent from the Short Outfall to affect shoreline water quality. The EIR will evaluate whether discharges to the Short Outfall will result in the need to close beaches any time during the four-to-six weeks of discharge.

During construction if wet weather conditions result in flows that exceed the Short Outfall capacity, excess flows would be discharged to the Santa Ana River through the existing emergency discharge weirs located at Plant 2.

Alternatives 1 and 2 would employ one of three construction options Carbon Fiber Wrap, Fiberglas Pipe Insert, and Steel Pipe Insert to repair beach box.

The Sanitation District is soliciting the views of interested persons and agencies as to the scope and content of the environmental information to be studied in the EIR. In accordance with CEQA, agencies are requested to review the project description provided in this NOP and provide comments on environmental issues related to the statutory responsibilities of the agency. The EIR will address written comments submitted during this initial review period and will evaluate potential impacts of the proposed project.

In accordance with the time limits mandated by CEQA, comments on the NOP must be received by the Sanitation District no later than 30 days after receipt of this notice. The Sanitation District requests that comments be received no later than **September 8, 2011.** Please send your comments to: Jim Burror at the address shown below. Please include a return address and contact name with your comments.

The NOP is available for public viewing at the Sanitation District's website at www.ocsd.com. To access, go to "Notice of Preparation - Rehabilitation of Land Section of Long Outfall System". Copies of the NOP are also available for public review at the following locations:

Orange County Sanitation District, Administrative Office Bldg., Engineering Department

Huntington Beach Central Library – 7111 Talbert Avenue, Huntington Beach, CA

Huntington Beach Banning Library – 9281 Banning Avenue, Huntington Beach, CA

PUBLIC SCOPING MEETING: A public scoping meeting will be held to receive public comments on the proposed Project. The scoping meeting will be open to the public on:

DATE:	Thursday, **August 25, 2011**
TIME:	6:30 p.m.
LOCATION:	Orange County Sanitation District Administrative Office Building – Board Room, at the address listed below

Written comments on the NOP can be sent to the Sanitation District at:

Address: Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

Or via e-mail at:

Email: jburror@ocsd.com

Introduction

The Notice of Preparation (NOP) has been prepared to notify agencies and interested parties pursuant to CEQA requirements that the Sanitation District, as the lead agency is beginning the preparation of an Environmental Impact Report (EIR) for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation (Project). The Sanitation District is proposing to rehabilitate its outfall system within its Treatment Plant 2 (Plant 2) in Huntington Beach and its Beach Junction Box (Beach Box), located at Huntington State Beach.

In 1999, the District prepared a Strategic Plan that identified projects needed to maintain and upgrade existing facilities to accommodate wastewater collection, treatment, and discharge requirements within its service area through 2020. The Sanitation District certified the Program Environmental Impact Report (PEIR) for the Strategic Plan in October 1999. The PEIR assessed the potential effects of the Strategic Plan on the local and regional environment, providing a program-level analysis for long-term planning.

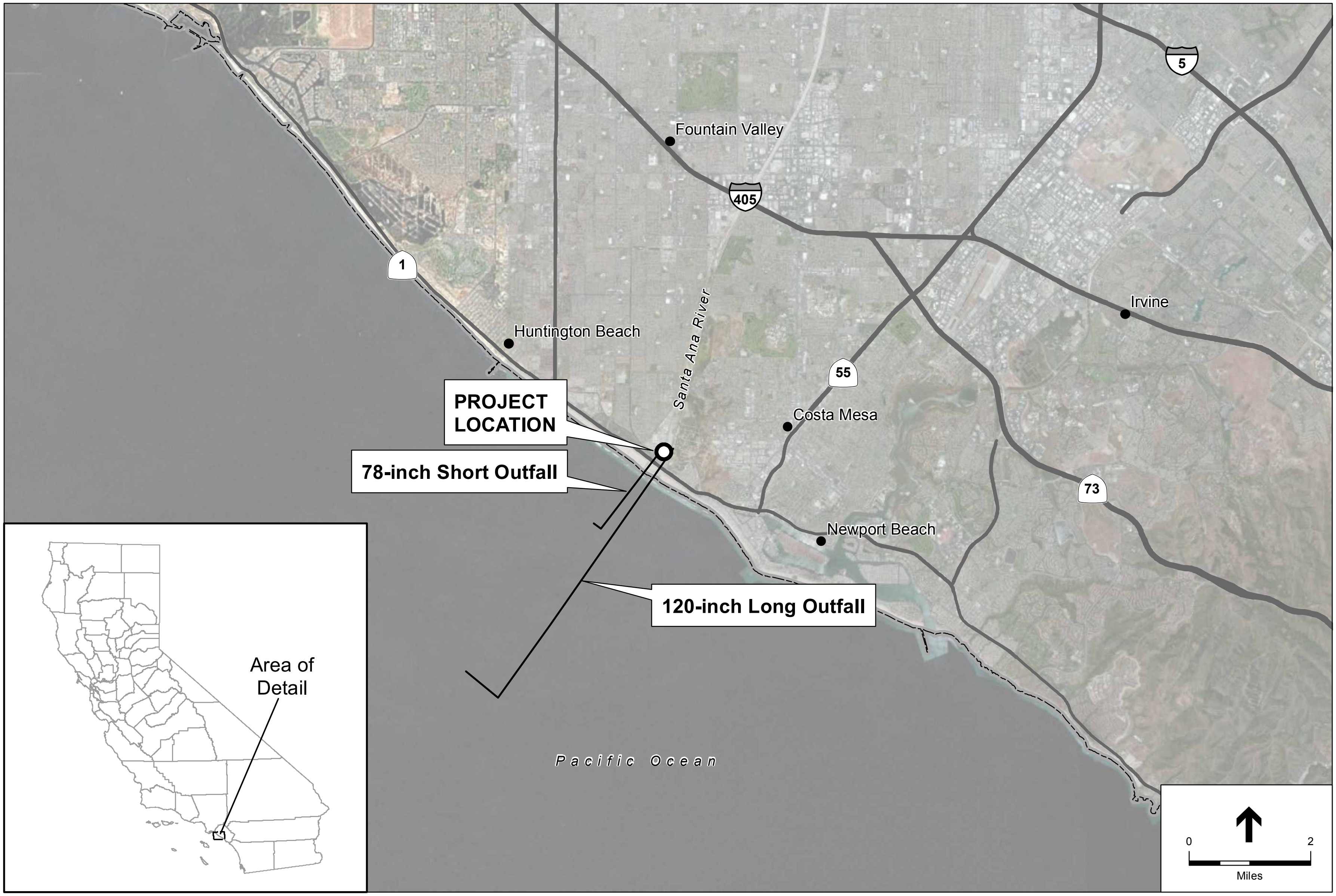
The proposed Project was not evaluated in the 1999 PEIR. Therefore, the Sanitation District is preparing an EIR to assess the Project. The EIR will incorporate by reference information from the 1999 PEIR, utilizing and referencing the analysis in the PEIR where appropriate, and augmenting that analysis to assess potential impacts of the proposed Project.

Project Background

Sanitation District is the third largest wastewater agency west of the Mississippi River serving a population of more than 2.6 million people. The Sanitation District is responsible for collection, treatment, recycle and disposal of treated wastewater generated in central and northwestern Orange County. The Sanitation District treats approximately 210 million gallons (mgd) of wastewater each day through two connected treatment plants located adjacent to the Santa Ana River (SAR), Reclamation Plant No. 1 in Fountain Valley and Treatment Plant No. 2 (Plant 2) in Huntington Beach. The combined treated effluent is discharged to the Pacific Ocean through a 120-inch diameter, primary, five-mile outfall (Long Outfall). **Figure 1** shows a schematic identifies the location of Plant 2 and the ocean outfall locations.

The Sanitation District maintains a smaller 78-inch diameter emergency 1-mile, short outfall (Short Outfall) that has been out of service since the Long Outfall was installed in 1971. The Sanitation District is permitted to discharge treated effluent to the Short Outfall during peak wet weather events and emergencies. The Sanitation District operates two outfall pump stations, the Ocean Outfall Booster Station (OOBS) and the Effluent Pump Station Annex (EPSA), located within Plant 2.

Of the average daily flow of 210 mgd the Sanitation District receives each day, an approximate net flow of 60 mgd is conveyed to the Groundwater Replenishment (GWR)



SOURCE: Bing Maps; ESA, 2011.

Outfall Land Section and OOBS Piping Rehabilitation. 211261

Figure 1
Regional Location Map

System for advanced treatment and recycling. The remaining average daily flow of 150 mgd is discharged through the Long Outfall system at Plant 2 to the Pacific Ocean on a regular basis.

Purpose and Need

Over the years, the Sanitation District has conducted several studies on the condition of its outfall systems and performed necessary repairs. To date the outfall system has only required minimal maintenance. However a recent engineering report revealed that the steel bulkhead walls on the east and west sides of the Beach Box may be experiencing severe corrosion and may be structurally deficient. The engineering report recommended that the Beach Box be rehabilitated as soon as possible to avoid any potential risk of Beach Box failure. Bulkheads separating the Long Outfall and the Short Outfall compartments and another at the east end of the Long Outfall compartment require that the Long Outfall compartment be taken out of service for access, proper inspection, and rehabilitation. Until this can be done, it will be difficult to assess the condition of these bulkheads or conduct the necessary rehabilitation. The recommended rehabilitation of the Beach Box is a key element of the proposed Project. Additionally, the Sanitation District outfall facilities are approximately forty years old and other repair and internal / external inspections on the Long Outfall System are also needed at this time.

Project Location

The Project site is located primarily within Plant 2 in the City of Huntington Beach, bounded by Hamilton Avenue to the north, Brookhurst Street to the west; Brookhurst Street runs adjacent to the property in a northwest to southeast manner. To the east is the Santa Ana River and to the south Pacific Coast Highway (PCH) and the Pacific Ocean. To the west and east lie residential neighborhoods.

Additionally, there are two offsite locations, one site in a vegetated area, along the western edge of the Orange County bike path, between the south side of Plant 2 and PCH, and the other site on the south side of PCH, between the Huntington Beach Least Tern Preserve and the Santa Ana River, within Huntington State Beach.

Project Description

The proposed Project will consist of inspection, condition assessment, and rehabilitation of corroded components of the land section of the existing 120-inch diameter, primary five-mile outfall (Long Outfall) system extending from Surge Tower No. 2 (Surge Tower 2) within the Sanitation District's Plant 2 to the Beach Box located on Huntington State Beach. Specifically, the proposed Project includes five project elements that comprise the Long Outfall System rehabilitation: (1) rehabilitation of Surge Tower 2, (2) rehabilitation of the land section of the Long Outfall, (3) abandonment of the Long Outfall metering ports and vaults, (4) replacement of the existing effluent flow meter on the Long Outfall and (5) rehabilitation of the Beach Box.

In order to accomplish this, it is necessary to take the Long Outfall System out of service. Two ways in which this could be accomplished are: 1) treated effluent flows from the Long Outfall could be temporarily diverted upstream of the Surge Tower 2 to the land section of the one-mile short outfall (Short Outfall) around the isolated project area and reconnect by constructing aboveground pipelines (a bypass) from the Short Outfall to the Long Outfall and continue to discharge treated effluent to the ocean, without use of the Short Outfall; or 2) divert flows from the Long Outfall upstream of Surge Tower 2 into the Short Outfall to discharge treated effluent to the ocean, without use the Long Outfall.

The EIR will evaluate the potential for the discharge of effluent from the Short Outfall to affect shoreline water quality. The EIR will evaluate whether discharges to the Short Outfall will result in the need to close beaches for any period of time during the four-to-six week construction period.

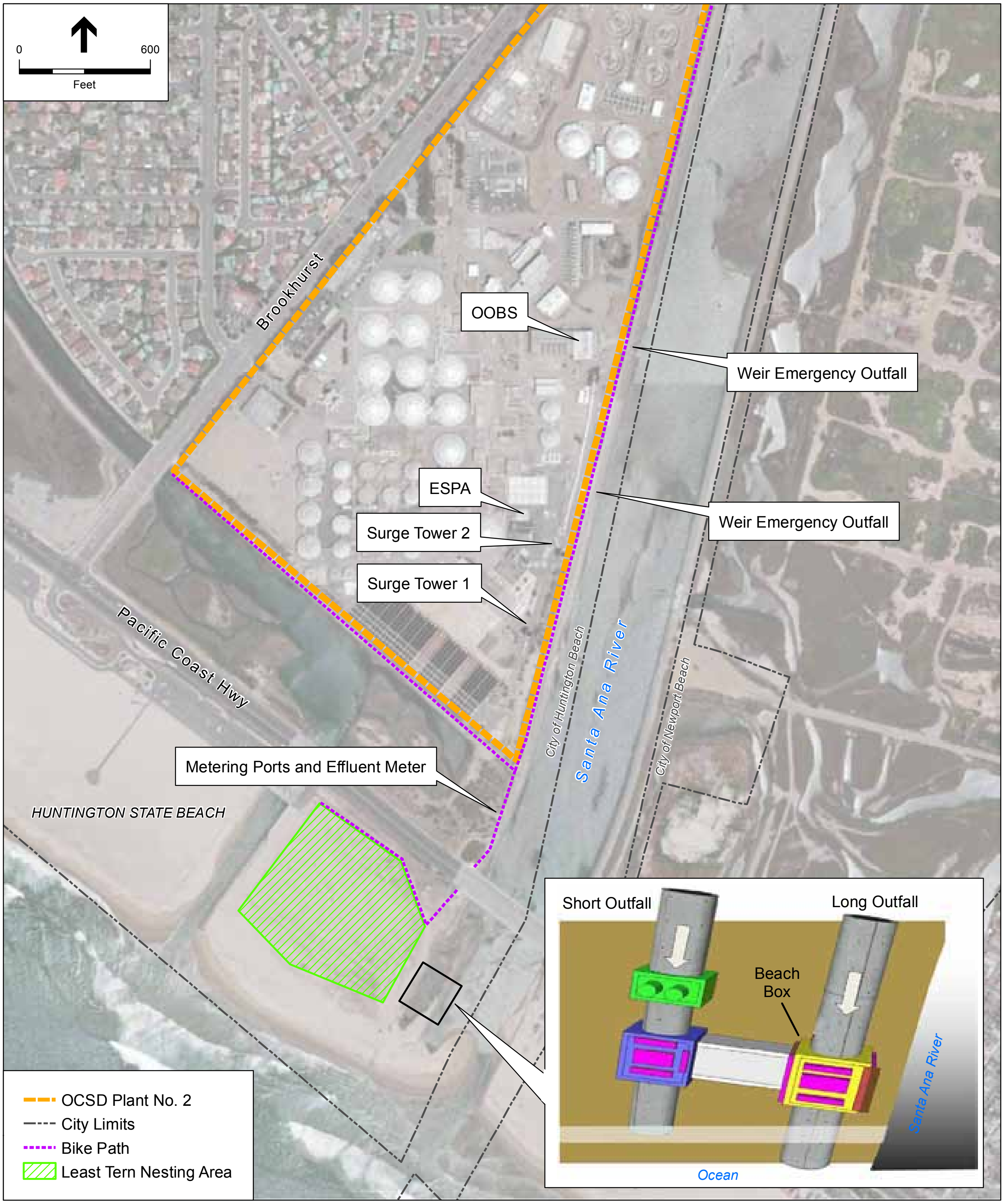
During construction if wet weather conditions result in flows that exceed the Short Outfall capacity, excess flows would be discharged to the Santa Ana River through the existing emergency discharge weirs located at Plant 2.

The two Alternatives considered for diverting flows are: Alternative 1, Bypass with no discharge to the Short Outfall and Alternative 2, Non-Bypass with discharge to the Short Outfall. Alternatives 1 and 2 would also employ one of three construction options: Carbon Fiber Wrap, Fiberglass Pipe Insert, and Steel Pipe Insert to repair the Beach Box. The EIR will evaluate the five project elements identified above that are applicable to Alternatives 1 and 2. The five project elements are further explained below. **Figure 2** shows the location of the project elements. **Figure 3** provides an additional view of the project element locations.

Surge Tower No. 2

Surge Tower No. 2 is located adjacent to the Santa Ana River within the Plant 2 boundaries downstream of Sanitation District (OOBS). Surge Tower 2 is 84.5 feet high and 26 feet in diameter, providing a tidal surge storage capacity of 318,000 gallons. The lower portion of Surge Tower 2 is made of concrete while the upper portion is made of steel. This structure is open to the atmosphere at the top. Treated effluent is pumped from one of the two existing ocean outfall pump stations, OOBS or EPSA, through Surge Tower 2 into the Long Outfall.

During a recent inspection of the Surge Tower 2, corrosion was observed along the upper edge of the steel portion of the Surge Tower 2. In order to protect this asset from further corrosion exterior and interior steel surfaces of the Surge Tower 2 will be blasted and recoated. In addition, the stairs and stair supports on the outside of Surge Tower 2 will be repaired. The stair treads leading to the top of the Surge Tower 2 will also be upgraded to meet current industry standards. During this process, electrical, instrumentation and low glare type lighting upgrades will also be performed.

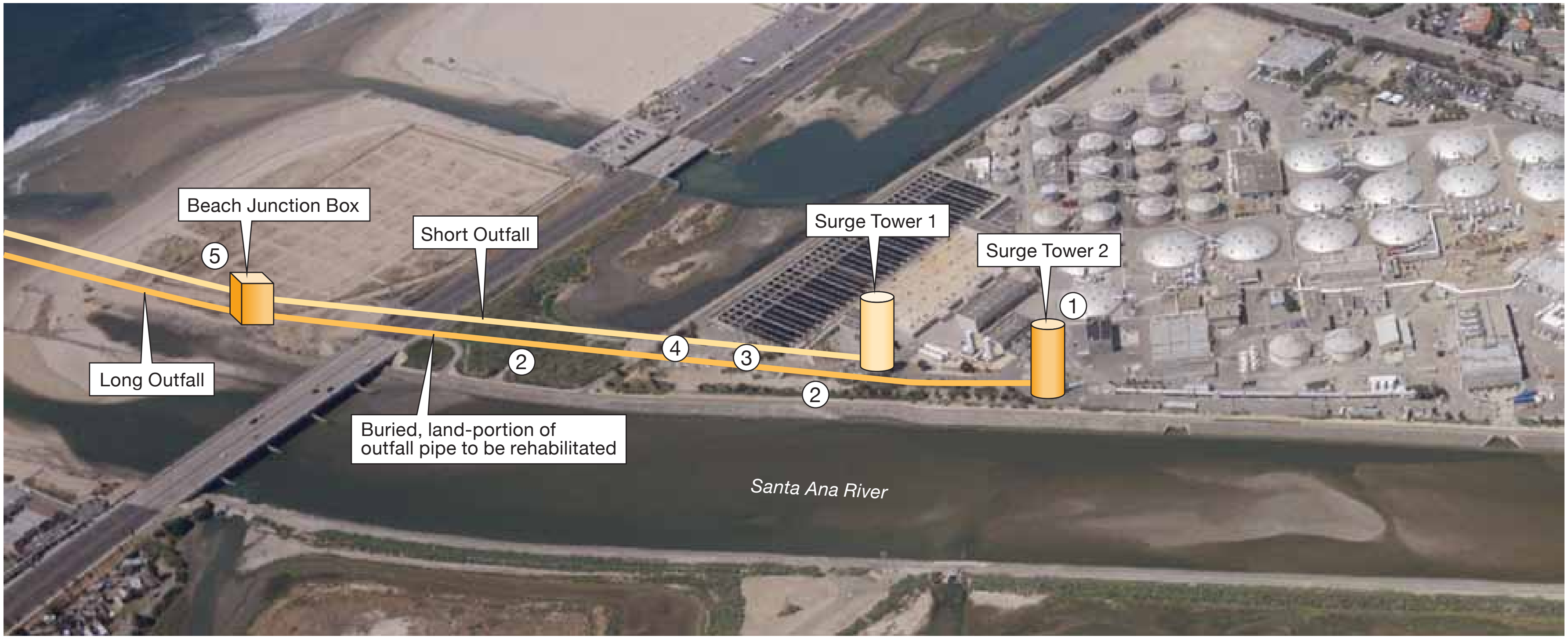


SOURCE: Bing Maps; ESA, 2011.

Outfall Land Section and OOBS Piping Rehabilitation. 211261

Figure 2

Location of Proposed Project Components



Scope

1. Coat inside / outside of Surge Tower 2
2. Long Outfall Repairs (including rehab of pipe risers)
3. Metering ports/vaults
4. Replace Effluent Meter
5. Inspect and repair Beach Junction Box (Beach Box)

SOURCE: Orange County Sanitation District, 2011.

Figure 3
Project Components

Long Outfall

The land section of the Long Outfall is approximately 1,900 feet long and 120-inches in diameter, and constructed of reinforced concrete pipe (RCP). There are three steel risers on the land section of the Long Outfall; two 24-inch diameter and one 42-inch diameter. The risers are welded to an internal steel cage in the Long Outfall. At ground level, these risers connect to the effluent sampler and two air vacuum release structures. The effluent sampler and one of the air vacuum release structures are located within the Plant 2 boundaries. A second air vacuum release structure is located outside of Plant 2 boundaries in a vegetated area, along the western edge of the Orange County bike path, between the southside of Plant 2 and PCH.

Corrosion was observed at the weld joints of these risers, which will require structural strengthening of riser connections. The proposed repairs entail structurally lining connection points of risers to the steel cage of the Long Outfall

Long Outfall Metering Ports/Vaults

The outfall meter ports are located within two meter vaults that straddle the Long Outfall within Plant 2 boundaries. These vaults/ports are obsolete and are expected to be abandoned in-place under the proposed Project.

The abandonment of the meter ports include: Removing the existing flow meter transducer probes and sealing interior surfaces. The abandonment of the metering vaults includes sealing the vaults with steel plates and lightweight cellular concrete. This requires taking out of service the land section of the Long Outfall

New Effluent Meter

An ultrasonic flow meter is located on the Long Outfall within Plant 2 boundaries. It is used to measure the effluent flow as required by the Sanitation District’s NPDES permit. The current metering technology is obsolete and replacement parts for repairs are not available. The Sanitation District is currently evaluating metering technologies which may simplify repair and maintenance requirements. The new meter will be installed in the same location as the existing effluent meter. This requires taking out of service the land section of the Long Outfall.

Beach Box

The Beach Box consists of two compartments: the Long Outfall compartment and the Short Outfall compartment (see Figure 2). The Long Outfall compartment is associated with the Long Outfall and includes both concrete and steel bulkhead sections. The Short Outfall compartment is attached to the Short Outfall and only has concrete sections. The original intent of the Beach Box was to provide an accessible location to isolate the Long Outfall and block the tidal flow of the Long Outfall System prior to manned entry for inspection, maintenance and rehabilitation. The proposed Project involves the rehabilitation of the Long Outfall compartment.

The Long Outfall compartment of the Beach Box consists of three levels: ground, intermediate and bottom. At ground level, a concrete cover has been placed over the Beach Box to prevent intruders from entering the Beach Box. At the intermediate level, there is a concrete deck that has three openings covered by steel frames and covers. The largest cover provides access to the outfall at the bottom. The Long Outfall enters and exits the Beach Box at the bottom level. The deck and metal covers at the intermediate level are under pressure from the effluent discharge.

Alternative 1, Bypass - No use of the Short Outfall

In order to accomplish the repairs identified above, the land section of the Long Outfall will need to be taken out of service for the duration of construction. Two alternatives have been developed to provide access to the Long Outfall for the construction activities. Alternative 1 includes the five project elements describe herein and adds the installation of a temporary bypass structure immediately downstream of the Beach Box. The purpose of this structure is to allow the rehabilitation of the Beach Box including the land section of the Long Outfall without diverting treated effluent into the Short Outfall to discharge to the ocean. The Short Outfall is the Sanitation District’s 1-mile pipeline for use under peak wet-weather flow events and other special conditions, as approved by the Regional Water Quality Control Board. The Bypass structure would consist of two 60-inch (5-foot diameter) aboveground pipes that would connect the land section of the Short Outfall with the land section of the Long Outfall. The Bypass pipes would be connected using a concrete drill to cut a hole in the existing pressurized pipe to make a new connection without service interruption or effluent leakage, a procedure known as “hot-tapping”. The overhead 60-inch pipes would be connected to pipe flanges on the Long and the Short Outfalls. Line stops (or isolation gates) would be installed upstream of the bypass structure on the Long Outfall and downstream of the bypass structure on the Short Outfall.

After construction is completed, the temporary aboveground bypass piping would be removed. The aboveground bypass structure would be temporary in nature and would be removed upon completion of construction.

Alternative 1 would employ one of three construction Options A, B, or C, identified below to repair the Beach Box.

- Option A - Carbon Fiber Wrap

  This Option includes structurally lining the bottom level of the Long Outfall compartment of the Beach Box with a Carbon Fiber Reinforced Polymer (CFRP) Liner. Walls, ceiling, and floor of the bottom level would be lined with this material. The underside of the concrete deck and interior concrete surfaces at the bottom level would be repaired as needed prior to installing the liner. The frames and plates around the openings on the intermediate level and the opening covers would be replaced. Concrete repairs to the walls from the deck to the ground level would also be made, as required.

- Option B Fiberglas Pipe Insert

  This involves removing most of the deck on the intermediate level so that two sections of fiberglass pipe may be lowered into the bottom level of the Beach Box. Each section, which is smaller in diameter than the existing Long Outfall, would be pushed up into the Long Outfall, upstream and downstream of the Beach Box. A 54-inch diameter riser with an access cover would be lowered into the Beach Box and connected to the two sections of fiberglass pipe. The riser would provide access to the Long Outfall. Fiberglass closure couplings would be used to connect the fiberglass pipe to the existing Long Outfall. After the pipes are set in place, the space above the pipes would be filled with a reinforced concrete material up to ground level.

- Option C Steel Pipe Insert

  This Option includes removing the covers from the intermediate level and inserting sections of steel pipe through the largest opening in the deck into the bottom level. The pipe sections would then be welded together in place. A 36-inch riser and access cover would be lowered into the bottom level and connected to the steel pipe sections. The riser will provide access to the Long Outfall. The pipes and riser would be wrapped with the CRFP material as well as the connection points between the steel pipe and the Long Outfall. The annular space surrounding the steel insert would be filled with grout. The existing concrete cover would be modified to accommodate the 36-inch riser and would be bolted back onto the frame at the top of the Beach Box. A coupling would be welded between the riser and the access cover to seal the interior of the Beach Box from the environment.

During construction if wet weather conditions resulted in flows that exceeded the Bypass capacity, excess flows would be discharged through the Short Outfall to the ocean. This potential discharge will be evaluated in the EIR.

Alternative 2, Non Bypass – Use of the Short Outfall

Alternative 2 – Includes all five project elements identified above and use of the Short Outfall System to minimize the duration of the proposed Project construction activities. The Short Outfall is the Sanitation District’s one-mile pipeline for use under peak flow events and other special conditions, as approved by the Regional Water Quality Control Board. This Alternative would divert flow from the Long Outfall upstream of Surge Tower 2 to the Short Outfall for discharge of treated effluent to the ocean for the duration of the rehabilitation activities -

This Alternative considers the same three construction options as Alternative 1 for repairing the Beach Box: Carbon Fiber Reinforced Polymer (CFRP) wrap, fiberglass insert, or steel insert.

During construction, additional repairs, such as meter replacement, Surge Tower 2 repairs, etc. would also take place on the Long Outfall System.

When the work is complete, the plug downstream of the Beach Box would be removed and flow will be diverted back to the Long Outfall.

During construction if wet weather conditions result in flows that exceed the Short Outfall capacity, excess flows would be discharged to the Santa Ana River through the existing emergency discharge weirs located at Treatment Plant No. 2. The EIR will evaluate the potential for the discharge of treated effluent from the Short Outfall to affect shoreline water quality. The EIR will evaluate whether discharges to the Short Outfall will result in the need to close beaches any time during the four-to-six weeks of discharge.

No Project Alternative

The EIR will evaluate the No Project Alternative. Under this Alternative, routine maintenance is anticipated to continue for the existing Long Outfall System. No rehabilitation or repairs would be implemented. The risk of potential failure of the discharge system would increase. A catastrophic failure of the system could result in effluent spills on the treatment plant site and at Huntington State Beach.

Construction Methods and Schedule

Construction of the proposed Project will vary depending on the Alternative:

- Alternative 1 Bypass, total construction duration approximately 5-6 months with no discharge to the Short Outfall;

- Alternative 2 Non-Bypass, total construction duration of 4-6 months with a period of between four to six weeks of discharge to the Short Outfall

Construction methods would vary depending on the Alternative, but could include activities such as excavation and backfill activities, sheet piling, dewatering, abrasive blasting, coating, cement pouring, framing and construction of bypass structure. The EIR will provide detailed descriptions of construction methods to be employed for each Alternative.

Potential Environmental Effects

The EIR will assess the physical changes to the environment that would likely result from construction and operation of the Project, including direct, indirect and cumulative impacts. Potential impacts of the Project are summarized below. The EIR will identify mitigation measures, as necessary, to minimize potentially significant impacts of the proposed project. The EIR also will include an analysis of project alternatives as required by CEQA.

Aesthetics

The Project would have aesthetic and visual impacts associated with construction on the Huntington State Beach. An analysis and description of existing visual conditions within the project area will be conducted to evaluate if the project would substantially degrade the existing visual character of the project area. Alternative 1 would require 5-6 months of construction on the beach that would install temporary large industrial bypass pipelines visible from all directions. Under Alternative 2, construction activities would likely be 24 hours a day, seven days a week to minimize use of the Short Outfall, The EIR will evaluate impacts from nighttime light and glare. The EIR will also evaluate the potential effects to public view corridors resulting from the Project and determine whether it would substantially alter the character of the site or create substantial new sources of light and glare. Mitigation measures will be developed as necessary to reduce the level of impact where possible

Air Quality and Greenhouse Gas (GHG) Emissions

The Project would generate air emissions during project construction. Construction emissions sources include equipment exhaust, earth movement, construction workers' commute, and material hauling. The EIR will estimate construction-related emissions and long-term operational emissions. The EIR will compare project emissions with the South Coast Air Quality Management District (SCAQMD) thresholds of significance and will also evaluate the Project's consistency with the regional air quality attainment plans. Mitigation measures will be developed as necessary to reduce the level of impact where possible

Construction-related and operational Greenhouse Gas Emissions (GHGs) for the Project would be quantified and analyzed in terms of CO_2 equivalents (CO_2e) to account for varying warming potential of gases. The EIR will analyze and compare to regional thresholds of significance. The EIR will also evaluate and determine whether the project would interfere with implementation of the California Global Warming Solutions Act of 2006 (Assembly Bill No. 32 [AB32]), which sets Statewide goals to reduce GHGs to 1990 levels by 2020 Mitigation measures will be developed, as necessary, to reduce impact to a less than significance level.

Biological Resources

The Project would include construction on the Huntington State Beach that could affect biological resources including rare plants, the least tern and snowy plover. Limiting construction to the non-nesting season as proposed would substantially reduce any effect to these species. The EIR will include a list of threatened and endangered and other sensitive species with potential to occur within, or adjacent to, the project area through the California Department of Fish and Game (CDFG) and the California Natural Diversity Database (CNDDB). The EIR will evaluate the potential impacts to sensitive species and habitats on the Huntington State Beach and mitigation measures will be developed to reduce the level of significant impact where possible.

Cultural Resources and Paleontological Resources

The minimal excavation required for this Project could uncover previously unknown archaeological or paleontological resources. The EIR will assess potential project impacts to archeological, historical, and paleontological resources. Mitigation measures will be developed as necessary to minimize impacts where possible

Geology, Soils and Seismicity

The Project would be located in a seismically active region. The construction of Project components could be subject to potential seismic hazards including ground shaking. The EIR will evaluate Project-related geologic impacts and develop mitigation measures as necessary to reduce potential effects from the proposed project. Mitigation measures will be developed, as necessary, to reduce the level of impact where possible

Hazards and Hazardous Materials

The EIR will summarize known hazardous waste contamination sites in the project area and will list potentially hazardous materials used and stored during construction and operation of the Project. The EIR will include mitigation measures for safe handling and disposal of hazardous materials and contaminated soils. The EIR also will address the potential for soil contamination and groundwater contamination and develop mitigation measures to prevent contamination, as necessary.

Hydrology and Water Quality

The Project site is located in close proximity to the Santa Ana River and to the Pacific Ocean. Excavation and construction activities would affect storm water quality if sediment or spills run off the project construction site. The EIR will describe storm water runoff control requirements and provide mitigation, as necessary, to meet construction and operational storm water runoff quality requirements. The EIR will also evaluate potential water quality impacts of discharging to the Santa Ana River during peak wet weather events. Groundwater dewatering may be necessary under Alternative 1. The EIR will evaluate impacts associated with groundwater dewatering activities. Mitigation measures will be developed, as necessary, to reduce the level of impact where possible.

Land Use

The EIR will identify current land uses and sensitive receptors in the project vicinity. Local General Plans, airport land use plans, and habitat conservation plans will be identified and summarized if applicable. The Coastal Element will also be evaluated and summarized. The Coastal Element includes a land use plan and specific policies associated to coastal-related issues and proposed development within a jurisdiction's Coastal Zone boundary as required by the Local Coastal Programs and Coastal Act. The EIR will evaluate allowable activities within State Department of Parks and Recreation (State Parks) and project consistency with the existing land use and zoning designations. Mitigation measures will be developed as necessary to reduce the level of impact where possible

Marine Environment

The EIR will evaluate possible adverse impacts to marine life and ocean water quality during the discharge of treated effluent. The EIR will evaluate results of a particle transport model that will estimate the likelihood of the discharge plume reaching the shoreline under various ocean current scenarios. He EIR will evaluate the potential for the discharge of treated effluent from the Short Outfall under Alternative 2 to affect shoreline water quality. The EIR will evaluate whether discharges to the Short Outfall will result in the need to close beaches any time during the four to six week discharge period. The EIR will also evaluate potential impacts to ocean water quality from potential discharge to the Santa Ana River during wet weather events that may occur during the construction period under Alternative 2. The EIR will develop mitigation measures as necessary to minimize any potential significant impacts.

Noise and Vibration

Construction and operation of the Project would generate noise during construction activities that could affect nearby residences and other sensitive receptors in the Project vicinity. Under Alternative 2, construction activities will likely be 24 hours a day seven days a week to minimize use of the Short Outfall. The EIR will evaluate peak noise and vibration levels generated by construction equipment and activities on the beach. The EIR will evaluate state and local noise policies, regulations, and standards and determine the Project's ability to comply with existing noise standards and policies. Mitigation measures will be developed as necessary to reduce the level of impact where possible.

Recreation

The Project site is located on the Huntington State Beach. The EIR will discuss potential impacts to recreational activities, including the potential to affect beach access, bike path and beach parking, and identify significance thresholds for impacts to recreational facilities. The EIR will identify mitigation measures to reduce the effects of the proposed Project to recreation facilities and activities in the area.

Traffic and Transportation

Construction of the Project could affect parking at Huntington State Beach and would temporarily close or detour existing bike path(s) in the project vicinity. The EIR will characterize roadways and bike paths and analyze potential project-related impacts. The

EIR will assess potential construction traffic impacts to local roadways. The EIR will develop mitigation measures as necessary to minimize any potential significant impacts.

Utilities and Service Systems

The proposed Project would require that the Long Outfall be out of commission during construction of Alternative 2, requiring the Short Outfall to accommodate full discharge volumes for a period of four to six weeks. The EIR will evaluate impacts to public services and utilities while using the Short Outfall during construction. The EIR will develop mitigation measures, as necessary, to minimize any potential effects.

Comments on the NOP

August 18, 2011

Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

Attention: Jim Burror

RE: The Orange County Sanitation District's Notice Of Preparation of an Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation

Dear Mr. Burror:

I have reviewed the above Notice of Preparation and I have the following comments:

I strongly support Alternative One because I believe Alternative Two (discharging up to 150 mgd of treated sewage from the short outfall) would pose a significant threat to recreational ocean swimmers in both Newport Beach and Huntington Beach.

Prior to 1970 before the construction of the long outfall, effluent discharges from the short outfall came ashore on a number of occasions.

I have learned that, recently, it was necessary to use the short outfall for effluent discharge and there was a surfacing of the plume resulting in a large boil. This is not surprising because the short outfall is located in shallow water and lacks a thermocline barrier needed to prevent the plume from surfacing. Along with wind-driven surface currents, this puts the nearby beaches and swimming areas at much greater risk of contamination.

Even if the discharge is to be all secondary treated sewage with chlorination, it is still expected that human viruses would persist. It is much easier to remove or kill the indicator bacteria than it is to remove or kill the viruses responsible for gastrointestinal illnesses in swimmers and it is the viruses that primarily put the swimmers at risk.

For these reasons, I believe that Alternative One should be the only alternative acceptable for this project. With this alternative, flows out the long outfall would be maintained by installing a temporary bypass structure immediately downstream from the Beach Box that would thereby allow the restoration project to be completed without diverting treated sewage into the short outfall that discharges just one mile off of popular swimming beaches.

Thank you for the opportunity to comment on this matter.

Sincerely,

John F. Skinner, M.D.
Diplomate, American Board of Internal Medicine

Southern
California
Gas Company

A Sempra Energy utility℠

1919 S. State College Blvd.
Anaheim, CA 92806-6114

August 23, 2011

Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

Attention: J Burror

Subject: Program Environmental Impact Report For Outfall Land Section And Ocean Outfall Booster Pump Station Piping Rehabilitation

Thank you for providing the opportunity to respond to this E.I.R. Document. We are pleased to inform you that Southern California Gas Company has facilities in the area where the aforementioned project is proposed. Gas service to the project can be provided from an existing gas main located in various locations. The service will be in accordance with the Company's policies and extension rules on file with the California Public Utilities Commission when the contractual arrangements are made.

This letter is not a contractual commitment to serve the proposed project but is only provided as an informational service. The availability of natural gas service is based upon conditions of gas supply and regulatory agencies. As a public utility, Southern California Gas Company is under the jurisdiction of the California Public Utilities Commission. Our ability to serve can also be affected by actions of federal regulatory agencies. Should these agencies take any action, which affect gas supply or the conditions under which service is available, gas service will be provided in accordance with the revised conditions.

This letter is also provided without considering any conditions or non-utility laws and regulations (such as environmental regulations), which could affect construction of a main and/or service line extension (i.e., if hazardous wastes were encountered in the process of installing the line). The regulations can only be determined around the time contractual arrangements are made and construction has begun.

Estimates of gas usage for residential and non-residential projects are developed on an individual basis and are obtained from the Commercial-Industrial/Residential Market Services Staff by calling (800) 427-2000 (Commercial/Industrial Customers) (800) 427-2200 (Residential Customers). We have developed several programs, which are available upon request to provide assistance in selecting the most energy efficient appliances or systems for a particular project. If you desire further information on any of our energy conservation programs, please contact this office for assistance.

Sincerely,

Mike Harriel
Technical Services Supervisor
Orange Coast Region - Anaheim

MH/ag
eir02.doc

Sent: Wednesday, August 24, 2011 8:11 AM
Subject: NOP Outfall Land Section and Ocean Outfall

The Orange County Fire Authority has reviewed the subject documents and has no comments.

Michele Hernandez
Management Analyst
Orange County Fire Authority
714-573-6199

Sent: Wednesday, August 24, 2011 2:29 PM
Subject: RE: Notice of Preparation - EIR for Ocean Outfall Rehabilitation

1. Possible use of the short outfall obviously raises concerns regarding potential high bacteria counts at the beach, despite the current increased level of treatment and the chlorination. We believe that it's important the the beaches at Huntington State Beach and north Newport Beach be intensively monitoring (perhaps twice per day) during any period of use of the short outfall. The monitoring should probably start at least a week before the switchover so baseline data can be generated.

2. What is the capacity of the short outfall versus the current flow of about 150 MGD? What has been the history of wet weather flow increases in Sept-Oct.? This is a major concern because, according to the NOP, excess flows would go directly to the Santa Ana River.
3. Has the short outfall been inspected for integrity recently or will it be inspected prior to this work? This is critical to the use of Alternative 2.
4. Regarding Alternative 1, this contemplates the use of a "hot tapping" procedure to cut into the large/long outfall line when it is in use to make the bypass connections. How reliable is this method? What contingencies would be used in case of a leak?

5. It is important to minimize any closures of the bike path and reduction in parking at Huntington State Beach.

We may submit additional comments based upon information presented at the public scoping meeting.

Thank you for the opportunity to comment on this project.

949-492-8170 x415
rwilson@surfrider.org

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Check out Surfrider's Beachapedia, our compendium of coastal information.

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LOCAL AGENCY FORMATION COMMISSION

ORANGE COUNTY

August 30, 2011

Mr. Jim Burror
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

SUBJECT: Comments on Notice of Preparation of an Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation

Dear ~~Mr. Burror~~ Jim:

Thank you for this opportunity to comment on the above mentioned Notice of Preparation (NOP). As a responsible agency, the Local Agency Formation Commission (LAFCO) has reviewed the NOP and has no comments at this time. However, we would like to review the Environmental Impact Report when it is available.

If you have any questions or concerns, please contact me at blegbandt@oclafco.org or (714) 934-2556.

Best Regards,

Benjamin Legbandt
Policy Analyst II

12 Civic Center Plaza, Room 235, Santa Ana, CA 92701
(714) 834-2556 ◆ FAX (714) 834-2643
http://www.oclafco.org

Sent: Tuesday, August 30, 2011 8:43 AM
Subject: OCSD Outfall Repair Project

Hi Michael,

Nice chatting this a.m. My gut reaction to their proposal is to support the use of the shorter outfall without the extra construction to divert back and forth between the two to use the longer outfall while the repairs are done. I haven't talked with Jim Burror but I encourage you as the President Newport Shores Homeowners Association to have direct conversation with him about the impacts to using the shorter outfall for a period of time. I would hope the use of the shorter outfall could be minimized and done during the winter months. I would also assume they have some sort of modeling to show negligible effects on ocean water quality at the surf line of using the shorter outfall.

I ccd Jim here so he could hear my thoughts as well. I have also attached his contact information. Talk with you soon.

Michael J. Sinacori, P.E.

Assistant City Engineer
City of Newport Beach
Phone: 949-644-3342 * Fax: 949-644-3308 * Cell: 949-795-8948
Email: Msinacori@newportbeachca.gov
Public Works Department ~ A Well-Engineered Machine
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OCTA

AFFILIATED AGENCIES

Orange County
Transit District

Local Transportation
Authority

Service Authority for
Freeway Emergencies

Consolidated Transportation
Service Agency

Congestion Management
Agency

Service Authority for
Abandoned Vehicles

August 30, 2011

Mr. Jim Burror
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, California 92708

Dear Mr. Burror:

Thank you for the opportunity to review the Notice of Preparation of an Environmental Impact Report (EIR) for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation project. The Orange County Transportation Authority (OCTA) has completed its review and has the following comments:

1. In general, any construction or permanent impacts to OCTA bus service and facilities (i.e., bus shelters or benches) along affected routes such as Pacific Coast Highway and Brookhurst Street need to be addressed in the EIR.

2. If any impacts described above are anticipated, OCTA should be contacted to initiate early coordination.

If you have any questions regarding these comments you can contact me at (714) 560-5907.

Sincerely,

Dan Phu
Section Manager, Environmental Programs

c: Beth McCormick, OCTA General Manager, Transit
   Carolyn Mamaradlo, OCTA Planning

Orange County Transportation Authority
550 South Main Street / P.O. Box 14184 / Orange / California 92863-1584 / (714) 560-OCTA (6282)

South Coast
Air Quality Management District
AQMD
21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 · www.aqmd.gov

August 26, 2011

Jim Burror
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

Notice of Preparation of a CEQA Document for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation

The South Coast Air Quality Management District (SCAQMD) appreciates the opportunity to comment on the above-mentioned document. The SCAQMD's comments are recommendations regarding the analysis of potential air quality impacts from the proposed project that should be included in the draft environmental impact report (EIR). Please send the SCAQMD a copy of the Draft EIR upon its completion. Note that copies of the Draft EIR that are submitted to the State Clearinghouse are not forwarded to the SCAQMD. Please forward a copy of the Draft EIR directly to SCAQMD at the address in our letterhead. **In addition, please send with the draft EIR all appendices or technical documents related to the air quality and greenhouse gas analyses and electronic versions of all air quality modeling and health risk assessment files. These include original emission calculation spreadsheets and modeling files (not Adobe PDF files). Without all files and supporting air quality documentation, the SCAQMD will be unable to complete its review of the air quality analysis in a timely manner. Any delays in providing all supporting air quality documentation will require additional time for review beyond the end of the comment period.**

Air Quality Analysis

The SCAQMD adopted its California Environmental Quality Act (CEQA) Air Quality Handbook in 1993 to assist other public agencies with the preparation of air quality analyses. The SCAQMD recommends that the Lead Agency use this Handbook as guidance when preparing its air quality analysis. Copies of the Handbook are available from the SCAQMD's Subscription Services Department by calling (909) 396-3720. The lead agency may wish to consider using land use emissions estimating software such as URBEMIS 2007 or the recently released CalEEMod. These models are available on the SCAQMD Website at: http://www.aqmd.gov/ceqa/models.html.

The Lead Agency should identify any potential adverse air quality impacts that could occur from all phases of the project and all air pollutant sources related to the project. Air quality impacts from both construction (including demolition, if any) and operations should be calculated. Construction-related air quality impacts typically include, but are not limited to, emissions from the use of heavy-duty equipment from grading, earth-loading/unloading, paving, architectural coatings, off-road mobile sources (e.g., heavy-duty construction equipment) and on-road mobile sources (e.g., construction worker vehicle trips, material transport trips). Operation-related air quality impacts may include, but are not limited to, emissions from stationary sources (e.g., boilers), area sources (e.g., solvents and coatings), and vehicular trips (e.g., on- and off-road tailpipe emissions and entrained dust). Air quality impacts from indirect sources, that is, sources that generate or attract vehicular trips should be included in the analysis.

The SCAQMD has developed a methodology for calculating PM2.5 emissions from construction and operational activities and processes. In connection with developing PM2.5 calculation methodologies, the SCAQMD has also developed both regional and localized significance thresholds. The SCAQMD requests that the lead agency quantify PM2.5 emissions and compare the results to the recommended PM2.5 significance thresholds. Guidance for calculating PM2.5 emissions and PM2.5 significance thresholds can be found at the following internet address: http://www.aqmd.gov/ceqa/handbook/PM2_5/PM2_5.html.

In addition to analyzing regional air quality impacts the SCAQMD recommends calculating localized air quality impacts and comparing the results to localized significance thresholds (LSTs). LST's can be used in addition to the recommended regional significance thresholds as a second indication of air quality impacts when preparing a CEQA document. Therefore, when preparing the air quality analysis for the proposed project, it is recommended that the lead agency perform a localized significance analysis by either using the LSTs developed by the SCAQMD or performing dispersion modeling as necessary. Guidance for performing a localized air quality analysis can be found at http://www.aqmd.gov/ceqa/handbook/LST/LST.html.

In the event that the proposed project generates or attracts vehicular trips, especially heavy-duty diesel-fueled vehicles, it is recommended that the lead agency perform a mobile source health risk assessment. Guidance for performing a mobile source health risk assessment ("Health Risk Assessment Guidance for Analyzing Cancer Risk from Mobile Source Diesel Idling Emissions for CEQA Air Quality Analysis") can be found on the SCAQMD's CEQA web pages at the following internet address: http://www.aqmd.gov/ceqa/handbook/mobile_toxic/mobile_toxic.html. An analysis of all toxic air contaminant impacts due to the decommissioning or use of equipment potentially generating such air pollutants should also be included.

Mitigation Measures

In the event that the project generates significant adverse air quality impacts, CEQA requires that all feasible mitigation measures that go beyond what is required by law be utilized during project construction and operation to minimize or eliminate significant adverse air quality impacts. To assist the Lead Agency with identifying possible mitigation measures for the project, please refer to Chapter 11 of the SCAQMD CEQA Air Quality Handbook for sample air quality mitigation measures. Additional mitigation measures can be found on the SCAQMD's CEQA web pages at the following internet address: www.aqmd.gov/ceqa/handbook/mitigation/MM_intro.html Additionally, SCAQMD's Rule 403 – Fugitive Dust, and the Implementation Handbook contain numerous measures for controlling construction-related emissions that should be considered for use as CEQA mitigation if not otherwise required. Other measures to reduce air quality impacts from land use projects can be found in the SCAQMD's Guidance Document for Addressing Air Quality Issues in General Plans and Local Planning. This document can be found at the following internet address: http://www.aqmd.gov/prdas/aqguide/aqguide.html. In addition, guidance on siting incompatible land uses can be found in the California Air Resources Board's Air Quality and Land Use Handbook: A Community Perspective, which can be found at the following internet address: http://www.arb.ca.gov/ch/handbook.pdf. CARB's Land Use Handbook is a general reference guide for evaluating and reducing air pollution impacts associated with new projects that go through the land use decision-making process. Pursuant to state CEQA Guidelines §15126.4 (a)(1)(D), any impacts resulting from mitigation measures must also be discussed.

Data Sources

SCAQMD rules and relevant air quality reports and data are available by calling the SCAQMD's Public Information Center at (909) 396-2039. Much of the information available through the Public Information Center is also available via the SCAQMD's World Wide Web Homepage (http://www.aqmd.gov).

The SCAQMD is willing to work with the Lead Agency to ensure that project-related emissions are accurately identified, categorized, and evaluated. If you have any questions regarding this letter, please call Ian MacMillan, Program Supervisor, CEQA Section, at (909) 396-3244.

Sincerely,

Susan Nakamura
Planning and Rules Manager
Planning, Rule Development & Area Sources

IM
ORC110810-10
Control Number

State of California • Natural Resources Agency **Edmund G. Brown, Jr., *Governor***

DEPARTMENT OF PARKS AND RECREATION **Ruth Coleman, *Director***
Orange Coast District ▪ 3030 Avenida del Presidente ▪ San Clemente, CA 92672
949-492-0802 ▪ FAX 949-492-8412

Transmitted via email to: Jburror@ocsd.com

September 6, 2011

Jim Burror, Engineering Supervisor
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

In Re: Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation
Notice of Preparation of Draft Environmental Impact Report – SCH No. 2011081022

Dear Mr. Burror:

We appreciate the opportunity to provide feedback on the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation – Notice of Preparation ("NOP") of Draft Environmental Impact Report ("EIR") SCH No. 2011081022. The California Department of Parks and Recreation ("State Parks"), as defined by the California Environmental Quality Act ("CEQA") and its implementing regulations, is a State Agency (Pub. Res. Code § 21082.1) a Responsible Agency (Pub. Rec. Code § 20169) and a Trustee Agency (CEQA Guideline 15386) for the resources affected by this proposed project within units of the State Park System. State Parks' mission in part is to provide for the health, inspiration and education of the people of California by preserving the state's extraordinary biodiversity, protecting its most valued natural and cultural resources and creating opportunities for high quality outdoor recreation.

We have an interest and concern about the contemplated land use in the vicinity of parks in Orange County, namely Huntington State Beach ("HSB") – home to the HSB Least Tern Natural Preserve. The long term health of HSB is dependent on the health of the regional ecosystems because the biotic boundaries of the park extend beyond its jurisdictional boundaries.

As this project may impact HSB, the park visitors and those resources that State Parks is mandated to protect, we submit the following comments for consideration and ask that these issues be addressed.

Biological Resources – Huntington State Beach Least Tern Natural Preserve: (1) The area at HSB is defined by the California State Parks Commission as the" Huntington State Beach Least Tern Natural Preserve" and should be named as such. (2) The California Least Tern Natural Preserve is annually one of the top 5 colonies statewide in production of this endangered species. Great care and appropriate timing is needed to avoid impacts to the breeding colony. The USFWS names the breeding season for this species as April 1 to Sept. 1 of each year. If construction work extended into the breeding season, sound walls and other appropriate protections for the colony would be needed. (3) This Natural Preserve contains Western snowy plovers throughout the year and California least terns during the breeding season. Daily biological monitors will be required to ensure impact avoidance. (4) All work for this project should be conducted so as not to enhance known predators to the least terns. Black rats in jetty rocks should not be afforded lunch food debris for example. Coyotes should not be attracted to the site as they have also been problematic. (5) California least terns nested within the limits of Alternative 1 project proposal and as such will need to be fully mitigated for this endangered species' breeding and loafing areas.

Biological Resources – Vegetation- Wetland/Riparian: (1) Mapping of impacts should be more clearly defined to better locate inland impacts to the Huntington Beach Wetlands restoration areas and mitigations needed. (2) Proposed work SE of the CLT colony needs to be carefully defined and mitigations assigned. CNPS 1B1 plants grow in abundance, as well as rare foredune habitat plants that will need to be fully mitigated at the end of the project.

Hydrology/Water Quality: (1) Any condition that necessitates emergency diversions of effluent into the Santa Ana River should be avoided.

Land Use: A review of the easements and identified boundaries of HSB and the Sanitation District need to be clearly defined. A survey of the corners and alignments should be reviewed during planning and before any earth work is conducted. A Right-of-Entry permit will be required if work takes place on any portion of HSB.

Recreation: Any alternative that closes beaches at the popular surfing and swimming area should be avoided.

Traffic/Circulation: (1) Construction activities, access routes, and laydown areas all need to consider visitor activity in and around this popular location. Separation of construction activities from the bike path needs careful consideration. (2) After construction activities, the final surface needs to be barefoot friendly.

***Cumulative Impacts*:** State Parks requires all of their facilities be made whole or improved at the end of the project to including fencing, signs, access routes, bike path, parking lots, barriers, light poles, painting and striping.

We appreciate efforts to preserve the viability of Huntington State Beach as well as recreational opportunities. Please include careful analysis to assess the possibility of impacts to Huntington State Beach and other down-coast resources in your draft EIR.

Should you have any questions or need additional information, please do not hesitate to contact Park and Recreation Specialist Julie Tobin at 949-607-9510 and/or via email to Jtobin@parks.ca.gov.

We appreciate the opportunity to comment on this project.

Respectfully,

Rich Haydon
Acting District Superintendent
Orange Coast District

Copy via email to: Clarissa Sampaga, DPR – Natural Resources Division
Copy via email to: State Clearing House
Copy via email to: CA Dept. of Water Resources

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY EDMUND G. BROWN Jr., Governor

DEPARTMENT OF TRANSPORTATION
District 12
3347 Michelson Drive, Suite 100
Irvine, CA 92612-8894
Tel: (949) 724-2241
Fax: (949) 724-2592

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September 7, 2011

Jim Burror
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, California 92708-7018

File: IGR/CEQA
SCH#: 2011081022
Log #: 2772
SR-1

Subject: Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation

Dear Ms. Burror,

Thank you for the opportunity to review and comment on the **Notice of Preparation (NOP) for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation Project.** The proposal includes the inspection, condition assessment, and rehabilitation of corroded components of the land section of the existing 120-inch diameter, primary five-mile Long Outfall system from Surge Tower 2 to the Beach Box located on Huntington State Beach across Pacific Coast Highway (PCH). The project site is generally located within the OCSD Treatment Plant No.2 at 22212 Brookhurst Street in the City of Huntington Beach. The nearest State route to the project site is SR-1.

The Department of Transportation (Department) is a responsible agency on this project and we have the following comments:

1. Any project work proposed in the vicinity of the Department's right-of-way would require an encroachment permit and all environmental concerns must be adequately addressed. If the environmental documentation for the project does not meet the Department's requirements, additional documentation would be required before approval of the encroachment permit. Please coordinate with Department to meet requirements for any work within or near State right-of-way. All entities other than the Department working within the Department's right-of-way must obtain an Encroachment Permit prior to commencement of work. Please allow 2 to 4 weeks for a complete submittal to be reviewed and for a permit to be issued. When applying for an Encroachment Permit, please incorporate Environmental Documentation, SWPPP/ WPCP, Hydraulic Calculations, Traffic Control Plans, Geotechnical Analysis, right-of-way certification and all relevant design details including design exception approvals. For specific details on the Caltrans Encroachment Permits procedure, please refer to the Caltrans Encroachment Permits Manual. The latest edition of the manual is available on the web site: http://www.dot.ca.gov/hq/traffops/developserv/permits/

Please continue to keep us informed of this project and any future developments, which could potentially impact the State Transportation Facilities. If you have any questions or need to contact us, please do not hesitate to call Marlon Regisford at (949) 724-2241.

Sincerely,

Christopher Herre

Christopher Herre, Branch Chief
Local Development/Intergovernmental Review

C: Scott Morgan, Office of Planning and Research

Department of Toxic Substances Control

Matthew Rodriquez
Secretary for
Environmental Protection

Deborah O. Raphael, Director
5796 Corporate Avenue
Cypress, California 90630

Edmund G. Brown Jr.
Governor

September 7, 2011

Mr. J. Burror
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, California 92708

NOTICE OF PREPARATION (NOP) FOR OUTFALL LAND SECTION AND OCEAN OUTFALL BOOSTER PUMP STATION PIPING REHABILITATION

Dear Mr. Burror:

The Department of Toxic Substances Control (DTSC) has received your submitted Notice of Preparation Report for the above-mentioned project. The following project description is stated in your document: "The proposed Project will consist of inspection, condition assessment, and rehabilitation of corroded components of the land section of the existing 120-inch diameter, primary five-mile outfall (Long Outfall) system extending from Surge Tower No. 2 (Surge Tower 2) within the Sanitation District's Plant 2 to the Beach Box located on Huntington State Beach. Specifically, the proposed Project includes five project elements that comprise the Long Outfall System rehabilitation: (1) rehabilitation of Surge Tower 2, (2) rehabilitation of the land section of the Long Outfall, (3) abandonment of the Long Outfall metering ports and vaults, (4) replacement of the existing effluent flow meter on the Long Outfall and (5) rehabilitation of the Beach Box".

Based on the review of the submitted document DTSC has the following comments:

1) The EIR should evaluate whether conditions within the project area may pose a threat to human health or the environment. Following are the databases of some of the regulatory agencies:

- National Priorities List (NPL): A list maintained by the United States Environmental Protection Agency (U.S.EPA).

- Envirostor (formerly CalSites): A Database primarily used by the California Department of Toxic Substances Control, accessible through DTSC's website (see below).

- Resource Conservation and Recovery Information System (RCRIS): A database of RCRA facilities that is maintained by U.S. EPA.

- Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS): A database of CERCLA sites that is maintained by U.S.EPA.

- Solid Waste Information System (SWIS): A database provided by the California Integrated Waste Management Board which consists of both open as well as closed and inactive solid waste disposal facilities and transfer stations.

- GeoTracker: A List that is maintained by Regional Water Quality Control Boards.

- Local Counties and Cities maintain lists for hazardous substances cleanup sites and leaking underground storage tanks.

- The United States Army Corps of Engineers, 911 Wilshire Boulevard, Los Angeles, California, 90017, (213) 452-3908, maintains a list of Formerly Used Defense Sites (FUDS).

2) The EIR should identify the mechanism to initiate any required investigation and/or remediation for any site that may be contaminated, and the government agency to provide appropriate regulatory oversight. If necessary, DTSC would require an oversight agreement in order to review such documents.

3) Any environmental investigations, sampling and/or remediation for a site should be conducted under a Workplan approved and overseen by a regulatory agency that has jurisdiction to oversee hazardous substance cleanup. The findings of any investigations, including any Phase I or II Environmental Site Assessment Investigations should be summarized in the document. All sampling results in which hazardous substances were found above regulatory standards should be clearly summarized in a table. All closure, certification or remediation approval reports by regulatory agencies should be included in the EIR.

4) If buildings, other structures, asphalt or concrete-paved surface areas are being planned to be demolished, an investigation should also be conducted for the presence of other hazardous chemicals, mercury, and asbestos containing materials (ACMs). If other hazardous chemicals, lead-based paints (LPB) or products, mercury or ACMs are identified, proper precautions should be taken during demolition activities. Additionally, the contaminants should be remediated in compliance with California environmental regulations and policies.

5) Future project construction may require soil excavation or filling in certain areas. Sampling may be required. If soil is contaminated, it must be properly disposed and not simply placed in another location onsite. Land Disposal Restrictions

(LDRs) may be applicable to such soils. Also, if the project proposes to import soil to backfill the areas excavated, sampling should be conducted to ensure that the imported soil is free of contamination.

6) Human health and the environment of sensitive receptors should be protected during any construction or demolition activities. If necessary, a health risk assessment overseen and approved by the appropriate government agency should be conducted by a qualified health risk assessor to determine if there are, have been, or will be, any releases of hazardous materials that may pose a risk to human health or the environment.

7) If it is determined that hazardous wastes are, or will be, generated by the proposed operations, the wastes must be managed in accordance with the California Hazardous Waste Control Law (California Health and Safety Code, Division 20, Chapter 6.5) and the Hazardous Waste Control Regulations (California Code of Regulations, Title 22, Division 4.5). If it is determined that hazardous wastes will be generated, the facility should also obtain a United States Environmental Protection Agency Identification Number by contacting (800) 618-6942. Certain hazardous waste treatment processes or hazardous materials, handling, storage or uses may require authorization from the local Certified Unified Program Agency (CUPA). Information about the requirement for authorization can be obtained by contacting your local CUPA.

8) DTSC can provide cleanup oversight through an Environmental Oversight Agreement (EOA) for government agencies that are not responsible parties, or a Voluntary Cleanup Agreement (VCA) for private parties. For additional information on the EOA or VCA, please see www.dtsc.ca.gov/SiteCleanup/Brownfields, or contact Ms. Maryam Tasnif-Abbasi, DTSC's Voluntary Cleanup Coordinator, at (714) 484-5489.

If you have any questions regarding this letter, please contact me at ashami@dtsc.ca.gov, or by phone at (714) 484-5472.

Sincerely,

Al Shami
Project Manager
Brownfields and Environmental Restoration Program

cc: Governor's Office of Planning and Research
State Clearinghouse
P.O. Box 3044
Sacramento, California 95812-3044
state.clearinghouse@opr.ca.gov

CEQA Tracking Center
Department of Toxic Substances Control
Office of Environmental Planning and Analysis
P.O. Box 806
Sacramento, California 95812
nritter@dtsc.ca.gov.

CEQA # 3300

City of Huntington Beach

2000 MAIN STREET **CALIFORNIA 92648**

DEPARTMENT OF PLANNING AND BUILDING
www.huntingtonbeachca.gov

Planning Division
714.536.5271

Building Division
714.536.5241

September 7, 2011

Jim Burror
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

Subject: Notice of Preparation of an Environmental Impact Report for Orange County Sanitation District (Ocean Outfall Booster Pump Station Piping Rehabilitation Project)

Dear Mr. Burror:

The City of Huntington Beach has reviewed the Notice of Preparation for the subject project and recommends that the following comments be addressed in the Draft Environmental Impact Report (EIR) that will be prepared for this project.

EIR Notification

- The City recommends that OCSD provides notification of the draft EIR, when it becomes available, to the Huntington Beach Wetlands Conservancy, Orange County Coastkeeper, Orange County Chapter of the Surfrider Foundation, and the Coastal Conservancy. Organizations and agencies with an interest in coastal issues and marine conservation should be notified of the project.

Biological Resources

- The NOP states that the EIR will analyze potential impacts to sensitive species, rare plants, the least tern and snowy plover on the Huntington State Beach as a result of project construction. The EIR should also identify and analyze any potential impacts to marine biological resources that could occur due to utilization of the short outfall for discharge of treated effluent as proposed under Alternative 2.

Recreation

- The NOP states that the EIR will analyze recreational impacts, specifically potential impacts to beach access, bike path and parking. Additionally, the EIR should analyze potential impacts to adjacent beach areas that could occur from increased recreational use as a result of project construction and potential beach closures due to water quality issues that may arise from discharge of effluent to the short outfall.

Stormwater

- The EIR should include the following information related to discharge requirements for stormwater runoff: If any of the project alternatives result in soil disturbance of one or more acres of land, the applicant shall demonstrate that coverage has been obtained under the Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ) [General Construction Permit] by providing a copy of the Notice of Intent (NOI) submitted to the State of California Water Resources Control Board and a copy of the subsequent notification of the issuance of a Waste Discharge Identification (WDID) Number and shall prepare and implement a Stormwater Pollution Prevention Plan (SWPPP).

Alternative 2

- Alternative 2 states that work will be conducted 24 hours/7 days/week and that the EIR would address impacts on beach closures. The EIR should also address whether beach testing will also occur 7 days/week for the duration of the project.

Thank you for the opportunity to comment on the Notice of Preparation for the proposed project. The City of Huntington Beach looks forward to reviewing the Draft Environmental Impact Report when it becomes available.

Sincerely,

Jennifer Villasenor
Senior Planner

Cc: Scott Hess, Planning and Building Director
Mary Beth Broeren, Planning Manager

CITY OF NEWPORT BEACH

COMMUNITY DEVELOPMENT DEPARTMENT
Planning Division

September 7, 2011

Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

RE: Notice of Preparation (NOP) of an Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation Project

To Whom It May Concern,

The City of Newport Beach ("City") has received and reviewed your Notice of Preparation (NOP) dated August 8, 2011. We appreciate the opportunity to comment on your proposed project.

The NOP states that the environmental impact report (EIR) will evaluate the Huntington Beach Coastal Element. If there are possible adverse impacts to areas within the City of Newport Beach, analysis of the policies of the City of Newport Beach General Plan and Coastal Land Use Plan should be evaluated as well.

The NOP also states that the EIR will evaluate possible adverse impacts to marine life and ocean water quality. This analysis should include possible adverse impacts to the Semeniuk Slough and the Newport Submarine Canyon.

The NOP also states that the EIR will evaluate whether discharges to the Short Outfall will result in the need to close beaches any time during the four-to-six weeks of discharge. However, it is not clear if the beach closures would only occur in the Huntington State Beach. Potential closures to City of Newport Beach beaches should be evaluated as well.

Please feel free to contact me at (949) 644-3232 or PAlford@newportbeachca.gov if you have any questions.

Sincerely,

Patrick J. Alford
Planning Manager

State of California -The Natural Resources Agency
DEPARTMENT OF FISH AND GAME
South Coast Region
3883 Ruffin Road
San Diego, CA 92123
(858) 467-4201
www.dfg.ca.gov

EDMUND G. BROWN, JR, *Governor*
CHARLTON H. BONHAM, *Director*

September 8, 2011

Mr. Jim Burror
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708-7018

Subject: Comments on the Notice of Preparation of a Draft Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation Project, SCH # 2011081022 Orange County

Dear Mr. Burror:

The Department of Fish and Game (Department) has reviewed the above-referenced Notice of Preparation (NOP) for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation Draft Environmental Impact Report (DEIR). The following statements and comments have been prepared pursuant to the Department's authority as Trustee Agency with jurisdiction over natural resources affected by the project (CEQA Guidelines §15386) and pursuant to our authority as a Responsible Agency under CEQA Guidelines Section 15381 over those aspects of the proposed project that come under the purview of the California Endangered Species Act (CESA, Fish and Game Code §2050 *et seq.*) and Fish and Game Code Section 1600 *et seq*.

The project area is located within the southeast corner of the Orange County Sanitation District's Treatment Plant No. 2 (Plant 2) located in the southwest portion of the City of Huntington Beach south of Brookhurst Street and bound on west side by Pacific Coast Highway (PCH). An additional two offsite locations will be involved in the project: one is a vegetated area, along the western edge of Orange County Bike Path, between the south side of Plant 2 and PCH, and the other site is on the south side of PCH, between the Huntington Beach least tern preserve and the Santa Ana River, within Huntington State Beach.

The proposed project would consist of inspection, condition assessment, and rehabilitation of corroded components of the land section of the existing 120-inch diameter, primary five-mile outfall (Long Outfall) system extending from Surge Tower No. 2 (Surge Tower 2) within Plant 2 to Beach Box located on Huntington State Beach. Specifically, the proposed Project includes five project elements that comprise the Long Outfall System rehabilitation: (1) rehabilitation of Surge Tower 2, (2) rehabilitation of the land Long Outfall, (3) abandonment of the Long Outfall metering ports and vaults, (4) replacement of the existing effluent flow meter on the Long Outfall and (5) rehabilitation of the Beach Box.

The Department offers the following comments and recommendations to assist the in avoiding or minimizing potential project impacts on biological resources.

Specific Comments

1) The Project element (2), rehabilitation of the land Long Outfall, proposes to rehabilitate a section of Long Outfall in a vegetated area along the Orange County Bike Path and PCH. The DEIR should provide adequate discussion of the possible short-term and long-term impacts and mitigation measures for the CESA-listed endangered Belding's savannah sparrow (*Passerculus sandwichensis beldingi*). Further detail is needed for the Department to determine the proposed effects on this species. Because this species is a year-round resident of coastal salt marshes seasonal work restrictions alone will not reasonably reduce significant adverse impacts resulting from disturbance and displacement. The DEIR should evaluate avoidance and minimization measures to limit construction activities (including access routes) adjacent to Talbert Marsh while still feasibly attaining project objectives.

To avoid and minimize impacts to Belding's savannah sparrow the Department recommends the following:

a) Night-time illumination of construction staging and access areas should be sufficiently shielded and directed away from open space.
b) If marsh habitat is anticipated to be impacted, then design, implementation, and the location of remaining habitat for Belding's savannah sparrow nesting should be disclosed in DEIR. The project should avoid leaving isolated fragments of high marsh habitat, if temporary or permanent habitat removal is required for rehabilitation.
c) Post project restoration of temporary grading impacts should be analyzed and designed to avoid areas that pond freshwater. Areas of pooling and retention of freshwater can create the transition of salt-marsh habitat to freshwater vegetation communities. Freshwater marsh and upland habitats attract marsh birds like the song sparrow (*Melospiza melodia*). Marsh birds are known to negatively impact breeding success of Belding's savannah sparrow (Zembal et al. 2006).

1) The DEIR should include, at a minimum, the following information.

a) Discussions regarding the regional setting, pursuant to the CEQA Guidelines Section 15125(a), should be included with special emphasis on the marine resources that are rare, sensitive or unique to the region. Emphasis should be given to habitats that are important to listed or sensitive species that may be affected by the Project. The project area potentially includes sandy beach, intertidal and subtidal marine habitats. Giant kelp, *Macrocystis pyrifera*, surfgrass, *Phyllospadix* spp. and black abalone, *Haliotis cracherodii*, an Endangered Species Act-listed endangered species, may occur in the project area. Relatively flat wide beaches in this area have historically supported spawning California grunion, *Leuresthes tenuis,* and Pismo clams, *Tivela stultorum*, which may be found in the intertidal surf zone and/or the subtidal areas. Potential and expected impacts of the project on these species and habitats should be fully addressed.
b) Detailed discussions of potential direct or indirect releases of toxic substances, or increases in sedimentation, turbidity and any other impacts to ocean water quality that are related to the project should be included.

c) A discussion of potential impacts to marine resources related to fill, shading, or loss of marine habitat, dredging, vehicle traffic within the intertidal, or pipe construction on the beach and nearshore should be fully addressed.
d) Marine biological surveys of the proposed and alternative project footprints to describe any type of potentially impacted marine substrates, such as sandy beach, rocky reef, kelp beds, intertidal, subtidal, and other habitats that may be affected. Surveys should include invasive species, if applicable. Site maps and tables should be used in the DEIR to summarize survey information which should include the area or acreage of various marine habitats that will be impacted.
e) Marine biological impact mitigation and monitoring plans should be included in the DEIR. Best management practices and avoidance measures for each construction activity should be included. Such plans should include conducting construction activities during low tide conditions to avoid marine waters, avoidance of sensitive habitats when locating pipes, and avoidance of spawning and/or nesting seasons when appropriate. All such plans should be drafted in consultation with the Department's Marine Region staff and other appropriate resource agencies.

General Comments

1) The Department has responsibility for wetland and riparian habitats. It is the policy of the Department to strongly discourage development in wetlands or conversion of wetlands to uplands. We oppose any development or conversion which would result in a reduction of wetland acreage or wetland habitat values, unless, at a minimum, project mitigation assures there will be "no net loss" of either wetland habitat values or acreage. Development and conversion include but are not limited to conversion to subsurface drains, placement of fill or building of structures within the wetland, and channelization or removal of materials from the streambed. All wetlands and watercourses, whether intermittent or perennial, should be retained and provided with substantial setbacks which preserve the riparian and aquatic values and maintain their value to on-site and off-site wildlife populations. Mitigation measures to compensate for impacts to mature riparian corridors must be included in the DEIR and must compensate for the loss of function and value of a wildlife corridor.

    a) The project area supports aquatic, riparian, and wetland habitats; therefore, a jurisdictional delineation of the creeks and their associated riparian habitats should be included in the DEIR. The delineation should be conducted pursuant to the U. S. Fish and Wildlife Service wetland definition adopted by the Department.[1] Please note that some wetland and riparian habitats subject to the Department's authority may extend beyond the jurisdictional limits of the U.S. Army Corps of Engineers.
    b) The Department also has regulatory authority over activities in streams and/or lakes that will divert or obstruct the natural flow, or change the bed, channel, or bank (which may include associated riparian resources) of a river or stream, or use

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[1] Cowardin, Lewis M., et al. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service.

material from a streambed. For any such activities, the project applicant (or "entity") must provide written notification to the Department pursuant to Section 1600 *et seq.* of the Fish and Game Code. Based on this notification and other information, the Department determines whether a Lake and Streambed Alteration Agreement (LSA) with the applicant is required prior to conducting the proposed activities. The Department's issuance of a LSA for a project that is subject to CEQA will require CEQA compliance actions by the Department as a responsible agency. The Department as a responsible agency under CEQA may consider the local jurisdiction's (lead agency) Negative Declaration or Environmental Impact Report for the project. To minimize additional requirements by the Department pursuant to Section 1600 *et seq.* and/or under CEQA, the document should fully identify the potential impacts to the stream or riparian resources and provide adequate avoidance, mitigation, monitoring and reporting commitments for issuance of the LSA.[2]

2) The Department considers adverse impacts to a species protected by the CESA, for the purposes of CEQA, to be significant without mitigation. As to CESA, take of any endangered, threatened, or candidate species that results from the project is prohibited, except as authorized by state law (Fish and Game Code, §§ 2080, 2085.) Consequently, if the Project, Project construction, or any Project-related activity during the life of the Project results in take of a species designated as endangered or threatened, or a candidate for listing under CESA, the Department recommends that the project proponent seek appropriate take authorization under CESA prior to implementing the project. Appropriate authorization from the Department may include an incidental take permit or a consistency determination in certain circumstances, among other options (Fish and Game Code §§ 2080.1, 2081, subds. (b),(c)). Early consultation is encouraged, as significant modification to a project and mitigation measures may be required in order to obtain a CESA Permit. Revisions to the Fish and Game Code, effective January 1998, may require that the Department issue a separate CEQA document for the issuance of a 2081 permit unless the project CEQA document addresses all project impacts to listed species and specifies a mitigation monitoring and reporting program that will meet the requirements of a 2081 permit. For these reasons, the following information is requested:

   a) Biological mitigation monitoring and reporting proposals should be of sufficient detail and resolution to satisfy the requirements for a CESA Permit.
   b) Department-approved Mitigation Agreement and Mitigation Plan are required for plants listed as rare under the Native Plant Protection Act.

3) To enable the Department to adequately review and comment on the proposed project from the standpoint of the protection of plants, fish and wildlife, we recommend the following information be included in the DEIR.

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[2] A notification package for a LSA may be obtained by accessing the Department's web site at www.dfg.ca.gov/1600 .

a) A complete discussion of the purpose and need for, and description of, the proposed project, including all staging areas and access routes to the construction and staging areas.
b) A range of feasible alternatives to ensure that alternatives to the proposed project are fully considered and evaluated; the alternatives should avoid or otherwise minimize impacts to sensitive biological resources particularly state listed species and wetlands (as the proposed project would result in significant impacts to wetland/riparian habitat within Santa Ana River, and Talbert Marsh). Specific alternative locations for by-pass should be evaluated in areas with lower resource sensitivity where appropriate.

Biological Resources within the Project's Area of Potential Effect

4) To provide a complete assessment of the flora and fauna within and adjacent to the project area, with particular emphasis upon identifying endangered, threatened, sensitive, and locally unique species and sensitive habitats. The DEIR should include the following information.

a) Per CEQA Guidelines, Section 15125(c), information on the regional setting that is critical to an assessment of environmental impacts, with special emphasis should be placed on resources that are rare or unique to the region.
b) A thorough assessment of rare plants and rare natural communities, following the Department's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (see: http://www.dfg.ca.gov/habcon/plant/) (hard copy available on request).
c) A current inventory of the biological resources associated with each habitat type on site and within the area of potential effect. The Department's California Natural Diversity Data Base in Sacramento should be contacted at (916) 322-2493 or www.dfg.ca.gov/biogeodata/ to obtain current information on any previously reported sensitive species and habitat, including Significant Natural Areas identified under Chapter 12 of the Fish and Game Code.
d) An inventory of rare, threatened, and endangered, and other sensitive species on site and within the area of potential effect. Species to be addressed should include all those which meet the CEQA definition (see CEQA Guidelines, §15380). This should include sensitive fish, wildlife, reptile, and amphibian species. Seasonal variations in use of the project area should also be addressed. Focused species-specific surveys, conducted at the appropriate time of year and time of day when the sensitive species are active or otherwise identifiable, are required. Acceptable species-specific survey procedures should be developed in consultation with the Department and the U.S. Fish and Wildlife Service.

Analyses of the Potential Project-Related Impacts on the Biological Resources

5. To provide a thorough discussion of direct, indirect, and cumulative impacts expected to adversely affect biological resources, with specific measures to offset such impacts, the following should be addressed in the DEIR.

a) A discussion of impacts associated with increased lighting, noise, human activity, changes in drainage patterns, changes in water volume, velocity, and quality, soil erosion, and /or sedimentation in streams and water courses on or near the project site, with mitigation measures proposed to alleviate such impacts should be included.
b) Discussions regarding indirect project impacts on biological resources, including resources in nearby public lands, open space, adjacent natural habitats, riparian ecosystems, and any designated and/or proposed or existing reserve lands (*e.g.*, preserve lands associated with a Natural Community Conservation Plan). Impacts on, and maintenance of, wildlife corridor/movement areas, including access to undisturbed habitats in adjacent areas, should be fully evaluated and provided. A discussion of potential adverse impacts from lighting, noise, human activity, exotic species, and drainage. The latter subject should address: project-related changes on drainage patterns on and downstream of the project site; the volume, velocity, and frequency of existing and post-project surface flows; polluted runoff; soil erosion and/or sedimentation in streams and water bodies; and post-project fate of runoff from the project site. The discussions should also address the proximity of the extraction activities to the water table, whether dewatering would be necessary, and the potential resulting impacts on the habitat, if any, supported by the groundwater.
c) The zoning of areas for development projects or other uses that are nearby or adjacent to natural areas may inadvertently contribute to wildlife-human interactions. A discussion of possible conflicts and mitigation measures to reduce these conflicts should be included in the environmental document.
d) A cumulative effects analysis should be developed as described under CEQA Guidelines, Section 15130. General and specific plans, as well as past, present, and anticipated future projects, should be analyzed relative to their impacts on similar plant communities and wildlife habitats.

Mitigation for the Project-related Biological Impacts

6) The DEIR should include measures to fully avoid and otherwise protect Rare Natural Communities (Attachment) from project-related impacts. The Department considers these communities as threatened habitats having both regional and local significance.

7) The DEIR should include mitigation measures for adverse project-related impacts to sensitive plants, animals, and habitats. Mitigation measures should emphasize avoidance and reduction of project impacts. For unavoidable impacts, on-site habitat restoration or enhancement should be discussed in detail. If on-site mitigation is not feasible or would not be biologically viable and therefore not adequately mitigate the loss of biological functions and values, off-site mitigation through habitat creation and/or acquisition and preservation in perpetuity should be addressed.

8) For proposed preservation and/or restoration, the DEIR should include measures to perpetually protect the targeted habitat values from direct and indirect negative impacts. The objective should be to offset the project-induced qualitative and quantitative losses of wildlife habitat values. Issues that should be addressed include

restrictions on access, proposed land dedications, monitoring and management programs, control of illegal dumping, water pollution, increased human intrusion, etc.

9) In order to avoid impacts to nesting birds, the DEIR should require that clearing of vegetation, and when biologically warranted construction, occur outside of the peak avian breeding season which generally runs from February 1 through September 1 (as early as January for some raptors). If project construction is necessary during the bird breeding season, a qualified biologist should conduct a survey for nesting birds, within three days prior to the work in the area, and ensure no nesting birds in the project area would be impacted by the project. If an active nest is identified, a buffer shall be established between the construction activities and the nest so that nesting activities are not interrupted. The buffer shall be a minimum width of 300 feet (500 feet for raptors), shall be delineated by temporary fencing, and shall remain in effect as long as construction is occurring or until the nest is no longer active. No project construction shall occur within the fenced nest zone until the young have fledged, are no longer being fed by the parents, have left the nest, and will no longer be impacted by the project.

10) The Department generally does not support the use of relocation, salvage, and/or transplantation as mitigation for impacts to rare, threatened, or endangered species. Studies have shown that these efforts are experimental in nature and largely unsuccessful.

11) Plans for restoration and revegetation should be prepared by persons with expertise in southern California ecosystems and native plant revegetation techniques. Each plan should include, at a minimum: (a) the location of the mitigation site; (b) the plant species to be used, container sizes, and seeding rates; (c) a schematic depicting the mitigation area; (d) planting schedule; (e) a description of the irrigation methodology; (f) measures to control exotic vegetation on site; (g) specific success criteria; (h) a detailed monitoring program; (i) contingency measures should the success criteria not be met; and (j) identification of the party responsible for meeting the success criteria and providing for conservation of the mitigation site in perpetuity.

We appreciate the opportunity to comment on the referenced NOP. Questions regarding this letter and further coordination on issues should be directed to Matt Chirdon (terrestrial) at (858) 467-4284 and Loni Adams (marine) at (858) 627-3985.

Sincerely,

Edmund Pert
Regional Manager
South Coast Region

cc: Scott Morgan (State Clearinghouse)

Enclosure:
Sensitivity of Top Priority Rare Natural Communities in Southern California

References:

Zembel, R., John Konecny, and Susan M. Hoffman. 2006. A Survey of the Belding's Savannah Sparrow (*Passerculus Sandwichensis beldingi*) in California, 2006. Calif. Dep. Fish and Game, Habitat Conservation Planning Branch, Species Conservation and Recovery Program Report 2006-03, San Diego, CA. page 4.

Sensitivity of Top Priority Rare Natural Communities in Southern California

Sensitivity rankings are determined by the Department of Fish and Game, California Natural Diversity Data Base and based on either number of known occurrences (locations) and/or amount of habitat remaining (acreage). The three rankings used for these top priority rare natural communities are as follows:

S1.# Fewer than 6 known locations and/or on fewer than 2,000 acres of habitat remaining.

S2.# Occurs in 6-20 known locations and/or 2,000-10,000 acres of habitat remaining.

S3.# Occurs in 21-100-known locations and/or 10,000-50,000 acres of habitat remaining.

The number to the right of the decimal point after the ranking refers to the degree of threat posed to that natural community regardless of the ranking. For example:

S1.<u>1</u> = <u>very threatened</u>
S2.<u>2</u> = <u>threatened</u>
S3.<u>3</u> = <u>no current threats known</u>

Sensitivity Rankings (February 1992)

Rank	Community Name
S1.1	Mojave Riparian Forest
	Sonoran Cottonwood Willow Riparian
	Mesquite Bosque
	Elephant Tree Woodland
	Crucifixion Thorn Woodland
	Allthorn Woodland
	Arizonan Woodland
	Southern California Walnut Forest
	Mainland Cherry Forest
	Southern Bishop Pine Forest
	Torrey Pine Forest
	Desert Mountain White Fir Forest
	Southern Dune Scrub
	Southern Coastal Bluff Scrub
	Maritime Succulent Scrub
	Riversidean Alluvial Fan Sage Scrub
	Southern Maritime Chaparral
	Valley Needlegrass Grassland
	Great Basin Grassland
	Mojave Desert Grassland
	Pebble Plains
	Southern Sedge Bog
	Cismontane Alkali Marsh

S1.2	Southern Foredunes Mono Pumice Flat Southern Interior Basalt Flow Vernal Pool
S2.1	Venturan Coastal Sage Scrub Diegan Coastal Sage Scrub Riversidean Upland Coastal Sage Scrub Riversidean Desert Sage Scrub Sagebrush Steppe Desert Sink Scrub Mafic Southern Mixed Chaparral San Diego Mesa Hardpan Vernal Pool San Diego Mesa Claypan Vernal Pool Alkali Meadow Southern Coastal Salt Marsh Coastal Brackish Marsh Transmontane Alkali Marsh Coastal and Valley Freshwater Marsh Southern Arroyo Willow Riparian Forest Southern Willow Scrub Modoc-Great Basin Cottonwood Willow Riparian Modoc-Great Basin Riparian Scrub Mojave Desert Wash Scrub Engelmann Oak Woodland Open Engelmann Oak Woodland Closed Engelmann Oak Woodland Island Oak Woodland California Walnut Woodland Island Ironwood Forest Island Cherry Forest Southern Interior Cypress Forest Bigcone Spruce-Canyon Oak Forest
S2.2	Active Coastal Dunes Active Desert Dunes Stabilized and Partially Stabilized Desert Dunes Stabilized and Partially Stabilized Desert Sandfield Mojave Mixed Steppe Transmontane Freshwater Marsh Coulter Pine Forest Southern California Fellfield White Mountains Fellfield
S2.3	Bristlecone Pine Forest Limber Pine Forest

ORANGE COUNTY
OC Public Works
Our Community. Our Commitment.

Jess A. Carbajal, Director
300 N. Flower Street
Santa Ana, CA

P.O. Box 4048
Santa Ana, CA 92702-4048

Telephone: (714) 834-2300
Fax: (714) 834-5188

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2011 SEP 12 AM 10: 14
ENGINEERING

NCL 11-033

September 8, 2011

Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, California 92708

SUBJECT: Notice of Preparation of an Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation – NCL 11-033

To Whom it May Concern:

The County of Orange has reviewed the Notice of Preparation of an Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation and offers the following comments:

Environmental Resources:
In response to your request for input on the subject project, Environmental Resources has reviewed the document, and offers the following comments:

Successful implementation of the provisions of NPDES Areawide Urban Stormwater Runoff Permit CAS 618030 by the County of Orange, Orange County Flood Control District, and the incorporated cities of Orange County requires the cooperation of public agency organizations within Orange County having programs/activities that have an impact on stormwater quality. This, as determined by the Santa Ana Regional Water Quality Control in that permit's issuance, includes the Orange County Sanitation District (see Permit Finding No. 77). The County and the District have actively cooperated in such programs as preventing sanitary sewer overflows and contaminated discharges, and spill response.

Potential water quality impacts of the proposed project, including the potential for temporary discharges to the Santa Ana River via existing emergency discharge weirs, should be evaluated in the DEIR, consistent with Permit CAS 618030 and the Orange County Drainage Area Management Plan. At minimum, the following information should be provided:

1. Description of project characteristics with respect to water quality issues, such as project site location in a given watershed, site acreage, known ground contamination, known ground-water contamination, and anticipated change in percent impervious surface area.

2. Identification of receiving waters; The EIR should identify all downstream receiving waters that may receive contributory runoff from the project site.

3. Description of the sensitivity of the receiving waters; In particular the EIR should identify Areas of Special Biological Significance, water bodies with Total Maximum Daily Loads (TMDL), and Clean Water Act Sec. 303(d) listed impaired water bodies.

4. Characterization of the potential water quality impacts from the proposed project and identification of the anticipated pollutants to be generated by the project.

5. Identification of downstream hydrologic conditions of concern that may be affected by project, if any - related changes in runoff volume and velocity; sediment load, makeup or characteristics; reduced infiltration; and/or increased flow, frequency, duration, and peak(s) of storm runoff.

6. Evaluation of thresholds of significance.

7. Assessment of project impact significance to water quality.

8. If a proposed project has the potential to create a major new stormwater discharge to a water body with an established TMDL, the EIR should consider quantitative analysis of the anticipated pollutant loads in the stormwater discharges to the receiving waters.

9. A reasonable analysis of the cumulative impacts of the proposed project together with past, present and reasonably anticipated future projects (related projects) that could produce cumulative impacts together with the proposed project.

If you require any additional information, please contact Grant Sharp at (714) 955-0674.

Flood Programs/SAR

Santa Ana River Project (SARP) staff has reviewed the NCL 2011-033, Notice of an Environmental Impact Report for the Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation. SARP staff requests that the Orange County Sanitation District (OCSD) work closely with Orange County during the development of this project as it appears that Orange County and Orange County Flood Control District (OCFCD) right of way will be impacted by the project. As the various alternatives to the project are developed, SARP would request the ability to review the plans as each alternative affects Orange County in a different manner.

The potential impacts to Orange County and OCFCD right of way may include but are not limited to the Talbert Marsh trail, the Santa Ana River Trail, and parcel number E01-la07 which OCFCD leases from the States Lands Commission. Attached is an exhibit which depicts the parcel which is leased. The lease has a number of conditions which OCFCD must adhere to and Alternative 1, Bypass – No use of the Short Outfall proposes to place two 60 inch pipelines above ground from the Beach Box. These pipelines would most likely traverse through the leased land thus would require permits from both OCFCD and the State Lands Commission.

Alternative 2, Non Bypass – Use of the Short Outfall discusses the potential for discharging of excess effluent from OCSD directly to the Santa Ana River through the existing emergency discharge weirs during wet weather conditions. The EIR should evaluate the impacts discharging effluent directly into the Santa Ana River. Potential duration and flow rates expected into the Santa Ana River from the emergency weirs should be developed. It should be noted that the emergency weirs have flap gates and during wet weather conditions the Santa Ana River water surface elevation may be above those flap gates making them ineffective in discharging effluent above the capacity of the Short Outfall pipe.

Please contact John Spencer, P.E. at 714-647-3965 if you have questions regarding this request.

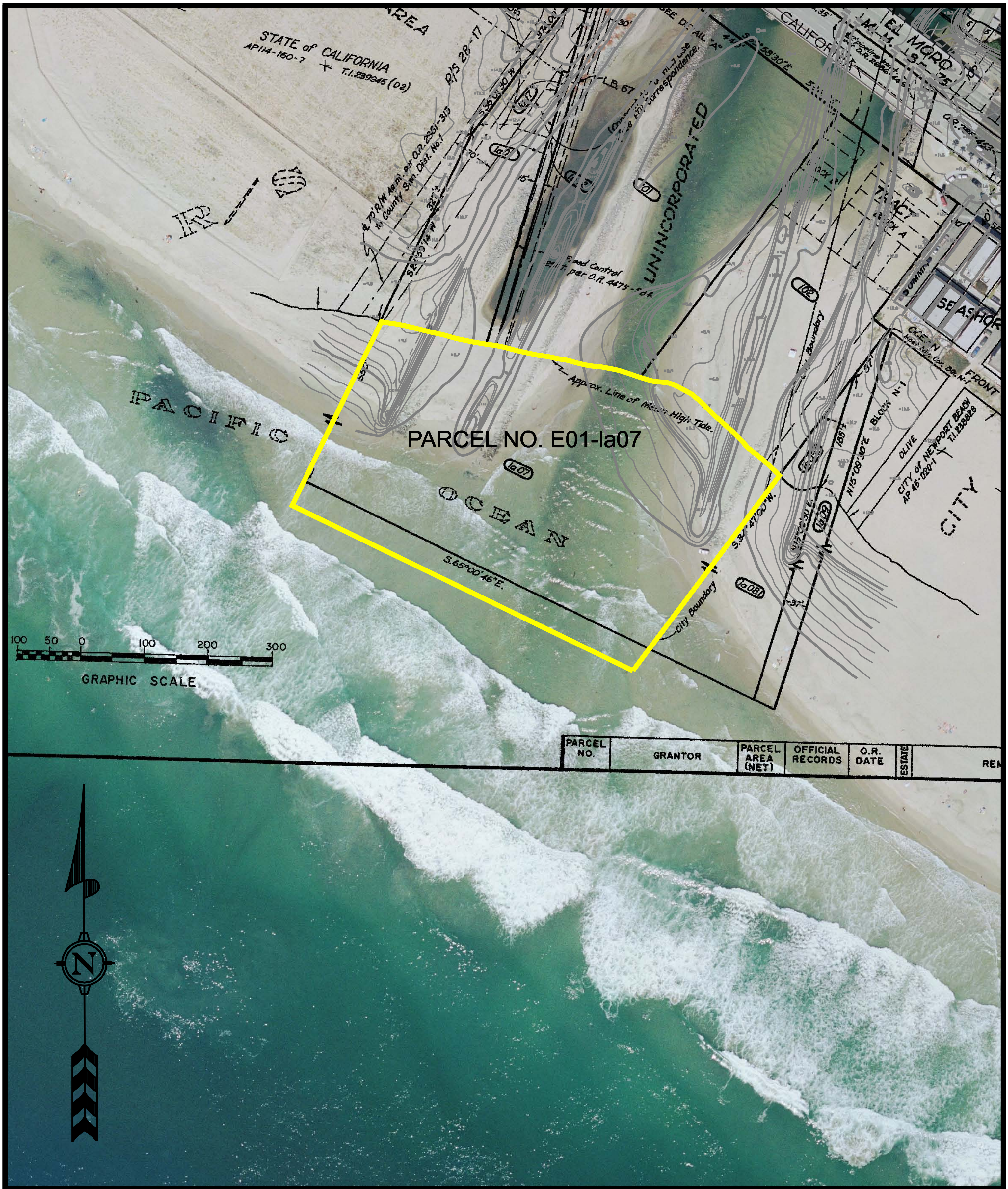
Sincerely,

M Balsamo

Michael Balsamo, Manager
General Land Use Planning

MB/mmc

cc: Lance Natsuhara, Flood Programs./SAR
Chris Crompton, Environmental Resources



COUNTY OF ORANGE
OC PUBLIC WORKS
RIGHT - OF - WAY ENGINEERING

ID # 2009 - 010

SCALE : 1" = 200'

EXHIBIT

PROJECT : PERMIT PARCEL NO. E01-la07

Sent: Thursday, September 08, 2011 2:43 PM
Subject: CEQA Response - NOP for Ocean Outfall Rehab Project

To:
Jim Burror, Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

NOP - Orange County Water District's (OCSD) proposed Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation Project, OCSD Regional Plant No. 2 (RP-2)

The following is Regional Board staff's response to the Notice of Preparation of an Environmental Impact Report for the above project, within the comment period ending today, September 8, 2011:

1. Board staff prefer that the Draft EIR reflect a preference, and OCSD's eventual implementation, of the NOP's Alternative One. Alternative One is the installation of a temporary bypass structure to the Long Outfall (5-mile pipeline; Discharge Serial 001 in the RP-2 Waste Discharge Requirements) without use of the Short Outfall (1-mile pipeline; Discharge Serial 002). Alternative One is more protective of water quality standards (Basin Plan water quality objectives and beneficial uses), and it definitely complies with the current Waste Discharge Requirements (WDRs; Order No. R8-2004-0062) for OCSD Regional Plant No. 2.

2. The NOP (pgs. 2,16) anticipates "potential discharge to the Santa Ana River during wet weather events that may occur during the construction period under Alternative 2." We request that the document reflect that the Alternative 2 contingency to discharge not only through Discharge Serial 002 (Short Outfall), but to additionally anticipate the need of discharging high peak stormflows through Discharge Serial 003 (through two emergency weirs at the mouth of the Santa Ana River, Figure 2), should be avoided on the basis of the following:

a) An RP-2 "emergency discharge" to the Santa Ana River at Discharge Serial 003 is permitted by the WDRs only for overwhelming, unplanned conditions of high flow volume, and then, only after approval by the Executive Officer. The DEIR should reflect that all steps will be taken to avoid this contingency. Use of the Short Outfall and the emergency outfalls, as the NOP considers, will probably exceed Basin Plan and WDR objectives for bacteria and other pathogens. This will impact the REC1 beneficial use and, even if beach closure occurs, the REC2 beneficial use.

b) Only the work in the Beach Box is an immediate time-sensitive component. Therefore, this work item can be done first during the dry season between the tern nesting season and rainy season (though during peak summer use of Huntington Beach State Park). If the other repair items cannot be completed within this period as well, then they can be scheduled for completion during the following year. The bypass may be left in place until the next window of opportunity....

....By extending the work schedule around the rainy season and high-flow peaks, OCSD can avoid discharges through Discharge Serials 002 and 003. In the past, repair work on the land section of the Long Outfall line has been scheduled using this strategy.

We thank you for the opportunity to comment.

Mark Adelson, Chief, Regional Planning Programs Section
Julio Lara, Permitting and Compliance Section
Glenn Robertson, Regional Planning Programs Section

Glenn Robertson, Engineering Geologist
CEQA Coordinator
California Regional Water Quality Control Board, Santa Ana Region (8)
3737 Main Street, Suite 500
Riverside, CA 92501-3348
(951) 782-3259
Fax (951) 781-6288
Email grobertson@waterboards.ca.gov
Website: www.waterboards.ca.gov/santaana

Sent: Friday, October 07, 2011 8:56 AM
Subject: SCH 2011081022 OLS OOBS Rehab Project

Dear Mr. Burror,
I apologize for the lateness of the comments.

The rehabilitation of the Long Outfall Beach Box, project element 5 of the NOP, qualifies as maintenance activities under the terms of the original lease, No. PRC 4007.9. However, this project element may also disrupt the jetty and dike located at this site, authorized under lease No. PRC 2171.9 to the Orange County Flood Control District.

Please provide evidence that the rehabilitation will not affect the existing jetty and dike. State Lands will require a letter of non-objection from the OC Flood Control District stating their acceptance of the OC Sanitation project at this location.

Additionally, please provide more detailed site plans for the Beach Junction Box so that we may be able to determine the exact location relative to the current Lease Premises of PRC 4007.9 and PRC 2171.9.

Thank you.
Sincerely,

Spencer N. Paschall

Calif. State Lands Commission
Land Management Division
100 Howe Ave., Suite 100 S.
Sacramento, CA 95825-8202
916-574-0451 (office)
916-574-1835 (fax)

spencer.paschall@slc.ca.gov<mailto:spencer.paschall@slc.ca.gov>
http://www.slc.ca.gov<http://www.slc.ca.gov/>

Appendix B
Air Quality Data Sheets

OCSD J-112

Orange County, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Light Industry	10	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Climate Zone 8

Wind Speed (m/s) 2.2

Precipitation Freq (Days) 30

Utility Company Southern California Edison

1.3 User Entered Comments

Project Characteristics -

Land Use - Site disturbance

Construction Phase - Surge Tower Rehabilitation9/16/201412/12/2014
Bypass Construction9/16/201412/27/2014
Beach Box Rehabilitation1/7/20151/26/2015
Air Vac 1/8/2015 1/21/2015

Off-road Equipment - Air Compressors; Off-Highway Trucks, Pumps, Cranes, Tractors/Loaders/Backhoes, Generator Sets, Generator Sets

Off-road Equipment - Air Compressors, Cranes, Rubber Tired Dozers, Excavators, Tractors/Loaders/Backhoes, Generator Sets
Load factors updated based on ARB's Off-Road Emissions Inventory update.

Off-road Equipment - Air Compressors24Cranes 16
Load factors updated based on ARB's Off-Road Emissions Inventory update.
Grading - Conservative acreage estimate

Off-road Equipment - Air Compressors, Cranes, Welders, Other construction equipment.
Load factors adjusted based on ARB's Off-Road Emissions Inventory update.

Trips and VMT - From trip generation data provided by B&V

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	9.04	97.04	39.26	0.13	6.95	3.37	10.31	3.33	3.37	6.70	0.00	14,011.57	0.00	0.81	0.00	14,028.55
2015	8.67	89.11	36.36	0.13	0.29	3.16	3.45	0.01	3.16	3.17	0.00	14,791.59	0.00	0.77	0.00	14,807.84
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	9.04	97.04	39.26	0.13	6.19	3.37	9.55	3.33	3.37	6.70	0.00	14,011.57	0.00	0.81	0.00	14,028.55
2015	8.67	89.11	36.36	0.13	0.01	3.16	3.17	0.01	3.16	3.17	0.00	14,791.59	0.00	0.77	0.00	14,807.84
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Bypass Construction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					6.17	0.00	6.17	3.31	0.00	3.31						0.00
Off-Road	7.99	89.28	34.06	0.11		2.96	2.96		2.96	2.96		12,757.16		0.72		12,772.22
Total	**7.99**	**89.28**	**34.06**	**0.11**	**6.17**	**2.96**	**9.13**	**3.31**	**2.96**	**6.27**		**12,757.16**		**0.72**		**12,772.22**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.02	0.01	0.00	0.09	0.00	0.09	0.00	0.00	0.00		4.42		0.00		4.42
Vendor	0.08	0.84	0.56	0.00	0.06	0.03	0.08	0.00	0.03	0.03		162.24		0.00		162.33
Worker	0.10	0.10	1.11	0.00	0.28	0.01	0.29	0.01	0.01	0.02		214.82		0.01		215.06
Total	**0.18**	**0.96**	**1.68**	**0.00**	**0.43**	**0.04**	**0.46**	**0.01**	**0.04**	**0.05**		**381.48**		**0.01**		**381.81**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					6.17	0.00	6.17	3.31	0.00	3.31						0.00
Off-Road	7.99	89.28	34.06	0.11		2.96	2.96		2.96	2.96	0.00	12,757.16		0.72		12,772.22
Total	**7.99**	**89.28**	**34.06**	**0.11**	**6.17**	**2.96**	**9.13**	**3.31**	**2.96**	**6.27**	**0.00**	**12,757.16**		**0.72**		**12,772.22**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00		4.42		0.00		4.42
Vendor	0.08	0.84	0.56	0.00	0.00	0.03	0.03	0.00	0.03	0.03		162.24		0.00		162.33
Worker	0.10	0.10	1.11	0.00	0.01	0.01	0.02	0.01	0.01	0.02		214.82		0.01		215.06
Total	**0.18**	**0.96**	**1.68**	**0.00**	**0.01**	**0.04**	**0.05**	**0.01**	**0.04**	**0.05**		**381.48**		**0.01**		**381.81**

3.3 Surge Tower Rehabilitation - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.79	6.14	2.84	0.01		0.35	0.35		0.35	0.35		702.97		0.07		704.46
Total	**0.79**	**6.14**	**2.84**	**0.01**		**0.35**	**0.35**		**0.35**	**0.35**		**702.97**		**0.07**		**704.46**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.01	0.08	0.05	0.00	0.26	0.00	0.26	0.00	0.00	0.00		14.05		0.00		14.05
Vendor	0.05	0.56	0.37	0.00	0.04	0.02	0.06	0.00	0.02	0.02		108.16		0.00		108.22
Worker	0.02	0.02	0.25	0.00	0.06	0.00	0.06	0.00	0.00	0.00		47.74		0.00		47.79
Total	**0.08**	**0.66**	**0.67**	**0.00**	**0.36**	**0.02**	**0.38**	**0.00**	**0.02**	**0.02**		**169.95**		**0.00**		**170.06**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.79	6.14	2.84	0.01		0.35	0.35		0.35	0.35	0.00	702.97		0.07		704.46
Total	**0.79**	**6.14**	**2.84**	**0.01**		**0.35**	**0.35**		**0.35**	**0.35**	**0.00**	**702.97**		**0.07**		**704.46**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.01	0.08	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00		14.05		0.00		14.05
Vendor	0.05	0.56	0.37	0.00	0.00	0.02	0.02	0.00	0.02	0.02		108.16		0.00		108.22
Worker	0.02	0.02	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00		47.74		0.00		47.79

Total	**0.08**	**0.66**	**0.67**	**0.00**	**0.00**	**0.02**	**0.02**	**0.00**	**0.02**	**0.02**		**169.95**		**0.00**		**170.06**

3.4 Beach Box Rehabilitation - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	7.75	82.41	32.33	0.12		2.88	2.88		2.88	2.88		13,485.12		0.69		13,499.70
Total	**7.75**	**82.41**	**32.33**	**0.12**		**2.88**	**2.88**		**2.88**	**2.88**		**13,485.12**		**0.69**		**13,499.70**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.01	0.08	0.05	0.00	0.07	0.00	0.07	0.00	0.00	0.00		17.59		0.00		17.60
Vendor	0.02	0.25	0.17	0.00	0.02	0.01	0.03	0.00	0.01	0.01		54.26		0.00		54.29
Worker	0.02	0.02	0.23	0.00	0.06	0.00	0.06	0.00	0.00	0.00		46.68		0.00		46.73
Total	**0.05**	**0.35**	**0.45**	**0.00**	**0.15**	**0.01**	**0.16**	**0.00**	**0.01**	**0.01**		**118.53**		**0.00**		**118.62**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	7.75	82.41	32.33	0.12		2.88	2.88		2.88	2.88	0.00	13,485.12		0.69		13,499.70

Total	**7.75**	**82.41**	**32.33**	**0.12**		**2.88**	**2.88**		**2.88**	**2.88**	**0.00**	**13,485.12**		**0.69**		**13,499.70**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.01	0.08	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00		17.59		0.00		17.60
Vendor	0.02	0.25	0.17	0.00	0.00	0.01	0.01	0.00	0.01	0.01		54.26		0.00		54.29
Worker	0.02	0.02	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00		46.68		0.00		46.73
Total	**0.05**	**0.35**	**0.45**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.01**	**0.01**		**118.53**		**0.00**		**118.62**

3.5 Air Vac - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.78	5.52	2.81	0.01		0.25	0.25		0.25	0.25		970.25		0.07		971.70
Total	**0.78**	**5.52**	**2.81**	**0.01**		**0.25**	**0.25**		**0.25**	**0.25**		**970.25**		**0.07**		**971.70**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					

Hauling	0.00	0.04	0.02	0.00	0.02	0.00	0.03	0.00	0.00	0.00		8.21		0.00		8.21
Vendor	0.07	0.76	0.52	0.00	0.06	0.02	0.08	0.00	0.02	0.03		162.79		0.00		162.87
Worker	0.02	0.02	0.23	0.00	0.06	0.00	0.06	0.00	0.00	0.00		46.68		0.00		46.73
Total	**0.09**	**0.82**	**0.77**	**0.00**	**0.14**	**0.02**	**0.17**	**0.00**	**0.02**	**0.03**		**217.68**		**0.00**		**217.81**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.78	5.52	2.81	0.01		0.25	0.25		0.25	0.25	0.00	970.25		0.07		971.70
Total	**0.78**	**5.52**	**2.81**	**0.01**		**0.25**	**0.25**		**0.25**	**0.25**	**0.00**	**970.25**		**0.07**		**971.70**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00		8.21		0.00		8.21
Vendor	0.07	0.76	0.52	0.00	0.00	0.02	0.03	0.00	0.02	0.03		162.79		0.00		162.87
Worker	0.02	0.02	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00		46.68		0.00		46.73
Total	**0.09**	**0.82**	**0.77**	**0.00**	**0.00**	**0.02**	**0.03**	**0.00**	**0.02**	**0.03**		**217.68**		**0.00**		**217.81**

OCSD J-112

Orange County, Winter

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Light Industry	10	1000sqft

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**	Southern California Edison
Climate Zone	8	**Precipitation Freq (Days)**	30		

1.3 User Entered Comments

Project Characteristics -

Land Use - Site disturbance

Construction Phase - Surge Tower Rehabilitation9/16/201412/12/2014
Bypass Construction9/16/201412/27/2014
Beach Box Rehabilitation1/7/20151/26/2015
Air Vac 1/8/2015 1/21/2015

Off-road Equipment - Air Compressors; Off-Highway Trucks, Pumps, Cranes, Tractors/Loaders/Backhoes, Generator Sets, Generator Sets
Load factors updated based on ARB's Off-Road Emission Inventory update.

Off-road Equipment - Air Compressors, Cranes, Rubber Tired Dozers, Excavators, Tractors/Loaders/Backhoes, Generator Sets
Load factors updated based on ARB's Off-Road Emissions Inventory update.

Off-road Equipment - Air Compressors24Cranes 16
Load factors updated based on ARB's Off-Road Emissions Inventory update.

Grading - Conservative acreage estimate

Off-road Equipment - Air Compressors, Cranes, Welders, Other construction equipment.
Load factors adjusted based on ARB's Off-Road Emissions Inventory update.

Trips and VMT - From trip generation data provided by B&V

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	9.06	97.13	39.30	0.13	6.95	3.37	10.31	3.33	3.37	6.70	0.00	13,992.77	0.00	0.81	0.00	14,009.75
2015	8.68	89.17	36.43	0.13	0.29	3.16	3.46	0.01	3.16	3.18	0.00	14,784.04	0.00	0.77	0.00	14,800.30
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	9.06	97.13	39.30	0.13	6.19	3.37	9.55	3.33	3.37	6.70	0.00	13,992.77	0.00	0.81	0.00	14,009.75

2015	8.68	89.17	36.43	0.13	0.01	3.16	3.18	0.01	3.16	3.18	0.00	14,784.04	0.00	0.77	0.00	14,800.30
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Bypass Construction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					6.17	0.00	6.17	3.31	0.00	3.31						0.00
Off-Road	7.99	89.28	34.06	0.11		2.96	2.96		2.96	2.96		12,757.16		0.72		12,772.22
Total	**7.99**	**89.28**	**34.06**	**0.11**	**6.17**	**2.96**	**9.13**	**3.31**	**2.96**	**6.27**		**12,757.16**		**0.72**		**12,772.22**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.03	0.02	0.00	0.09	0.00	0.09	0.00	0.00	0.00		4.40		0.00		4.40
Vendor	0.08	0.88	0.63	0.00	0.06	0.03	0.08	0.00	0.03	0.03		161.27		0.00		161.36
Worker	0.11	0.11	1.05	0.00	0.28	0.01	0.29	0.01	0.01	0.02		200.83		0.01		201.06

Total	**0.19**	**1.02**	**1.70**	**0.00**	**0.43**	**0.04**	**0.46**	**0.01**	**0.04**	**0.05**		**366.50**		**0.01**		**366.82**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					6.17	0.00	6.17	3.31	0.00	3.31						0.00
Off-Road	7.99	89.28	34.06	0.11		2.96	2.96		2.96	2.96	0.00	12,757.16		0.72		12,772.22
Total	**7.99**	**89.28**	**34.06**	**0.11**	**6.17**	**2.96**	**9.13**	**3.31**	**2.96**	**6.27**	**0.00**	**12,757.16**		**0.72**		**12,772.22**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00		4.40		0.00		4.40
Vendor	0.08	0.88	0.63	0.00	0.00	0.03	0.03	0.00	0.03	0.03		161.27		0.00		161.36
Worker	0.11	0.11	1.05	0.00	0.01	0.01	0.02	0.01	0.01	0.02		200.83		0.01		201.06
Total	**0.19**	**1.02**	**1.70**	**0.00**	**0.01**	**0.04**	**0.05**	**0.01**	**0.04**	**0.05**		**366.50**		**0.01**		**366.82**

3.3 Surge Tower Rehabilitation - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					

Off-Road	0.79	6.14	2.84	0.01		0.35	0.35		0.35	0.35		702.97		0.07		704.46
Total	**0.79**	**6.14**	**2.84**	**0.01**		**0.35**	**0.35**		**0.35**	**0.35**		**702.97**		**0.07**		**704.46**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.01	0.08	0.05	0.00	0.26	0.00	0.26	0.00	0.00	0.00		13.99		0.00		14.00
Vendor	0.05	0.59	0.42	0.00	0.04	0.02	0.06	0.00	0.02	0.02		107.52		0.00		107.57
Worker	0.02	0.02	0.23	0.00	0.06	0.00	0.06	0.00	0.00	0.00		44.63		0.00		44.68
Total	**0.08**	**0.69**	**0.70**	**0.00**	**0.36**	**0.02**	**0.38**	**0.00**	**0.02**	**0.02**		**166.14**		**0.00**		**166.25**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.79	6.14	2.84	0.01		0.35	0.35		0.35	0.35	0.00	702.97		0.07		704.46
Total	**0.79**	**6.14**	**2.84**	**0.01**		**0.35**	**0.35**		**0.35**	**0.35**	**0.00**	**702.97**		**0.07**		**704.46**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e

Category	lb/day										lb/day					
Hauling	0.01	0.08	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00		13.99		0.00		14.00
Vendor	0.05	0.59	0.42	0.00	0.00	0.02	0.02	0.00	0.02	0.02		107.52		0.00		107.57
Worker	0.02	0.02	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00		44.63		0.00		44.68
Total	**0.08**	**0.69**	**0.70**	**0.00**	**0.00**	**0.02**	**0.02**	**0.00**	**0.02**	**0.02**		**166.14**		**0.00**		**166.25**

3.4 Beach Box Rehabilitation - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	7.75	82.41	32.33	0.12		2.88	2.88		2.88	2.88		13,485.12		0.69		13,499.70
Total	**7.75**	**82.41**	**32.33**	**0.12**		**2.88**	**2.88**		**2.88**	**2.88**		**13,485.12**		**0.69**		**13,499.70**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.01	0.09	0.06	0.00	0.07	0.00	0.07	0.00	0.00	0.00		17.52		0.00		17.53
Vendor	0.03	0.27	0.19	0.00	0.02	0.01	0.03	0.00	0.01	0.01		53.93		0.00		53.95
Worker	0.02	0.02	0.21	0.00	0.06	0.00	0.06	0.00	0.00	0.00		43.63		0.00		43.68
Total	**0.06**	**0.38**	**0.46**	**0.00**	**0.15**	**0.01**	**0.16**	**0.00**	**0.01**	**0.01**		**115.08**		**0.00**		**115.16**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	7.75	82.41	32.33	0.12		2.88	2.88		2.88	2.88	0.00	13,485.12		0.69		13,499.70
Total	**7.75**	**82.41**	**32.33**	**0.12**		**2.88**	**2.88**		**2.88**	**2.88**	**0.00**	**13,485.12**		**0.69**		**13,499.70**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.01	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00		17.52		0.00		17.53
Vendor	0.03	0.27	0.19	0.00	0.00	0.01	0.01	0.00	0.01	0.01		53.93		0.00		53.95
Worker	0.02	0.02	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00		43.63		0.00		43.68
Total	**0.06**	**0.38**	**0.46**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.01**	**0.01**		**115.08**		**0.00**		**115.16**

3.5 Air Vac - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.78	5.52	2.81	0.01		0.25	0.25		0.25	0.25		970.25		0.07		971.70
Total	**0.78**	**5.52**	**2.81**	**0.01**		**0.25**	**0.25**		**0.25**	**0.25**		**970.25**		**0.07**		**971.70**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.04	0.03	0.00	0.02	0.00	0.03	0.00	0.00	0.00		8.18		0.00		8.18
Vendor	0.08	0.80	0.58	0.00	0.06	0.02	0.08	0.00	0.02	0.03		161.78		0.00		161.86
Worker	0.02	0.02	0.21	0.00	0.06	0.00	0.06	0.00	0.00	0.00		43.63		0.00		43.68
Total	**0.10**	**0.86**	**0.82**	**0.00**	**0.14**	**0.02**	**0.17**	**0.00**	**0.02**	**0.03**		**213.59**		**0.00**		**213.72**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.78	5.52	2.81	0.01		0.25	0.25		0.25	0.25	0.00	970.25		0.07		971.70
Total	**0.78**	**5.52**	**2.81**	**0.01**		**0.25**	**0.25**		**0.25**	**0.25**	**0.00**	**970.25**		**0.07**		**971.70**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00		8.18		0.00		8.18
Vendor	0.08	0.80	0.58	0.00	0.00	0.02	0.03	0.00	0.02	0.03		161.78		0.00		161.86
Worker	0.02	0.02	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00		43.63		0.00		43.68

Total	**0.10**	**0.86**	**0.82**	**0.00**	**0.00**	**0.02**	**0.03**	**0.00**	**0.02**	**0.03**		**213.59**		**0.00**		**213.72**

OCSD J-112

Orange County, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Light Industry	10	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Climate Zone 8

Wind Speed (m/s) 2.2

Precipitation Freq (Days) 30

Utility Company Southern California Edison

1.3 User Entered Comments

Project Characteristics -

Land Use - Site disturbance

Construction Phase - Surge Tower Rehabilitation9/16/201412/12/2014
Bypass Construction9/16/201412/27/2014
Beach Box Rehabilitation1/7/20151/26/2015
Air Vac 1/8/2015 1/21/2015
Off-road Equipment - Air Compressors; Off-Highway Trucks, Pumps, Cranes, Tractors/Loaders/Backhoes, Generator Sets, Generator Sets
Load factors updated based on ARB's Off-Road Emission Inventory update.

Off-road Equipment - Air Compressors, Cranes, Rubber Tired Dozers, Excavators, Tractors/Loaders/Backhoes, Generator Sets
Load factors updated based on ARB's Off-Road Emissions Inventory update.

Off-road Equipment - Air Compressors 24Cranes 16
Load factors updated based on ARB's Off-Road Emissions Inventory update.

Grading - Conservative acreage estimate

Off-road Equipment - Air Compressors, Cranes, Welders, Other construction equipment.
Load factors adjusted based on ARB's Off-Road Emissions Inventory update.

Trips and VMT - From trip generation data provided by B&V

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2014	0.33	3.56	1.44	0.00	0.25	0.12	0.38	0.12	0.12	0.25	0.00	465.83	465.83	0.03	0.00	466.39
2015	0.06	0.61	0.25	0.00	0.00	0.02	0.02	0.00	0.02	0.02	0.00	91.73	91.73	0.00	0.00	91.83
Total	**0.39**	**4.17**	**1.69**	**0.00**	**0.25**	**0.14**	**0.40**	**0.12**	**0.14**	**0.27**	**0.00**	**557.56**	**557.56**	**0.03**	**0.00**	**558.22**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2014	0.33	3.56	1.44	0.00	0.23	0.12	0.35	0.12	0.12	0.25	0.00	465.83	465.83	0.03	0.00	466.39
2015	0.06	0.61	0.25	0.00	0.00	0.02	0.02	0.00	0.02	0.02	0.00	91.73	91.73	0.00	0.00	91.83
Total	**0.39**	**4.17**	**1.69**	**0.00**	**0.23**	**0.14**	**0.37**	**0.12**	**0.14**	**0.27**	**0.00**	**557.56**	**557.56**	**0.03**	**0.00**	**558.22**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Bypass Construction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.23	0.00	0.23	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.30	3.30	1.26	0.00		0.11	0.11		0.11	0.11	0.00	428.09	428.09	0.02	0.00	428.59
Total	**0.30**	**3.30**	**1.26**	**0.00**	**0.23**	**0.11**	**0.34**	**0.12**	**0.11**	**0.23**	**0.00**	**428.09**	**428.09**	**0.02**	**0.00**	**428.59**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.00	0.15
Vendor	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.43	5.43	0.00	0.00	5.44
Worker	0.00	0.00	0.04	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	6.89	6.89	0.00	0.00	6.90
Total	**0.00**	**0.03**	**0.06**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**12.47**	**12.47**	**0.00**	**0.00**	**12.49**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.23	0.00	0.23	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.30	3.30	1.26	0.00		0.11	0.11		0.11	0.11	0.00	428.09	428.09	0.02	0.00	428.59
Total	**0.30**	**3.30**	**1.26**	**0.00**	**0.23**	**0.11**	**0.34**	**0.12**	**0.11**	**0.23**	**0.00**	**428.09**	**428.09**	**0.02**	**0.00**	**428.59**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.00	0.15
Vendor	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.43	5.43	0.00	0.00	5.44
Worker	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.89	6.89	0.00	0.00	6.90
Total	**0.00**	**0.03**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**12.47**	**12.47**	**0.00**	**0.00**	**12.49**

3.3 Surge Tower Rehabilitation - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.03	0.20	0.09	0.00		0.01	0.01		0.01	0.01	0.00	20.40	20.40	0.00	0.00	20.44
Total	**0.03**	**0.20**	**0.09**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**20.40**	**20.40**	**0.00**	**0.00**	**20.44**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.41	0.41	0.00	0.00	0.41
Vendor	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.13	3.13	0.00	0.00	3.13
Worker	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32	1.32	0.00	0.00	1.33
Total	**0.00**	**0.02**	**0.02**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**4.86**	**4.86**	**0.00**	**0.00**	**4.87**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.03	0.20	0.09	0.00		0.01	0.01		0.01	0.01	0.00	20.40	20.40	0.00	0.00	20.44
Total	**0.03**	**0.20**	**0.09**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**20.40**	**20.40**	**0.00**	**0.00**	**20.44**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.41	0.00	0.00	0.41
Vendor	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.13	3.13	0.00	0.00	3.13
Worker	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32	1.32	0.00	0.00	1.33

Total	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.86**	**4.86**	**0.00**	**0.00**	**4.87**

3.4 Beach Box Rehabilitation - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.05	0.58	0.23	0.00		0.02	0.02		0.02	0.02	0.00	85.61	85.61	0.00	0.00	85.70
Total	**0.05**	**0.58**	**0.23**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**85.61**	**85.61**	**0.00**	**0.00**	**85.70**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.00	0.11
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.34	0.00	0.00	0.34
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.00	0.00	0.28
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.73**	**0.73**	**0.00**	**0.00**	**0.73**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.05	0.58	0.23	0.00		0.02	0.02		0.02	0.02	0.00	85.61	85.61	0.00	0.00	85.70

Total	0.05	0.58	0.23	0.00		0.02	0.02		0.02	0.02	0.00	85.61	85.61	0.00	0.00	85.70

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.00	0.11
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.34	0.00	0.00	0.34
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.00	0.00	0.28
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.73**	**0.73**	**0.00**	**0.00**	**0.73**

3.5 Air Vac - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.00	0.03	0.01	0.00		0.00	0.00		0.00	0.00	0.00	4.40	4.40	0.00	0.00	4.41
Total	**0.00**	**0.03**	**0.01**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**4.40**	**4.40**	**0.00**	**0.00**	**4.41**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					

Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.04
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.74	0.00	0.00	0.74
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.20
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.98**	**0.98**	**0.00**	**0.00**	**0.98**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.00	0.03	0.01	0.00		0.00	0.00		0.00	0.00	0.00	4.40	4.40	0.00	0.00	4.41
Total	**0.00**	**0.03**	**0.01**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**4.40**	**4.40**	**0.00**	**0.00**	**4.41**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.04
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.74	0.00	0.00	0.74
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.20
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.98**	**0.98**	**0.00**	**0.00**	**0.98**

Surge Tower Coatings Emissions

Surface area of a cylinder (SA) = 2*PI*r*h

Surge Tower

Radius r	13	feet
Height h	84.5	feet

SA	6905	square feet

VOC limit	250	g/L	
Coverage	180	square feet/gallon	
Coatings	38.4	Gallons	
VOC	80.1	lb VOC	over entire construction duration
Days	64	For surge tower interior and exterior rehabilitation	
VOC	1.3	lb/day	Average VOC emissions per day

Conversion Factors

1	pound	453.6	grams
1	gallon	3.79	liters

Appendix C

Phase I Cultural Resources Assessment

OUTFALL LAND SECTION AND OCEAN OUTFALL BOOSTER PUMP STATION PIPING REHABILITATION PROJECT

Phase I Cultural Resources Assessment

Prepared for
Orange County Sanitation District

December 2011

ESA

OUTFALL LAND SECTION AND OCEAN OUTFALL BOOSTER PUMP STATION PIPING REHABILITATION PROJECT

Phase I Cultural Resources Assessment

December 2011

Prepared for:

Orange County Sanitation District

Prepared by:

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U.S.G.S. Quadrangle: Newport Beach, CA
Township 5 South, Range 9 West
Acres: Approx 6.56
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EXECUTIVE SUMMARY

Outfall Land Section and Ocean Outfall Booster Pump Station Piping Rehabilitation Project Phase I Cultural Resources Assessment

The Orange County Sanitation District (Sanitation District) is proposing to make repairs and upgrades to its outfall systems (Project). The Sanitation District will serve as the lead agency under the California Environmental Quality Act (CEQA) for the preparation of an Environmental Impact Report for this Project.

The proposed Project would consist of inspection, condition assessment, and rehabilitation of corroded areas within the land section of the 120-inch diameter primary, five-mile outfall (Long Outfall) System extending from the Surge Tower No. 2 (Surge Tower 2) in Treatment Plant No. 2 (Plant 2) to the Ocean Outfall Beach Junction Box (Beach Box) located on the Huntington State Beach. Specifically, the proposed Project includes five project elements: (1) rehabilitation of Surge Tower 2; (2) rehabilitation of the land section of the Long Outfall; (3) abandonment of the Long Outfall metering ports and vaults; (4) replacement of the existing effluent flow meter on the Long Outfall; and (5) rehabilitation of the Beach Box. Two Alternatives have been developed to isolate the work area while continuing discharging to the ocean: (1) Alternative 1: Bypass – No Direct Discharge to the Short Outfall; and (2) Alternative 2: Non-Bypass – Use of the Short Outfall Discharge. Only Alternative 1 requires ground disturbance.

A records search for the Project was conducted on August 8, 2011 at the South Central Coastal Information Center housed at California State University, Fullerton. The records search study area included the Project area and 0.5-mile buffer. The records search indicated that two prehistoric archaeological sites (CA-ORA-843 and CA-ORA-906) have been previously recorded within 0.5 mile of the Project area. No cultural resources have been recorded in the Project area.

The Native American Heritage Commission (NAHC) was contacted on August 2, 2011 to request a search of the sacred lands file. The NAHC responded to the request in a letter dated August 4, 2011. The letter indicated that “numerous” Native American cultural resources are known to be located within a 0.5-mile radius of the Project area. Contact letters to all individuals and groups indicated by the NAHC as having affiliation with the Project area were prepared and mailed on August 17, 2011. To date, one response has been received.

A field survey of a portion of the Project area was performed by ESA archaeologist Candace Ehringer, M.A., RPA, on August 30, 2011. The off-site limits of construction and the Air Vac (12+05) were surveyed by foot. The goal of the pedestrian survey was to identify any cultural resources present and to evaluate the Project area for its potential to contain buried cultural resources. No cultural resources were identified within the Project area as a result of the survey. The Project area appeared to have largely been disturbed by past construction activities, including the creation of a multipurpose trail, channelization of the Santa Ana River, and installation of Sanitation District facilities.

No cultural resources were identified within the Project area; however, the Project area is considered sensitive for prehistoric cultural resources. Alternative 1 would require excavation that could uncover previously unknown archaeological resources. It is recommended that all ground disturbance required for Alternative 1 be monitored by a qualified archaeologist meeting the Secretary of the Interior's Standards for professional archaeology. Alternative 2 would not require excavation and therefore no further work is required for this alternative.

OUTFALL LAND SECTION AND OCEAN OUTFALL BOOSTER PUMP STATION PIPING REHABILITATION PROJECT

Phase I Cultural Resources Assessment

Introduction

The Orange County Sanitation District (Sanitation District) is proposing to make repairs and upgrades to its outfall systems (Project). The Sanitation District will serve as the lead agency under the California Environmental Quality Act (CEQA) for the preparation of an Environmental Impact Report for this Project.

The Sanitation District proposes to implement the Outfall Land Section and Ocean Outfall Booster Station (OOBS) piping, to rehabilitate aging components of the land portion of the ocean outfall system. The proposed Project would consist of inspection, condition assessment, and rehabilitation of corroded areas within the land section of the 120-inch diameter primary, five-mile outfall (Long Outfall) System extending from the Surge Tower No. 2 (Surge Tower 2) in Treatment Plant No. 2 (Plant 2) to the Ocean Outfall Beach Junction Box (Beach Box) located on the Huntington State Beach.

This report has been prepared in compliance with CEQA and documents the results of a Phase 1 Cultural Resources Study. ESA personnel involved in the preparation of this report include Candace Ehringer, M.A., R.P.A., report author and surveyor, and Jason Nielsen, GIS Specialist. Monica Strauss, M.A., R.P.A., served as technical and quality control director. Resumes of key personnel are provided in Appendix A.

Project Location and Description

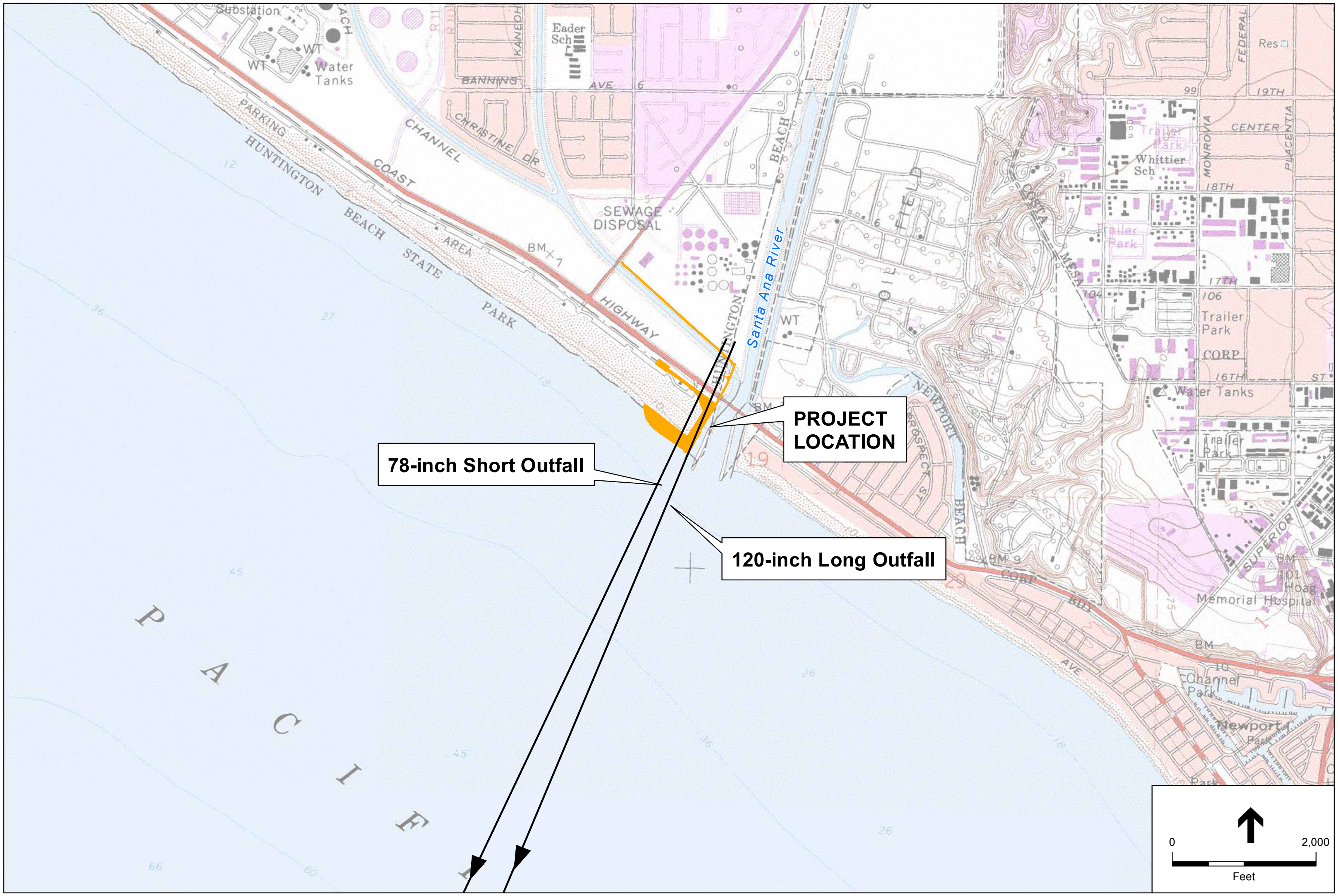
Project Location

The Project is located in Orange County in the City of Huntington Beach (**Figure 1**). A portion of the proposed Project is located within the Sanitation District's Treatment Plant 2 located at 22212 Brookhurst Street. Plant 2 is bounded by Hamilton Avenue to the north, the Santa Ana River to the east, Pacific Coast Highway (PCH) to the south, and Brookhurst Street to the west. A roadway separates the southern boundary of Plant 2, from Talbert Marsh. The proposed Project area also includes two offsite locations: an area along the western edge of the Orange County, Santa Ana River (Santa Ana River) bike trail between the southern side of Plant 2 and PCH, adjacent to the Talbert Marsh; and in the Huntington State Beach, east of the Huntington Beach Least Tern Preserve where the Beach Box is located (**Figure 2**).

SOURCE: Bing Maps; ESA, 2011.

Outfall Land Section and OOBS Piping Rehabilitation. 211261

Figure 1
Regional Location Map



SOURCE: Bing Maps; ESA, 2011.

Outfall Land Section and OOBS Piping Rehabilitation. 211261

Figure 2
Project Location Map

Project Description

The proposed Project would consist of inspection, condition assessment, and rehabilitation of corroded areas within the land section of the 120-inch diameter primary, five-mile Long Outfall System extending from Surge Tower 2 in Plant 2 to the Beach Box located on the Huntington State Beach. Specifically, the proposed Project includes five project elements: (1) rehabilitation of Surge Tower 2; (2) rehabilitation of the land section of the Long Outfall; (3) abandonment of the Long Outfall metering ports and vaults; (4) replacement of the existing effluent flow meter on the Long Outfall; and (5) rehabilitation of the Beach Box (**Figure 3**).

Two Alternatives have been developed to isolate the work area while continuing discharging to the ocean.

- Alternative 1: Bypass – No Direct Discharge to the Short Outfall. This alternative would install a temporary bypass structure downstream of the Beach Box to convey the flow from the Short Outfall to the Long Outfall prior to ocean discharge. In addition to the bypass, this alternative includes five additional project elements described below (**Table 1**).
- Alternative 2: Non-Bypass – Use of the Short Outfall Discharge. This alternative would discharge treated effluent through the Short Outfall while the Long Outfall System is being rehabilitated. With the exception of the bypass structure, Alternative 2 consists of the same five project elements described in Alternative 1.

TABLE 1
PROJECT ELEMENTS AND LOCATIONS

No. Project	Element Activity	Rehabilitation Location	Alternative 1	Alternative 2	Estimated Amount of Excavation
	Bypass Structure [a]	On State Beach	X	-	4,350 cy
1	Rehabilitation of Surge Tower 2	On Plant 2	X	X	-
2	Inspection and Rehabilitation of the Land Section of the Long Outfall	On Plant 2 and near Talbert Marsh	X X		-
3	Abandonment of the Long Outfall Metering Ports and Vaults	On Plant 2	X	X	-
4	Replacement of the Existing Effluent Flow Meter on the Long Outfall	On Plant 2	X	X	-
5	Rehabilitation of the Beach Box.	On State Beach	X	X	-

---

[a] The bypass structure is only constructed in Alternative 1

SOURCE: Bing Maps; ESA, 2011.

J-112 Outfall Land Section and OOBS Piping Rehabilitation. 211261

Figure 3
Project Elements

Alternative 1 – No Direct Discharge to the Short Outfall

Alternative 1 would install a bypass structure downstream of the Beach Box to allow for the diversion of flow from the land portion of the Short Outfall to the Long Outfall prior to discharge to the ocean. The bypass structure would allow the Long Outfall System to be taken out of service for rehabilitation without discharging treated effluent through the Short Outfall.

Construction of the bypass would require excavation to access both buried pipelines. Approximately 4,350 cubic yards of existing beach sand would be excavated and stockpiled within the construction zone. The excavation would be approximately 65-feet wide by 80-feet long and 20 to 25 feet deep. Groundwater is anticipated to be within 5 feet below ground surface. Therefore, an additional area for the dewatering equipment would be approximately 150-feet in width by 400-feet long (60,000 square feet) would be required. The total construction area would be approximately 6.56-acres. The stockpiled material would be located west of the excavation pit and parallel to the Santa Ana River jetty and/or south of the Least Tern Natural Preserve within the nearshore. The area would be fenced off to prevent access from the beach. Following construction, the existing stockpiled material would be used to backfill the excavation. No soil or sand would be exported from the construction site.

Prior to the rehabilitation work, the inside of the Long Outfall will also need to be dewatered, cleaned, and the inside dried. This process will also require one or two temporary dewatering pipeline(s) measuring approximately 8 to 12 inches in diameter. The pipeline would be placed aboveground along the western edge of the Santa Ana River bike path between the Beach Box and Plant. Specifically, the pipeline would be routed from the beach box, along the Santa Ana River trail to the Talbert Marsh trail a would be pumped to Sanitation District's nearby Plant 2 for treatment prior to being discharged through the outfall to the ocean. The pipeline will be installed in a buried trench to cross the bike path into Plant 2.

In order to maneuver heavy equipment around the beach box, at the Short Outfall and provide sufficient access for excavation, the construction area would extend approximately 10 feet west into the fenced least tern nesting area. The length of the fence to be moved is approximately 300-feet, depending on specific design requirements. The excavation zone would occur outside of the Sanitation District's easement. Equipment and material storage would occur at the Huntington State Beach parking lot. The existing bike trail south of PCH within the limits of the construction would be temporarily closed and equipment would be transported to the construction site via the bike trail between the parking lot and the Santa Ana River.

Alternative 1 includes the following five elements:

1) Rehabilitation of Surge Tower 2

Surge Tower 2 is located adjacent to the Santa Ana River within Plant 2 boundaries and downstream of the Sanitation District's OOBS. Surge Tower 2 is 84.5 ft high and 26 ft in diameter and was placed in operation in 1971. The lower portion of Surge Tower 2 is made of concrete and the upper portion is made of steel. In order to protect Surge Tower 2 from corrosion, exterior and interior steel surfaces would be repaired, abrasively blasted, and recoated with paint.

In addition, the stairs attached to the exterior of the building leading to the top of the Surge Tower 2 would be upgraded to meet current industry standards. During this process, electrical, bubbler panel instrumentation and low glare type lighting upgrades will also be performed. During work on the exterior, scaffolding with external containment will be built around Surge Tower 2. Staging areas and a work trailer would all be located on Plant 2. No ground disturbance is proposed for this Project element.

2) Replacement of the Effluent Meter

An ultrasonic flow meter is located on the Long Outfall within Plant 2 boundaries and is used to measure the effluent flow. The current metering technology was placed in operation in 1971 and is now out-of-date. Replacement parts for repairs are not available. The new meter would be installed in the same location as the existing effluent meter. This activity would be located entirely on the plant site and would not require any ground disturbance.

3) Inspection and Rehabilitation of Long Outfall

The land portion of the Long Outfall, constructed in 1971, is approximately 1,930 ft long, 120-inches in diameter. The piping system has been in service since it was constructed in 1971 without a major rehabilitation. Three steel risers connect the Long Outfall to the effluent sampler and two air vacuum release structures. The effluent sampler and one of the air vacuum release structures are located within the Plant 2 boundaries. The second air vacuum release structure is located outside of the Plant 2 boundaries east of Talbert Marsh inland of the western edge of the Orange County bike path, between the south side of Plant 2 and PCH on property owned and managed by the Huntington Beach Wetland Conservancy.

During previous inspections of the Long Outfall, corrosion was observed downstream of Surge Tower 2 and at the air vacuum valve outside of Plant 2. Prior to rehabilitation, the land portion of the Long Outfall will be taken out of service and allowed to dry. Workers will enter the pipeline to perform an inspection. Corrosion identified in the pipeline will be repaired using carbon-fiber wrap techniques. Access and egress from the pipeline will be from Plant 2.

The off-site air vacuum structure (air vac) site is located adjacent to the Santa Ana River bike path and is also adjacent to the Talbert Marsh, on property owned and managed by the Huntington Beach Wetland Conservancy. The structure will be accessed from the bike trail and existing cleared access road. No excavation or construction will occur at this location adjacent to the Talbert Marsh and temporary fencing will be installed to prevent inadvertent disturbance of on-site vegetation.

4) Abandonment of Long Outfall Metering Ports/Vaults

The outfall meter ports are located within two meter vaults that straddle the Long Outfall within Plant 2 boundaries. These vaults/ports are no longer used and will be abandoned in-place. The abandonment of the meter ports would include removing the existing flow meter transducer probes and sealing penetrations through the interior surfaces. In addition, steel plates would be welded over the tee sections of the exterior manholes on the outside of the pipe. The vaults would be filled with grout and lightweight cellular concrete. These activities would all occur on the plant site and would not require any ground disturbance.

5) Rehabilitation of the Beach Box

The Beach Box is located on Huntington State Beach. The top of the Beach Box is visible on the sand within an area enclosed by a chain link fence. The Beach Box consists of the Long Outfall compartment and the Short Outfall compartment. The Long Outfall compartment is associated with the Long Outfall and includes both concrete and steel bulkhead sections. The Short Outfall compartment is attached to the Short Outfall and only has concrete sections.

The Long Outfall compartment of the Beach Box consists of three levels: ground, intermediate and bottom. At ground level, a concrete cover has been placed over the Beach Box to prevent unauthorized persons from entering the Beach Box. At the intermediate level, there is a concrete deck that has three openings covered by steel frames and covers. Removal of the 5-foot by 10-foot steel cover, provides access to the interior of the outfall pipe. The Long Outfall enters and exits the Beach Box at the bottom level. The deck and metal covers at the intermediate level are under pressure from the effluent discharge.

Three options are under consideration for rehabilitating the Beach Box. Each option described below would require closure of the bike trail south of PCH for the duration of construction. Ground disturbance is not required for any of the three options.

Option A – Carbon Fiber Reinforced Polymer (CFRP) Liner

Under Option A, a high strength CFRP lining designed to withstand the maximum operating pressure of 40 pound-force per square inch would be installed on the concrete walls, ceiling, and floor on the lower level of the Beach Box. The CFRP liner would form a watertight seal inside the Beach Box that would not diminish flow capacity of the Long Outfall. The frames and plates around the openings on the intermediate level and the opening covers would be replaced once the CFRP lining was applied.

To accommodate the construction workers and staging areas, rehabilitation of the each Box would require that the bike trail south of PCH within the limit of construction be temporarily closed.

Option B – Fiberglass Pipe Insert

Under, Option B most of the deck on the intermediate level would be removed. Sections of fiberglass pipe would be lowered into the bottom level of the Beach Box. Each section would be pushed up into the Long Outfall, upstream and downstream of the Beach Box. A 54-inch diameter manhole with an access cover would be lowered into the Beach Box and connected to the two sections of fiberglass pipe to provide access to the Long Outfall.

The space above the pipes would be filled with a reinforced light-weight cellular concrete material up to an elevation of seven feet below the lip of Beach Box opening. The existing steel cover would be permanently removed. A CFRP liner would be applied at the ends of the fiberglass pipes and the RCP pipes. The construction zone would be similar to Option A.

Option C – Steel Pipe Insert

Option C is similar to B in that it would insert a reinforcing pipe into the Long Outfall to reinforce the pipeline at the Beach Box. Under Option C, the intermediate level of the Beach Box would be retained. The intermediate level covers would be removed and five sections of steel pipe, each measuring 3.5 feet long would be inserted through the largest opening in the deck into to the bottom level. The pipe sections would then be welded together in place. A 36-inch riser and access cover would be lowered into the bottom level and welded to the steel pipe sections. The riser would provide access to the Long Outfall. The inside of the sections and the riser would be lined with CRFP, and the space would be filled with grout. The construction zone would be similar to Option A.

Alternative 2 – Non-Bypass (Use of the Short Outfall)

Under Alternative 2, no bypass structure would be constructed on the beach. The same five Project elements outlined above would also be included in Alternative 2. The Beach Box would be rehabilitated as soon as possible by implementing either Option A, B or C. The remaining project elements of the Long Outfall System would be inspected, condition assessed, and rehabilitated as described above under Alternative 1. The work would be conducted primarily within the existing footprint of the Beach Box, with slight variations under Options A, B, and C. The construction zone within Huntington State Beach and the equipment and material storage area within its parking lot would have a considerable smaller footprint than Alternative 1, approximately 2.26-acres. This Alternative will also require the closure of the bike path south of PCH, in order to permit construction access and maintain pedestrian and biker safety in the project area.

Similar to Alternative 1, Alternative 2 would require one to two dewatering pipeline(s) be installed from the Beach Box to Treatment Plant 2 in order to dewater the Long Outfall pipeline once it is shutdown. A staging area would be located on the State Beach parking lot. Additionally, similar bike path detours would be required as described above under Alternative 1. Ground disturbance is not required for Alternative 2.

Setting

The following section provides a summary of the natural environment, historical context, and regulatory framework for the Project.

Environmental Setting

The proposed Project is located in the City of Huntington Beach, Orange County, in southern California. The topography of Orange County includes a combination of mountains, hills, flatlands, and shorelines. Urbanized Orange County is predominantly within an alluvial plain, semi-enclosed by the Puente and Chino Hills to the north, the San Joaquin Hills to the south, and the Santiago Foothills and the Santa Ana Mountains to the east. The Puente and Chino Hills, which identify the northern limit of the plains, extend for 22 miles and reach a peak height of 7,780 feet (ft). To the east and southeast of the plains are the Santa Ana Mountains, which have a peak height of 5,691 ft. The Santa Ana River is located adjacent to and just east of the Project area.

The City of Huntington Beach is located near the coastal margin of the Los Angeles Basin, which includes Orange County, and is underlain by more than 15,000 ft of stratified sedimentary rocks of marine origin (Oakeshott, 1978). Soils in the Project area are composed of younger alluvium that is divided into river floodplain deposits (washed in from the northeast as sand, gravel and silt), and tidal flat/lagoonal type deposits lie in the gaps (finer-grained silts and clays) (City of Huntington Beach, 1996).

Prehistoric Context

The prehistory of the region has been summarized within four major horizons or cultural periods: Early [10,000 to 8,000 before present (B.P.)], Millingstone (8,000 to 3,000 B.P.), Intermediate (3,000 to 1,500 B.P.), and Late Prehistoric (1,500 B.P to A.D. 1769) (Wallace, 1955; Warren, 1968).

Early Period (10,000 to 8,000 B.P.)

The southern California coast may have been settled as early as 10,000 years ago (Jones, 1992). These early inhabitants were likely maritime adapted groups exploiting shellfish and other marine resources found along the coastline (Dixon, 1999; Erlandson, 1994; Vellanoweth and Altschul, 2002). One site located in Newport Bay, Orange County (CA-ORA-64)dates to approximately 9,500 years B.P. and suggests early intensive utilization of shellfish, fish, and bird resources (Drover et al., 1983; Macko, 1998).

Millingstone Period (8,000 to 3,000 B.P.)

The Millingstone period dates to about 8,000 to 3,000 B.P. The transition from the Early Period to the Millingstone period is marked by an increased emphasis on the processing of seeds and edible plants. The increased utilization of seeds is evident by the high frequencies of handstones (manos) and milling slabs (metates). Around 5,000 B.P., mortar and pestles appear in the archaeological record. Mortars and pestles suggest the exploitation of acorns (Vellanoweth and Altschul, 2002).

Millingstone period sites in Orange County generally date to between 8,000 and 4,000 B.P. Archaeological evidence suggests a low, stable population centered around semi-permanent residential bases. These sites are located along coastal marine terraces, near the shoreline, bays, or estuaries. Satellite camps were used to take advantage of seasonally available resources. Marine resources were supplemented by seeds and small terrestrial mammals. Later Millingstone period sites indicate a growing reliance on shellfish (Cleland et al., 2007).

Intermediate Period (3,000 to 1,5000 B.P.)

The Intermediate period dates to between 3,000 to 1,500 B.P. Archaeological sites indicate a broader economic base, with increased reliance on hunting and marine resources. An expanded inventory of milling equipment is found at sites dated to this period. Intermediate period sites are characterized by the rise of the mortar and pestle and small projectile points (Cleland et al., 2007).

The number of Intermediate period sites in Orange County declined over time, particularly around Newport Bay. Climate changes and drier conditions led to the congregation of populations near freshwater sources. Settlement patterns indicate greater sedentism, with reduced exploitation of seasonal resources and a lack of satellite camps. Coastal terrace sites are not reoccupied during this time period. These shifts in settlement and subsistence strategies led to growing population densities, resource intensification, higher reliance on labor-intensive technologies, such as the circular fishhook, and more abundant and diverse hunting equipment. Rises in disease and inter-personal violence, visible in the archaeological record, may be due to the increased population densities (Cleland et al., 2007; Raab et al., 1995).

Late Prehistoric Period (1,500 B.P. to A.D. 1769)

The Late Prehistoric period began around 1,500 B.P. and lasted until Spanish contact in 1769. The Late Prehistoric period resulted in concentration of larger populations in settlements and communities, greater utilization of the available food resources, and the development of regional subcultures (Cleland et al., 2007). Artifacts from this period include milling implements, as well as bone and shell tools and ornaments.

Newport Bay and San Joaquin Hills, abandoned during the Intermediate period, were reoccupied during the Late Prehistoric period. These settlements were smaller than in the Intermediate. Village sites were located in areas with a multitude of resources. Small collector groups moved between a small number of these permanent settlements (Cleland et al., 2007).

Ethnographic Setting

The proposed Project is located in a region traditionally occupied by the Takic-speaking Gabrielino-Tongva Indians. Prior to European colonization, the Gabrielino-Tongva occupied a diverse area that included: the watersheds of the Los Angeles, San Gabriel, and Santa Ana rivers; the Los Angeles basin; and the islands of San Clemente, San Nicolas, and Santa Catalina (Kroeber, 1925). The Gabrielino-Tongva are reported to have been second only to the Chumash in terms of population size and regional influence (Bean and Smith, 1978).

The Gabrielino-Tongva Indians were hunter-gatherers and lived in permanent communities located near the presence of a stable food supply. Community populations generally ranged from 50-100 inhabitants, although larger settlements may have existed. The Gabrielino-Tongva are estimated to have had a population numbering around 5,000 in the pre-contact period (Kroeber, 1925).

Beginning with the Spanish Period, Native Americans suffered severe depopulation and their traditional culture was radically altered. Nonetheless, Gabrielino-Tongva descendants still reside in the greater Los Angeles and Orange County areas and maintain an active interest in their heritage.

Historical Setting

The historical setting for the Project area is divided into three primary periods: the Spanish Period (A.D. 1769-1821), the Mexican Period (A.D. 1821-1846), and the American Period (A.D. 1846 to present).

Spanish Period (A.D. 1769-1821)

The first European exploration of Orange County began in 1769 when the Gaspar de Portola expedition passed through on its way from Mexico to Monterey. A permanent Spanish presence was established with the founding of Mission San Juan Capistrano in 1776 (Hoover et al, 2002). The mission was founded to break the long journey from Mission San Diego to Mission San Gabriel (near Los Angeles). A large, ornate church was constructed at the mission from 1797 to 1806, but was destroyed only six years later in an earthquake. The church was not rebuilt.

In an effort to promote Spanish settlement of Alta California, Spain granted several large land concessions from 1784 to 1821. At this time, Spain retained title to the land; individual ownership of lands in Alta California was not granted. The part of Orange County that would become the City of Huntington Beach began as a Spanish land concession, known as Rancho Los Nietos. A grant of 300,000 acres was given to Manuel Nieto in 1784 in consideration of his military service (City of Huntington Beach, 2000; Logan, 1990).

Mexican Period (A.D. 1821-1846)

In 1821, Mexico won its independence from Spain. Mexico continued to promote settlement of California with the issuance of land grants. In 1833, Mexico secularized the missions, reclaiming the majority of mission lands and redistributing them as land grants. During this time, Rancho Los Nietos was divided into five smaller ranchos. The area of Huntington Beach became part of Rancho Las Bolsas, a 33,460-acre rancho granted to Maria Catarina Ruiz in 1834 (County of Orange, 2011). Maria was the widow of Jose Antonio Nieto, Manuel Nieto's son.

Many ranchos continued to be used for cattle grazing by settlers during the Mexican Period. Hides and tallow from cattle became a major export for Californios (Hispanic Californians), many of whom became wealthy and prominent members of society. These Californios led generally easy lives, leaving the hard work to vaqueros (Hispanic cowhands) and Indian laborers. Californios lives centered primarily around enjoying the fruits of their labors, throwing parties and feasting on Catholic holidays (Pitt, 1994; Starr, 2007).

American Period (A.D. 1846 to present)

Mexico ceded California to the United States as part of the Treaty of Guadalupe Hildalgo, which ended the Mexican-American War (1846-1848). The treaty also recognized right of Mexican citizens to retain ownership of land granted to them by Spanish or Mexican authorities. However, the claimant was required to prove their right to the land before a patent was given. The process was lengthy and costly, and generally resulted in the claimant losing at least a portion of their land to attorney's fees and other costs associated with proving ownership (Starr, 2007).

The Gold Rush (1849-1855) saw the first big influx of American settlers to California. Most of these settlers were men hoping to strike it rich in the gold fields. The increasing population provided an additional outlet for the Californios' cattle (Bancroft, 1890). As demand increased, the price of beef skyrocketed and Californios reaped the benefits.

The culmination of the Gold Rush, followed by devastating floods in 1861 and 1862 and droughts in 1863 and 1864, led to the rapid decline of the cattle industry (Bancroft, 1890). Many Californios lost their lands during this period, and former ranchos were subsequently divided and sold for agriculture and residential settlement.

Following the admission of California into the United States in 1850, the region of modern day Orange County was originally part of Los Angeles County. Orange County was established in 1889, with the City of Santa Ana as County Seat (Armor, 1921).

History of the Project Vicinity

The Project vicinity was once part of a 300,000-acre Spanish land grant, Rancho Los Nietos, a part of which became Rancho Las Bolsas during the Mexican Period. Abel Stearns later acquired the land for ranching and cultivation of barley. During the land boom of the 1880s, the area was subdivided for agricultural and residential development (County of Orange, 2011; Milkovich, 1986).

Previously called Shell Beach and later Pacific City, the town changed its name to Huntington Beach in 1904 when Henry E. Huntington extended Pacific Electric Railway service to the little community (Carlberg and Epting, 2009; Milkovich, 1986). Discovery of oil in the 1920s led to a population explosion in the town. In one month, the population of Huntington Beach went from 1,500 to 6,000.

A review of available historic maps and aerial photographs indicate that the Project area was historically covered by marsh lands (present-day Talbert Marsh) located at the mouth of the Santa Ana River. Until the OCSD facilities were constructed (between 1953 and 1972) the Project area appears to have been largely undeveloped. The Santa Ana River, located just east of and adjacent to the Project area, is visible on the 1953 aerial photograph prior to its channelization. Salt marshes, still present within the Project area, are also visible. Some portions of the Project area appear to have been under cultivation in 1953 (USGS, 1896; USGS, 1901; historicaerials.com, 2011).

The Sanitation District was created in 1946 under the County Sanitation District Act of 1923 and began full operation in 1954 with a network of trunk sewers, two treatment plants, and a 78-inch diameter one-mile ocean outfall (Short Outfall). In 1971, the 120-inch diameter five mile ocean outfall (Long Outfall) was installed and the Short Outfall was retained for emergency use only. Currently, the Sanitation District treats approximately 210 million gallons of wastewater each day.

Regulatory Setting

Numerous laws and regulations require federal, state, and local agencies to consider the effects a project may have on cultural resources. These laws and regulations stipulate a process for compliance, define the responsibilities of the various agencies proposing the action, and prescribe the relationship among other involved agencies. The National Historic Preservation Act (NHPA) of 1966, as amended; CEQA; and the California Register of Historical Resources (California Register), codified at Public Resources Code (PRC) 5024, are the primary federal and state laws governing and affecting preservation of cultural resources of national, state, regional, and local significance.

Federal

Section 106 of the NHPA

Archaeological resources are protected through the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC 470f), and its implementing regulation, Protection of Historic Properties (36 Code of Federal Regulations [CFR] Part 800), the Archaeological and Historic Preservation Act of 1974, and the Archaeological Resources Protection Act of 1979. Prior to implementing an “undertaking” (e.g., issuing a federal permit), Section 106 of the NHPA requires federal agencies to consider the effects of the undertaking on historic properties and to afford the Advisory Council on Historic Preservation and the State Historic Preservation Officer (SHPO) a reasonable opportunity to comment on any undertaking that would adversely affect properties eligible for listing in the National Register of Historic Places (National Register). As indicated in Section 101(d)(6)(A) of the NHPA, properties of traditional religious and cultural importance to a tribe are eligible for inclusion in the National Register. Under the NHPA, a resource is considered significant if it meets the National Register listing criteria at 36 CFR 60.4.

National Register of Historic Places

The National Register was established by the NHPA of 1966, as “an authoritative guide to be used by federal, State, and local governments, private groups and citizens to identify the Nation’s historic resources and to indicate what properties should be considered for protection from destruction or impairment” (36 CFR 60.2). The National Register recognizes both historical-period and prehistoric archaeological properties that are significant at the national, state, and local levels.

To be eligible for listing in the National Register, a resource must be significant in American history, architecture, archaeology, engineering, or culture. Districts, sites, buildings, structures, and objects of potential significance must meet one or more of the following four established criteria (U.S. Department of the Interior, 1995):

A. Are associated with events that have made a significant contribution to the broad patterns of our history;

B. Are associated with the lives of persons significant in our past;

C. Embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. Have yielded, or may be likely to yield, information important in prehistory or history.

Unless the property possesses exceptional significance, it must be at least fifty years old to be eligible for National Register listing (U.S. Department of the Interior 1995).

In addition to meeting the criteria of significance, a property must have integrity. Integrity is defined as "the ability of a property to convey its significance" (U.S. Department of the Interior 1995). The National Register recognizes seven qualities that, in various combinations, define integrity. The seven factors that define integrity are location, design, setting, materials, workmanship, feeling, and association. To retain historic integrity a property must possess several, and usually most, of these seven aspects. Thus, the retention of the specific aspects of integrity is paramount for a property to convey its significance.

State

The State implements the NHPA through its statewide comprehensive cultural resources surveys and preservation programs. The California Office of Historic Preservation (OHP), as an office of the California Department of Parks and Recreation, implements the policies of the NHPA on a statewide level. The OHP also maintains the California Historic Resources Inventory. The SHPO is an appointed official who implements historic preservation programs within the State's jurisdictions.

California Environmental Quality Act (CEQA)

CEQA is the principal statute governing environmental review of projects occurring in the State and is codified at PRC Section 21000 et seq. CEQA requires lead agencies to determine if a proposed project would have a significant effect on the environment, including significant effects on historical or archaeological resources.

Under CEQA (Section 21084.1), a project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment. The CEQA Guidelines (Section 15064.5) recognize that an historical resource includes: (1) a resource listed in, or determined to be eligible by the State Historical Resources Commission, for listing in the California Register; (2) a resource included in a local register of historical resources, as defined in PRC Section 5020.1(k) or identified as significant in a historical resource survey meeting the requirements of PRC Section 5024.1(g); and (3) any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California by the lead agency, provided the lead agency's determination is supported by substantial evidence in light of the whole record. The fact that a resource does not meet the three criteria outlined above does not preclude the lead agency from determining that the resource may be an historical resource as defined in PRC Sections 5020.1(j) or 5024.1.

If a lead agency determines that an archaeological site is a historical resource, the provisions of Section 21084.1 of CEQA and Section 15064.5 of the CEQA Guidelines apply. If a project may cause a substantial adverse change (defined as physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired) in the significance of an historical resource, the lead agency must identify potentially feasible measures to mitigate these effects (CEQA Guidelines Sections 15064.5(b)(1), 15064.5(b)(4)).

If an archaeological site does not meet the criteria for a historical resource contained in the CEQA Guidelines, then the site may be treated in accordance with the provisions of Section 21083, which is a unique archaeological resource. As defined in Section 21083.2 of CEQA a "unique" archaeological resource is an archaeological artifact, object, or site, about which it can be clearly demonstrated that without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

- Contains information needed to answer important scientific research questions and there is a demonstrable public interest in that information;
- Has a special and particular quality such as being the oldest of its type or the best available example of its type; or
- Is directly associated with a scientifically recognized important prehistoric or historic event or person.

If an archaeological site meets the criteria for a unique archaeological resource as defined in Section 21083.2, then the site is to be treated in accordance with the provisions of Section 21083.2, which state that if the lead agency determines that a project would have a significant effect on unique archaeological resources, the lead agency may require reasonable efforts be made to permit any or all of these resources to be preserved in place (Section 21083.1(a)). If preservation in place is not feasible, mitigation measures shall be required.

The CEQA Guidelines note that if an archaeological resource is neither a unique archaeological nor a historical resource, the effects of the project on those resources shall not be considered a significant effect on the environment (CEQA Guidelines Section 15064.5(c)(4)).

California Register of Historical Resources

The California Register is "an authoritative listing and guide to be used by State and local agencies, private groups, and citizens in identifying the existing historical resources of the State and to indicate which resources deserve to be protected, to the extent prudent and feasible, from substantial adverse change" (PRC Section 5024.1[a]). The criteria for eligibility for the California Register are based upon National Register criteria (PRC Section 5024.1[b]). Certain resources are determined by the statute to be automatically included in the California Register, including California properties formally determined eligible for, or listed in, the National Register.

To be eligible for the California Register, a prehistoric or historical-period property must be significant at the local, State, and/or federal level under one or more of the following four criteria:

1. Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;
2. Is associated with the lives of persons important in our past;
3. Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values; or
4. Has yielded, or may be likely to yield, information important in prehistory or history.

A resource eligible for the California Register must meet one of the criteria of significance described above, and retain enough of its historic character or appearance (integrity) to be recognizable as a historical resource and to convey the reason for its significance. It is possible that a historic resource may not retain sufficient integrity to meet the criteria for listing in the National Register, but it may still be eligible for listing in the California Register.

Additionally, the California Register consists of resources that are listed automatically and those that must be nominated through an application and public hearing process. The California Register automatically includes the following:

- California properties listed on the National Register and those formally Determined Eligible for the National Register;
- California Registered Historical Landmarks from No. 770 onward; and
- Those California Points of Historical Interest that have been evaluated by the OHP and have been recommended to the State Historical Commission for inclusion on the California Register.

Other resources that may be nominated to the California Register include:

- Historical resources with a significance rating of Category 3 through 5 (those properties identified as eligible for listing in the National Register, the California Register, and/or a local jurisdiction register);
- Individual historical resources;
- Historical resources contributing to historic districts; and,
- Historical resources designated or listed as local landmarks, or designated under any local ordinance, such as an historic preservation overlay zone.

California Coastal Act

California Coastal Act policy requires that significant historical and archeological resources of the Coastal Zone be identified and protected. The California Coastal Act identifies such resources located within the Coastal Zone, and sets forth policies to ensure reasonable protection and or enhancement of such resources.

Local

Orange County Community Development General Plan 2005

The Orange County Community Development General Plan 2005 includes the following goals, objectives, and policies regarding cultural resources including paleontological resources.

Goal 1

To raise the awareness and appreciation of Orange County's cultural and historic heritage.

Objectives

1.1 Facilitate and participate in activities that inform people about the social, cultural, economic, and scientific values of Orange County's heritage.

1.2 Work through the Orange County Historical Commission in the areas of history, paleontology, archaeology, and historical preservation.

Policies

1.1 To stimulate and encourage financial support for projects in the public and private sector.

1.2 To coordinate countywide programs and be the liaison for local organizations.

1.3 To advise and aid the public and private sectors in meeting museum needs and finding funding sources for same.

1.4 To stimulate and encourage research, writing, and publication of articles on Orange County subjects.

1.5 To develop and maintain a County archive for historically valuable records.

1.6\ To encourage and facilitate cooperation among local historical societies.

Goal 2

To encourage through a resource management effort the preservation of the county's cultural and historic heritage.

Objectives

2.1 Promote the preservation and use of buildings, sites, structures, objects, and districts of importance in Orange County through the administration of planning, environmental, and resource management programs.

2.2 Take all reasonable and proper steps to achieve the preservation of archaeological and paleontological remains, or their recovery and analysis to preserve cultural, scientific, and educational values.

2.3 Take all reasonable and proper steps to achieve the preservation and use of significant historic resources including properties of historic, historic architectural, historic archaeological, and/or historic preservation value.

2.4 Provide assistance to County agencies in evaluating the cultural environmental impact of proposed projects and reviewing EIRs.

2.5 Provide incentives to encourage greater private sector participation in historic preservation.

Policies

The following policies addressing archaeological, paleontological, and historical resources shall be implemented at appropriate stage(s) of planning, coordinated with the processing of a project application, as follows:

- Identification of resources shall be completed at the earliest stage of project planning and review such as general plan amendment or zone change.
- Evaluation of resources shall be completed at intermediate stages of project planning and review such as site plan review, subdivision map approval, or at an earlier stage of project review.
- Final preservation actions shall be completed at final stages of project planning and review such as grading, demolition, or at an earlier stage of project review.

Archaeological Resources Policies:

1. To identify archaeological resources through literature and records research and surface surveys.
2. To evaluate archaeological resources through subsurface testing to determine significance and extent.
3. To observe and collect archaeological resources during the grading of a project.
4. To preserve archaeological resources by: a) Maintaining them in an undisturbed condition, or b) Excavating and salvaging materials and information in a scientific manner.

Paleontological Resources Policies:

1. To identify paleontological resources through literature and records research and surface surveys.
2. To monitor and salvage paleontological resources during the grading of a project.
3. To preserve paleontological resources by maintaining them in an undisturbed condition.

Historic Resources Policies:

1. To identify historic resources through literature and records research and/or on-site surveys.
2. To evaluate historic resources through comparative analysis or through subsurface or materials testing.
3. To preserve significant historic resources by one or a combination of the following alternatives, as agreed upon by RDMD and the project sponsor: a) Adaptive reuse of historic resource; b) Maintaining the historic resource in an undisturbed condition; c) Moving the historic resource and arranging for its treatment; d)

Salvage and conservation of significant elements of the historic resources; e) Documentation (i.e., research narrative, graphics, photography) of the historic resource prior to destruction.

Goal 3

To preserve and enhance buildings structures, objects, sites, and districts of cultural and historic significance.

Objectives

3.1 Undertake actions to identify, preserve, and develop unique and significant cultural and historic resources.

3.2 Develop and maintain a County archive for historically valuable records, thereby promoting knowledge and understanding of the origins, programs, and goals of the County of Orange.

Policies

3.1 To pursue grants and innovative funding strategies for acquisition or development of significant properties.

3.2 To develop, utilize, and promote effective technical conservation and restoration strategies.

3.3 To appraise, collect, organize, describe, preserve, and make available County of Orange records of permanent, historical value.

3.4 To serve as a research center for the study of County history.

Archival Research

A records search for the Project was conducted on August 8, 2011 at the South Central Coastal Information Center (SCCIC) housed at California State University, Fullerton. The records search included a review of all recorded archaeological sites within a 0.5-mile radius of the Project area, as well as a review of cultural resource reports on file. In addition, the California Points of Historical Interest, the California Historical Landmarks, the California Register, the National Register, and the California State Historic Resources Inventory listings were reviewed for properties within or adjacent to the Project area.

Previous Cultural Resources Investigations

The records search indicated that a total of 12 cultural resources studies have been conducted within a 0.5-mile radius of the Project area (**Table 2**). Of these 12 studies, seven included portions of the Project area; however, it does not appear that the entire Project area has been systematically surveyed for the presence of cultural resources. Archaeological Research Inc. conducted a surface survey of the Sanitation District facilities at Plant 2 in 1975 (ARI, 1975).

TABLE 2
PREVIOUS CULTURAL RESOURCES STUDIES CONDUCTED WITHIN 0.5 MILE OF THE PROJECT AREA

Author	Report No. (OR-)	Title	Year
Ahlering, Michael L.	1[a]	Report of a Scientific Resources Survey and Inventory	1973
ARI	_[a]	Letter Report re CSDOC Plants No. 1 and 2	1975
Boxt, Matthew A. and Christeen M. Barretta	1360	Archaeological and Paleontological Assessment Surveys for the Proposed Costa Mesa/Newport Beach Pipeline Route	1992
Demcak, Carol R.	2256	Cultural Resources Assessments for Orange County Sanitation Districts	1999
Drover, Chripstopher E.	2129	A Cultural Resources Inventory for the Newport Banning Ranch	1999
Langenwalter, Paul E. and James Brock	801[a]	Phase II Archaeological Studies Prado Basin and Lower Santa Ana River	1985
Leonard, Nelson N. III and Mathew C. Hall	270[a]	Description and Evaluation of Cultural Resources within the USACOE Santa Ana River Project	1975
Mason, Roger D.	2033[a]	Research Design for Evaluation of Coastal Archaeological Sites in Northern Orange County	1987
Pettus, Roy	1119[a]	Marine Cultural Resources Survey within the Lower Santa Ana River Project near Shore Disposal Area	1991
Romani, John F.	644[a]	Archaeological Survey Report for the Proposed ORA-1 Widening Project	1982
Strudwick, Ivan H. and Riordan L. Goodwin	3535	Cultural Resources Assessment Survey for the 403-Acre Banning Ranch Property	2008
Van Horn, David M.	299	A Compilation of Archaeological, Historical and Paleontological Data for the City of Costa Mesa	1978
Van Horn, David M. and J.P. Brock	3579	Archaeological Posthole Testing Report: ORA-148	1980

[a] indicates study overlapping with Project area

Previously Recorded Cultural Resources

Two prehistoric archaeological sites (CA-ORA-843 and CA-ORA-906) have been previously recorded within 0.5 mile of the Project area and are described below. Both sites are approximately 0.45 miles from the current Project area. No other cultural resources, including historic-era built resources, have been recorded within 0.5 mile of the Project area.

Site CA-ORA-843 (P-30-000843)

Prehistoric site CA-ORA-843 was first recorded in 1979 and was located north of Pacific Coast Highway on a bluff overlooking the Santa Ana River (about 0.45 mile east of the Project area). At that time, the site measured 40 meters by 60 meters, encompassing an area of 2400 square meters, and was described as a “shell midden with few chert waste flakes” (Murray, 1979). Shell types were primarily scallop (*Pecten* sp.) and clam (*Chione* sp.). Noted site disturbances included oil well pads and access roads, and the site recorder surmised that much of the site had been destroyed. The site was re-surveyed in 1998, though no surface evidence observed at that time (Smith et al., 1998a). Shovel test pits conducted in 1998 determined that ongoing oilfield operations had disturbed the site and it was recommended not eligible for listing in the California Register or the National Register as cited in Newport Banning Ranch EIR, (BonTerra Consulting, 2011).

Site CA-ORA-906 (P-30-000906)

Site CA-ORA-906 was first recorded in 1980 and was located north of Pacific Coast Highway in an active oil field (about 0.45 mile northeast of the Project area) (Van Horn and Murray, 1980). The horizontal dimensions of the site could not be determined, but a recent cut by machinery exposed a midden deposit of at least 70 centimeters thick. The deposit was located under about 10 feet of artificial fill. Marine shell and bird bone were observed. The location of the site was re-surveyed in 1998, but surface evidence of the site could not be relocated (Smith et al., 1998b). Shovel test pits were also conducted at this site in 1998. It was determined that ongoing oilfield operations had disturbed the site and it was recommended not eligible for listing in the California Register or the National Register as cited in Newport Banning Ranch EIR, (BonTerra Consulting, 2011).

Additional Archival Research

Historic maps and historic aerial photographs were examined as part of this study. Two historic USGS topographic maps, the 15-minute Santa Ana quadrangles from 1896 and 1901, were available for the Project area. Both maps revealed that the Project area was historically covered by marsh lands located at the mouth of the Santa Ana River.

Historic aerial photographs were available for the years 2005, 2004, 2003, 1972, and 1953. Until the Sanitation District facilities were constructed (between 1953 and 1972) the Project area appears to have been largely undeveloped. The Santa Ana River, located just east of and adjacent to the Project area, is visible on the 1953 aerial photograph prior to its channelization. Salt marshes, still present within the Project area, are also visible. Some portions of the Project area appear to have been under cultivation in 1953 (historicaerials.com, 2011).

Native American Contact Program

The Native American Heritage Commission (NAHC) maintains a confidential Sacred Lands File containing sites of traditional, cultural, or religious value to the Native American community. The NAHc was contacted on August 2, 2011 to request a search of the sacred lands file. The NAHC responded to the request in a letter dated August 4, 2011. The letter indicated that “numerous” Native American cultural resources are known to be located within a 0.5-mile radius of the Project area. The letter also included an attached list of Native American contacts.

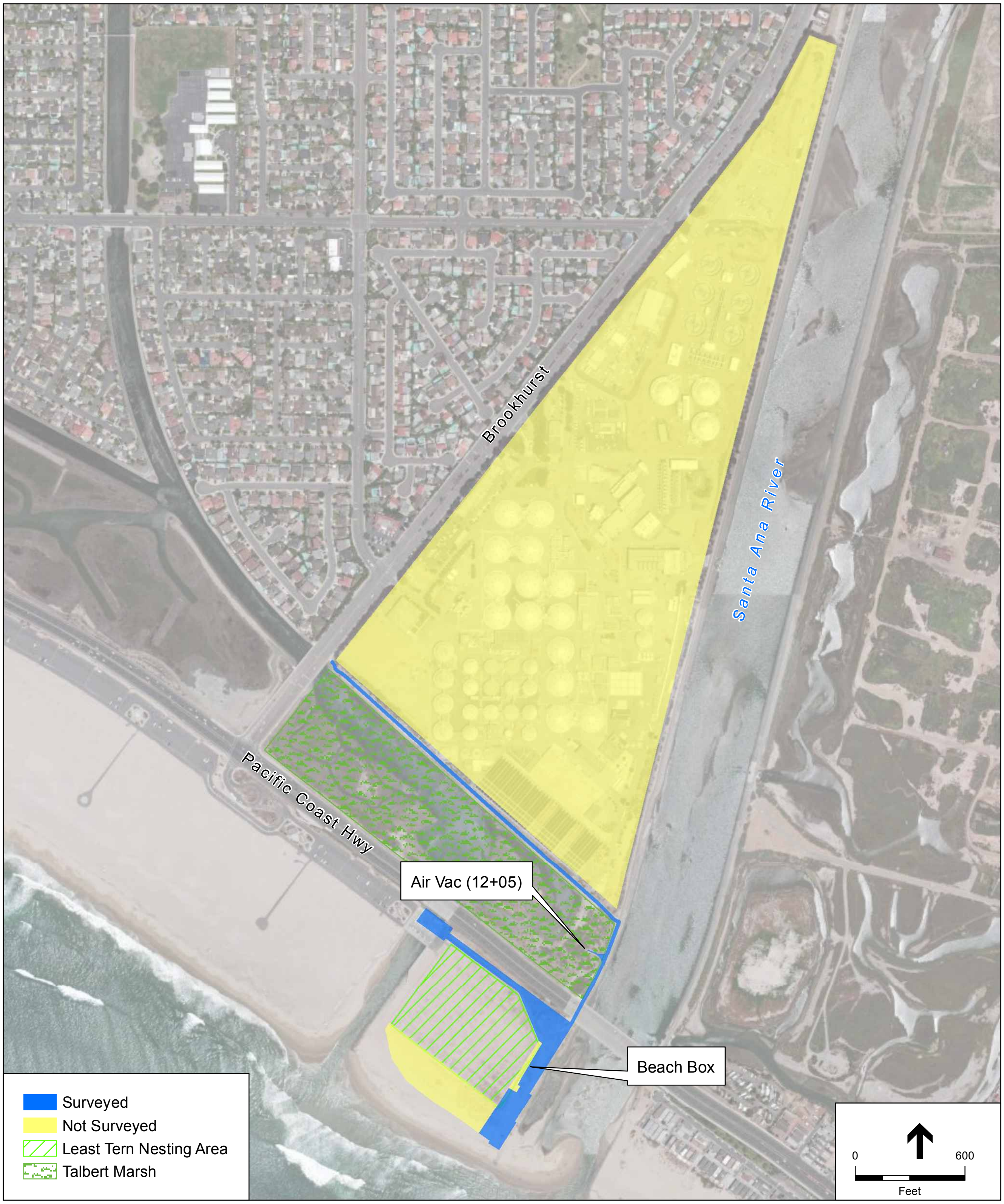
Contact letters to all individuals and groups indicated by the NAHC as having affiliation with the Project area were prepared and mailed on August 17, 2011. The letters described the proposed

Project and included a map depicting the location of the Project. Recipients were requested to reply with any information they are able to share about Native American resources that might be affected by the Project. To date, one response has been received. Alfred Cruz of the Juaneno Band of Mission Indians responded by phone on September 1, 2011. Mr. Cruz did not have any specific information about cultural resources within the Project area, but did express that the area was known to have been used in prehistoric times and there is a possibility of uncovering cultural resources during ground disturbance. He requested that an archaeological monitor be present during ground disturbing activities and that he be notified if any cultural resources were unearthed. All correspondence is attached as Appendix B.

Cultural Resources Survey

A field survey of a portion of Project area was performed by ESA archaeologist Candace Ehringer, M.A., R.P.A., on August 30, 2011. The off-site limits of construction and Air Vac (12+05) area were surveyed by foot, including the beach box area (**Figures 4** and **5**). The goal of the pedestrian survey was to identify any cultural resources present and to evaluate the Project area for its potential to contain buried cultural resources.

No cultural resources were identified within the Project area as a result of the survey. The Project area appeared to have largely been disturbed by past construction activities, including the creation of a multipurpose trail, channelization of the Santa Ana River, and installation of Sanitation District facilities.



SOURCE: Bing Maps; ESA, 2011.

J-112 Outfall Land Section and OOBS Piping Rehabilitation. 211261

Figure 4
Survey Coverage Map

Overview of Beach Box Area, view to the southwest

Channelized Santa Ana River adjacent to Project Area, view to the south

SOURCE: ESA, 2011.

Figure 5
Photos

Conclusions and Recommendations

Cultural Resources

No cultural resources were identified within the Project area as a result of the archival research or survey. However, the Project area is considered sensitive for prehistoric cultural resources. The marsh environment would have been an attractive area for resource procurement in prehistoric times and may have been utilized by indigenous peoples of the region.

In addition, two prehistoric archaeological sites (CA-ORA-843 and CA-ORA-906) have been previously recorded within 0.5 mile of the proposed Project and the NAHC database search indicated that numerous Native American cultural resources have been identified within 0.5 mile of the proposed Project. A representative of the Juaneno Band of Mission Indians indicated that the Project vicinity was used by Native Americans during prehistoric times and there is a possibility of uncovering prehistoric cultural resources during ground disturbance.

The Alternative 1 component of the project would require excavation that could potentially uncover previously unknown archaeological resources. While unlikely, inadvertent damage to significant buried archaeological deposits during construction would be a significant impact. Therefore, it is recommended that all ground disturbance required for Alternative 1 be monitored by a qualified archaeologist meeting the Secretary of the Interior’s Standards for professional archaeology.

Human Remains

No human remains were identified in the Project area as a result of the archival research or survey. However, the area was known to have been used by prehistoric Native Americans. In the unlikely event that human remains are uncovered during ground disturbing activities, work should halt, the Orange County Coroner should be contacted, and the procedures and protocols set forth in Section 15064.4 (e)(1) of the CEQA Guidelines should be implemented.

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APPENDIX A

Correspondence

ESA

626 Wilshire Boulevard
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Los Angeles, CA 90017
213.599.4300 phone
213.599.4301 fax

www.esassoc.com

August 2, 2011

Dave Singleton, Program Analyst
Native American Heritage Commission
915 Capitol Mall, Room 364
Sacramento, CA 95814
FAX- 916-657-5390

Subject: **SLF search request for OCSD Outfall Rehabilitation Project**

Dear Mr. Singleton:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

The proposed project is rehabilitation of the land section of the five-mile outfall system extending from the Ocean Outfall Booster Pump Station (OOBS) wetwell within the OCSD treatment plant, to the Beach Box located on Huntington State Beach. The proposed project will also consist of inspection, condition assessment, and the rehabilitation of corrosion damaged areas encompassing the OOBS piping system. Specifically, the proposed project includes four project elements that comprise the outfall rehabilitation: (1) rehabilitate ocean outfall metering ports and manhole structures, (2) rehabilitation of Surge Tower No.2, (3) rehabilitation of the long ocean outfall, and (4) reinforcement of the ocean outfall beach junction box.

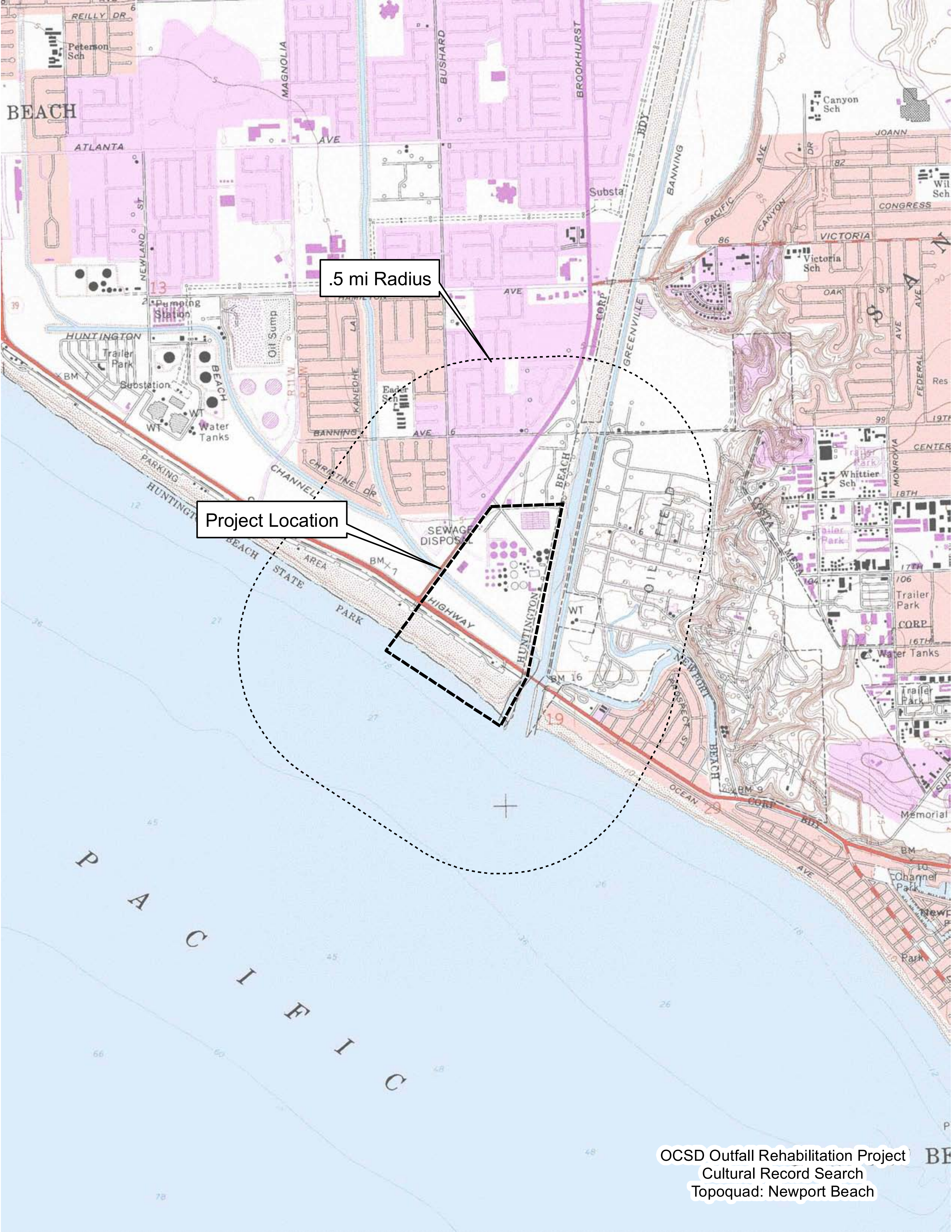
In an effort to provide an adequate appraisal of all potential impacts that may result from the proposed project, ESA is requesting that an SLF search be conducted for sacred lands or traditional cultural properties that may exist within the project area. We additionally request the names and contact information for Native American representatives who are associated with the project area so that we may provide these individuals with information regarding the project.

Please fax the SLF search results to 213.599.4301. Thank you for your time and cooperation regarding this matter. Please contact me at 213.599.4300 or at mbray@esassoc.com if you have any questions.

Sincerely,

Madeleine Bray

Madeleine Bray
Cultural Resources



OCSD Outfall Rehabilitation Project
Cultural Record Search
Topoquad: Newport Beach

STATE OF CALIFORNIA Edmund G. Brown, Jr., Governor

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-6251
Fax (916) 657-5390
Web Site www.nahc.ca.gov
ds_nahc@pacbell.net

August 4, 2011

Ms. Madeleine Bray, Cultural Resources
ESA
626 Wilshire Boulevard, Suite 1100
Los Angeles, CA 90017

Sent by FAX to: (213) 599-4301
No. of Pages: 4

Re: Sacred Lands File Search and Native American Contacts list for the **"Proposed Orange County Sanitation District (OCSD) Outfall Rehabilitation Project;"** located at 22212 Brookhurst Street, at the existing plant location impacting an area that includes the Pacific Ocean beaches of Huntington Beach and Newport Beach; Orange County, California

Dear Ms. Bray:

The Native American Heritage Commission (NAHC) conducted a Sacred Lands File search of the 'area of potential effect,' (APE) based on the USGS coordinates provided and found numerous **Native American cultural resources were identified** in the USGS coordinates you specified. Also, please note; the NAHC Sacred Lands Inventory is not exhaustive.

The California Environmental Quality Act (CEQA – CA Public Resources Code §§ 21000-21177, amendments effective 3/18/2010) requires that any project that causes a substantial adverse change in the significance of an historical resource, that includes archaeological resources, is a 'significant effect' requiring the preparation of an Environmental Impact Report (EIR) per the CEQA Guidelines defines a significant impact on the environment as 'a substantial, or potentially substantial, adverse change in any of physical conditions within an area affected by the proposed project, including ...objects of historic or aesthetic significance." In order to comply with this provision, the lead agency is required to assess whether the project will have an adverse impact on these resources within the 'area of potential effect (APE), and if so, to mitigate that effect. CA Government Code §65040.12(e) defines "environmental justice" provisions and is applicable to the environmental review processes.

Early consultation, even during Initial Study or First Phase surveys with Native American tribes in your area is the best way to avoid unanticipated discoveries once a project is underway. Local Native Americans may have knowledge of the religious and cultural significance of the historic properties of the proposed project for the area (e.g. APE). Consultation with Native American communities is also a matter of environmental justice as defined by California Government Code §65040.12(e). We urge consultation with those tribes and interested Native Americans on the list of Native American Contacts we attach to this letter in order to see if your proposed project might impact Native American cultural resources. Lead agencies should consider avoidance as defined in §15370 of the CEQA Guidelines when significant cultural resources as defined by the CEQA Guidelines §15064.5 (b)(c)(f) may be affected by a proposed project. If so, Section 15382 of the CEQA Guidelines defines a significant impact on the environment as "substantial," and Section 2183.2 which requires documentation, data recovery of cultural resources.

Partnering with local tribes and interested Native American consulting parties, on the NAHC list, should be conducted in compliance with the requirements of federal NEPA (42 U.S.C 4321-43351) and Section 106 4(f), Section 110 (f)(k) of federal NHPA (16 U.S.C. 470 *et seq*), 36 CFR Part 800.3 (f) (2) & .5, the President's Council on Environmental Quality (CSQ, 42 U.S.C 4371 *et seq.* and NAGPRA (25 U.S.C. 3001-3013) as appropriate. The 1992 *Secretary of the Interiors Standards for the Treatment of Historic Properties* were revised so that they could be applied to all historic resource types included in the National Register of Historic Places and including cultural landscapes. Also, federal Executive Orders Nos. 11593 (preservation of cultural environment), 13175 (coordination & consultation) and 13007 (Sacred Sites) are helpful, supportive guides for Section 106 consultation.

Also, California Public Resources Code Section 5097.98, California Government Code §27491 and Health & Safety Code Section 7050.5 provide for provisions for accidentally discovered archeological resources during construction and mandate the processes to be followed in the event of an accidental discovery of any human remains in a project location other than a 'dedicated cemetery', another important reason to have Native American Monitors on board with the project.

To be effective, consultation on specific projects must be the result of an ongoing relationship between Native American tribes and lead agencies, project proponents and their contractors, in the opinion of the NAHC. An excellent way to reinforce the relationship between a project and local tribes is to employ Native American Monitors in all phases of proposed projects including the planning phases.

Confidentiality of "historic properties of religious and cultural significance" may also be protected under Section 304 of he NHPA or at the Secretary of the Interior discretion if not eligible for listing on the National Register of Historic Places. The Secretary may also be advised by the federal Indian Religious Freedom Act (cf. 42 U.S.C., 1996) in issuing a decision on whether or not to disclose items of religious and/or cultural significance identified in or near the APE and possibility threatened by proposed project activity.

If you have any questions about this response to your request, please do not hesitate to contact me at (916) 653-6251.

Sincerely,

Dave Singleton

Attachment: Native American Contact List

California Native American Contact List
Orange County
August 3, 2011

Ti'At Society/Inter-Tribal Council of Pimu
Cindi M. Alvitre, Chairwoman-Manisar
3098 Mace Avenue, Aapt. D Gabrielino
Costa Mesa, , CA 92626
calvitre@yahoo.com
(714) 504-2468 Cell

Juaneno Band of Mission Indians Acjachemen Nation
David Belardes, Chairperson
32161 Avenida Los Amigos Juaneno
San Juan Capistrano CA 92675
(949) 493-4933 - home
chiefdavidbelardes@yahoo.com
(949) 293-8522

Tongva Ancestral Territorial Tribal Nation
John Tommy Rosas, Tribal Admin.
Private Address Gabrielino Tongva
,
tattnlaw@gmail.com
310-570-6567

Gabrieleno/Tongva San Gabriel Band of Mission
Anthony Morales, Chairperson
PO Box 693 Gabrielino Tongva
San Gabriel , CA 91778
GTTribalcouncil@aol.com
(626) 286-1632
(626) 286-1758 - Home
(626) 286-1262 -FAX

Gabrielino Tongva Nation
Sam Dunlap, Chairperson
P.O. Box 86908 Gabrielino Tongva
Los Angeles , CA 90086
samdunlap@earthlink.net

(909) 262-9351 - cell

Juaneno Band of Mission Indians Acjachemen Nation
Anthony Rivera, Chairman
31411-A La Matanza Street Juaneno
San Juan Capistrano CA 92675-2674
arivera@juaneno.com
(949) 488-3484
(949) 488-3294 - FAX
(530) 354-5876 - cell

Gabrielino Tongva Indians of California Tribal Council
Robert F. Dorame, Tribal Chair/Cultural Resources
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Bellflower , CA 90707
gtongva@verizon.net
562-761-6417 - voice
562-761-6417- fax

Juaneno Band of Mission Indians
Alfred Cruz, Culural Resources Coordinator
P.O. Box 25628 Juaneno
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alfredgcruz@sbcglobal.net
714-998-0721
714-998-0721 - FAX
714-321-1944 - cell

This list is current only as of the date of this document.
Distribution of this list does not relieve any person of the statutory responsibility as defined in Section 7050.5 of the Health and Safety Code, Section 5097.94 of the Public Resources Code and Section 5097.98 of the Public Resources Code.

This list is only applicable for contacting local Native Americans with regard to cultural resources for the proposed Orange County Sanitation District (OCSD) Outfall Rehabilitation Project; the Plant located on Brookhurst Street in the City of Huntington Beach and the impact on the beaches between Huntington Beach and Newport Beach; Orange County, California for which a Sacred Lands File search and Native American Contacts list were requested.

California Native American Contact List
Orange County
August 3, 2011

Juaneno Band of Mission Indians
Adolph 'Bud' Sepulveda, Vice Chairperson
P.O. Box 25828 Juaneno
Santa Ana , CA 92799
bssepul@yahoo.net
714-838-3270
714-914-1812 - CELL
bsepul@yahoo.net

Juaneño Band of Mission Indians
Sonia Johnston, Tribal Chairperson
P.O. Box 25628 Juaneno
Santa Ana , CA 92799
sonia.johnston@sbcglobal.net
(714) 323-8312

Juaneno Band of Mission Indians
Anita Espinoza
1740 Concerto Drive Juaneno
Anaheim , CA 92807
(714) 779-8832

United Coalition to Protect Panhe (UCPP)
Rebecca Robles
119 Avenida San Fernando Juaneno
San Clemente CA 92672
rebrobles1@gmail.com
(949) 573-3138

Gabrielino-Tongva Tribe
Bernie Acuna
1875 Century Pk East #1500 Gabrielino
Los Angeles , CA 90067
(619) 294-6660-work
(310) 428-5690 - cell
(310) 587-0170 - FAX
bacuna1@gabrieinotribe.org

Juaneno Band of Mission Indians Acjachemen Nation
Joyce Perry; Representing Tribal Chairperson
4955 Paseo Segovia Juaneno
Irvine , CA 92612
949-293-8522

Gabrielino-Tongva Tribe
Linda Candelaria, Chairwoman
1875 Century Park East, Suite 1500
Los Angeles , CA 90067 Gabrielino
lcandelaria1@gabrielinoTribe.org
626-676-1184- cell
(310) 587-0170 - FAX
760-904-6533-home

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ESA

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memorandum

date	September 1, 2011
to	Danielle Griffith
from	Candace Ehringer
subject	OCSD Outfall Project - Native American Response

I received a call today from Mr. Alfred Cruz of the Juaneno Band of Mission Indians in response to our request for information about Native American cultural resources within the OCSD Outfall project area. Mr. Cruz did not have any specific information about cultural resources within the project area, but did express that the area was known to have been used in prehistoric times and there was the possibility of uncovering cultural resources during ground disturbance. He requested that an archaeological monitor be present during ground disturbing activities and that he be notified if any cultural resources were unearthed.

ESA

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August 17, 2011

Bernie Acuna
Gabrielino-Tongva Tribe
1875 Century Park East #1500
Los Angeles, CA 90067

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Acuna:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

The proposed project is rehabilitation of the land section of the five-mile outfall system extending from the Ocean Outfall Booster Pump Station (OOBS) wetwell within the OCSD treatment plant, to the Beach Box located on Huntington State Beach. The proposed project will also consist of inspection, condition assessment, and the rehabilitation of corrosion damaged areas encompassing the OOBS piping system. Specifically, the proposed project includes four project elements that comprise the outfall rehabilitation: (1) rehabilitate ocean outfall metering ports and manhole structures, (2) rehabilitation of Surge Tower No.2, (3) rehabilitation of the long ocean outfall, and (4) reinforcement of the ocean outfall beach junction box.

In an effort to address any potential impact to archaeological or Native American resources, we are seeking comments and information from Native American representatives, and your name was supplied to us by the Native American Heritage Commission as a contact for this area. We would appreciate your comments identifying any sensitive sites in or near the project area that you may be aware of, any concerns or issues pertinent to this project, or the names of others who may be interested in this project.

Thank you for your cooperation on this matter. If you have any questions or comments, please contact me by phone at (213) 599-4300; by email at cehringer@esassoc.com, or by mail at the address in the letterhead.

Sincerely,

Candace Ehr

Candace Ehringer
Archaeologist

ESA

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Los Angeles, CA 90017
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August 17, 2011

Cindi Alvitre, Chairwoman-Manisar
Ti'At Society/Inter-Tribal Council of Pimu
3098 Mace Avenue, Apt. D
Costa Mesa, CA 92626

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Ms. Alivtre:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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Thank you for your cooperation on this matter. If you have any questions or comments, please contact me by phone at (213) 599-4300; by email at cehringer@esassoc.com, or by mail at the address in the letterhead.

Sincerely,

Candace Eh

Candace Ehringer
Archaeologist

ESA

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August 17, 2011

David Belardes, Chairperson
Juaneno Band of Mission Indians Acjachemen Nation
32161 Avenida Los Amigos
San Juan Capistrano, CA 92675

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Belardes:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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Sincerely,

Candace Ehr

Candace Ehringer
Archaeologist

ESA

626 Wilshire Boulevard
Suite 1100
Los Angeles, CA 90017
213.599.4300 phone
213.599.4301 fax

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August 17, 2011

Linda Candelaria, Chairwoman
Gabrielino-Tongva Tribe
1875 Century Park East, Suite 1500
Los Angeles, CA 90067

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Ms. Candelaria:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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Sincerely,

Candace Eh

Candace Ehringer
Archaeologist

ESA

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August 17, 2011

Alfred Cruz, Cultural Resources Coordinator
Juaneno Band of Mission Indians
P.O. Box 25628
Santa Ana, CA 92799

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Cruz:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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Sincerely,

Candace Ehr

Candace Ehringer
Archaeologist

ESA

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August 17, 2011

Robert Dorame, Tribal Chair
Gabrielino Tongva Indians of California Tribal Council
P.O. Box 490
Bellflower, CA 90707

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Dorame:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

The proposed project is rehabilitation of the land section of the five-mile outfall system extending from the Ocean Outfall Booster Pump Station (OOBS) wetwell within the OCSD treatment plant, to the Beach Box located on Huntington State Beach. The proposed project will also consist of inspection, condition assessment, and the rehabilitation of corrosion damaged areas encompassing the OOBS piping system. Specifically, the proposed project includes four project elements that comprise the outfall rehabilitation: (1) rehabilitate ocean outfall metering ports and manhole structures, (2) rehabilitation of Surge Tower No.2, (3) rehabilitation of the long ocean outfall, and (4) reinforcement of the ocean outfall beach junction box.

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Thank you for your cooperation on this matter. If you have any questions or comments, please contact me by phone at (213) 599-4300; by email at cehringer@esassoc.com, or by mail at the address in the letterhead.

Sincerely,

Candace Eh

Candace Ehringer
Archaeologist

ESA

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213.599.4301 fax

www.esassoc.com

August 17, 2011

Sam Dunlap, Chairperson
Gabrielino Tongva Nation
P.O. Box 86908
Los Angeles, CA 90086

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Dunlap:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

Anita Espinoza
Juaneno Band of Mission Indians
1740 Concerto Drive
Anaheim, CA 92807

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Ms. Espinoza:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

Sonia Johnston, Tribal Chairperson
Juaneno Band of Mission Indians
P.O. Box 25628
Santa Ana, CA 92799

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Ms. Johnston:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

Anthony Morales, Chairperson
Gabrielino/Tongva San Gabriel Band of Mission Indians
P.O. Box 693
San Gabriel, CA 91778

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Morales:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

Joyce Perry, Representing Tribal Chairperson
Juaneno Band of Mission Indians Acjachemen Nation
4955 Paseo Segovia
Irvine, CA 92612

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Ms. Perry:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

Anthony Rivera, Chairman
Juaneno Band of Mission Indians Acjachemen Nation
31411-A La Matanza Street
San Juan Capistrano, CA 92675-2674

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Rivera:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

Rebecca Robles
Unites Coalition to Protect Panhe (UCPP)
119 Avenida San Fernando
San Clemente, CA 92672

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Ms. Robles:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

John Tommy Rosas, Tribal Administrator
Tongva Ancestral Territorial Tribal Nation
tattnlaw@gmail.com

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Rosas:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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August 17, 2011

Adolph Sepulveda, Vice Chairperson
Juaneno Band of Mission Indians
P.O. Box 25828
Santa Ana, CA 92799

SUBJECT: **OCSD Outfall Rehabilitation Project**

Dear Mr. Sepulveda:

ESA is conducting environmental and cultural resources studies for the proposed OCSD (Orange County Sanitation District) Outfall Rehabilitation Project. The proposed project would be located onsite at the existing ocean outfall system in OCSD's Plant No. 2 located at 22212 Brookhurst Street, Huntington Beach, CA. The enclosed map shows the project area on the Newport Beach USGS 7.5' Quad.

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Sincerely,

Candace Ehr

Candace Ehringer
Archaeologist

Appendix D

Preliminary Geotechnical Evaluation Report

Converse Consultants

Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

PRELIMINARY GEOTECHNICAL EVALUATION REPORT
OCSD Project No. J-112 Replacements
Ocean Outfall Junction Box Site

Huntington Beach, California
OCSD Task Authorization No. 42

September 1, 2011

Converse Project No. 11-32-151-01

PREPARED FOR

Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

Converse Consultants

Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

September 1, 2011

Mr. Adam Nazaroff
Engineering and Construction Management
Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92708

Subject: **PRELIMINARY GEOTECHNICAL EVALUATION REPORT**
OCSD Project No. J-112 Replacements
Ocean Outfall Junction Box Site
Huntington Beach, California
OCSD Task Authorization No. 42
Converse Project No. 11-32-151-01

Dear Mr. Nazaroff,

Converse Consultants (Converse) has prepared the enclosed report to present our review of all available and pertinent as-built documents provided to us for the proposed OCSD Project No. J-112 Replacements Ocean Outfall Junction Box Site located in Huntington Beach, California. This report has been prepared in accordance with our discussion with you regarding the scope of work on August 25, 2011.

It is our understanding this Preliminary Geotechnical Evaluation Report is intended to provide preliminary information for planning level options for CEQA report only, and is not intended to be used for design and construction.

We appreciate this opportunity to be of service to Orange County Sanitation District. If you should have any questions regarding this report, please contact us at (626) 930-1200.

CONVERSE CONSULTANTS

William H. Chu, G.E.
Senior Vice President/ Principal Engineer

Dist.: 4/Addressee

SCL/WHC/amm

PROFESSIONAL CERTIFICATION

This report for the proposed OCSD Project No. J-112 Replacements, Ocean Outfall Junction Box Site, Huntington Beach, California has been prepared by the staff of Converse under the professional supervision of the individuals whose seals and signatures appear hereon. The findings, recommendations, specifications or professional opinions contained in this report were prepared in accordance with generally accepted professional engineering and engineering geologic principles and practice in this area of Southern California. There is no warranty, either expressed or implied.

CHI-HSIN LIN
No.2921
Exp. 9/30/12

Sean C. Lin, P.E., G.E.
Senior Engineer

CHU HSUEH-HSIN WILLIAM
No. 2482
Exp 6/30/12

William H. Chu, P.E., G.E.
Sr. Vice President/Principal Engineer

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Drawing No. 2, *Plot Plan*…………………………………………………….. *End of Document*
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1.0 INTRODUCTION

The objective of this report is to review and evaluate the available and pertinent geotechnical data, and provide preliminary geotechnical evaluation for the planned excavation, sheet piling, and dewatering for the OCSD J-112 Replacements Ocean Outfall Junction Box Site in Huntington Beach, California.

The project site is located at an unpaved land on the west side of Santa Ana River and south side of Pacific Coast Highway in Huntington Beach, California. The site location is shown on Drawing No. 1, *Site Location Map.*

There are two existing outfall pipes at the subject site. One with inner diameter of 78 inches which is not in service and the other one with inner diameter of 120 inches which is currently in service. The center lines of the pipes are situated at elevation -4 feet mean sea level (MSL).

A 120-inch tapping saddle with concrete encasement is planned to be installed at the 120-inch pipe. Shored excavation of an area of 65 feet by 80 feet is proposed for the construction as shown on Drawing No. 2, *Plot Plan*.

This report is intended for use by Orange County Sanitation District and their design professionals. Since this report is intended for use by the designer(s), it should be recognized that it is impossible to include all construction details in this report at this phase of the project. Additional consultation may be prudent to interpret these findings for contractors, or possibly refine these recommendations based upon the final design and actual conditions encountered during construction.

2.0 SUMMARY OF SUBSURFACE SOIL PROFILE

Based on the available geotechnical test hole logs, the earth materials consist of fill and natural soils. The fill is approximate 10 feet deep consisting of fine-grained sand (SP) with gravels, cobbles and boulders. Natural soils underlying fills consists of fine to medium-grained sand (SP) with gravel layers at approximate 20 feet below ground surface.

Based on our review of as-built plan, the pile zone for the existing 120-inch pipe is about 21 feet wide confined by sheet piling walls. The pipe zone consists of approximate 5 feet of backfilled sand underlain by Class B stone and gravel bedding to a depth of approximate 23 feet below ground surface. The as-built plan of the pipe zone for the 78-inch pipe was not available to us. However, it is assumed the soil profile is similar to the 120-inch pipe.

Groundwater was reported at 2 feet mean sea level (MSL) by LeRoy Crandall & Associates (1965). The groundwater level should be expected to vary with seasonal rainfall, tidal influence, local irrigation, and groundwater pumping, among other factors.

Drawing No. 3, *Schematic Cross Section A-A'* is prepared to illustrate the soil profile in the planned excavation area.

Based on our review of the available subsurface soil profiles and our experience, variations in the continuity and nature of subsurface conditions within the project site should be anticipated. Because of the uncertainties involved in the nature and depositional characteristics of the earth materials, care should be exercised in interpolating or extrapolating subsurface conditions between or beyond the boring locations. If, during construction, subsurface conditions different from those presented in this report are encountered, this office should be notified immediately so that recommendations can be revised and modified as needed.

3.0 GEOTECHNICAL CONSDERATIONS

The following site conditions should be considered for the planned construction:

1. Granular soils – The earth materials at the site are predominately sand and sand with gravels. Various amounts of cobbles should be anticipated. Excavations in the sandy soils at the site should not be expected to stand vertically. Sloped temporary excavations (if necessary) may be constructed to the slope ratio of 2H:1V. These material types can be excavatable with heavy-duty earth moving, drilling, and trenching equipments. Due to the shallow groundwater and cohesionless soils, the use of a dragline or clamshell excavator is recommended for excavation.

2. Shallow groundwater – The groundwater is anticipated to be at elevation of 2 feet MSL and vary with tidal changes.

3. High permeable soil – The predominately sand and sand with gravel are expected to have high permeability. Typical permeability coefficient for sand and sandy gravel ranges from 0.01 cm/sec to 0.4 cm/sec (0.02 ft/min to 0.8 ft/min).

4. As-built underground structures and fills – Based on our review of the as-built documents, lower portion of previously installed sheet piling remains in place. Old sheet piling, Class"C" stone and gravel bedding should be expected during excavations in the pipe zone. The gravel backfill around the existing pipe is also considered a conduit for groundwater that may cause high flow rate.

4.0 DEWATERING

4.1 Estimation of Pumping Rates

Estimation of pumping rate for dewatering is based on our review of soil conditions, and our experience on the nearby OCSD Plant No. 2. The pumping rates required for dewatering an excavation area of 80 feet by 65 feet are estimated in the range of 7.44×10^5 gal/day to 2.98×10^7 gal/day. The calculations are attached at the end of this report.

It should be noted that the estimated pumping rates are based on several assumptions that may not reflect the actual site conditions. If desired, it may be necessary to perform a site-specific pump test to determine the permeability and flow rate for the planned project.

In addition to estimation using well formulas, we have reviewed a hydrogeologic/dewatering investigation report at OCSD Plant No. 2 (Converse, 2006). Plant No. 2 is located at approximate 1/4 mile north of the subject site. Based on this report, the aquifer transmissivity is assumed to be in the range of 15,000 to 100,000 gal/day/ft at Plant No. 2, which can be a reference for the J-112 project. However, the aquifer transmissivity at the subject site may be greater than those at Plant No. 2 because the subject site is closer to the beach front and groundwater is shallower.

4.2 Dewatering System

Dewatering may be accomplished by installing a wellpoint system inside the perimeters of excavation. The normal range of wellpoint spacing is from 3 to 12 feet. The wellpoint should extend into the underlying sand. The dewatering system should be designed and installed by an experienced contractor.

Large amount of water flow should be expected for design of dewatering system. Sheet piling and grouting to construct a close-form water barrier may be a feasible option to reduce the water flow in the excavation area.

5.0 TEMPORARY SHORING

Based on the site conditions and our analyses, dewatering is expected to be challenging for this project. Based on the previous experience on OCSD Plant No. 2, sheet piling along with chemical grouting may be the feasible option the subject site. Sheet piling can be installed parallel to the existing pipeline alignment and the chemical grouting can be placed perpendicular to the pipeline alignment to construct a cut-off wall of groundwater flow. In addition, chemical grouting may be used to seal the bottom of excavation to reduce the amount of water flow if the capacity of dewatering system is not capable to handle the large amount of groundwater flow.

Based on our review of site conditions, temporary shoring consisting of the use of interlocking sheet piling is recommended. The shoring for excavations may be cantilevered or may be laterally supported by walers, cross bracing and tie-back anchors.

For the design of cantilever shoring supporting a level grade, preliminary equivalent fluid pressures based on our review of available document are tabulated below:

Table No. 1, Preliminary Earth Pressures Parameters

EQUIVALENT-FLUID-PRESSURES, pcf		
Excavation	**Active Pressure (pcf)**	**Passive Pressure (pcf)**
Above Water Level	35	350
Below Water level	18	250

For the portion of the walls below the water table, a hydrostatic water pressure of 62.4 pcf per foot should be added to the pressures tabulated above.

In addition to the lateral earth pressure, surcharge pressures due to miscellaneous loads, such as soil stockpiles, vehicular traffic or construction equipment located adjacent to the shoring, should be included in the design of the shoring. A uniform lateral pressure of 100 psf should be included in the upper 10 feet of the shoring to account for normal vehicular and construction traffic within 10 feet of the trench excavation. As previously mentioned, all shoring should be designed and installed in accordance with state and federal safety regulations.

Chemical grouting should be designed and placed by an experienced contractor specializing on chemical grouting technique.

6.0 CLOSURE

The design recommendations presented in this report were prepared in accordance with generally accepted professional engineering principles and practices in effect at this time in Southern California. Our conclusions and recommendations are based on our laboratory testing and engineering analysis performed in accordance with applicable industry standards.

This report has been prepared for the sole benefit and exclusive use of Orange County Sanitation District, in accordance with the terms and conditions attached to our proposal under which these services have been provided. Any reliance on this report by third parties shall be third party's sole risk. Our services have been performed in accordance with applicable state and local ordinances, and generally accepted practices within our profession. No other warranty, either expressed or implied, is made.

Converse Consultants is not responsible or liable for any claims or damages associated with interpretation of available information provided by others. Site exploration identifies actual soil conditions only at those points where samples are taken, when they are taken. Data derived through sampling and analytical testing are extrapolated by Converse employees who then render an opinion about overall soil conditions. Actual conditions in areas not sampled may differ. In the event that changes to the property occur, or additional, relevant information about the property is brought to our attention, the recommendations contained in this report may not be valid unless these changes and additional relevant information are reviewed and the recommendations of this report are modified or verified in writing.

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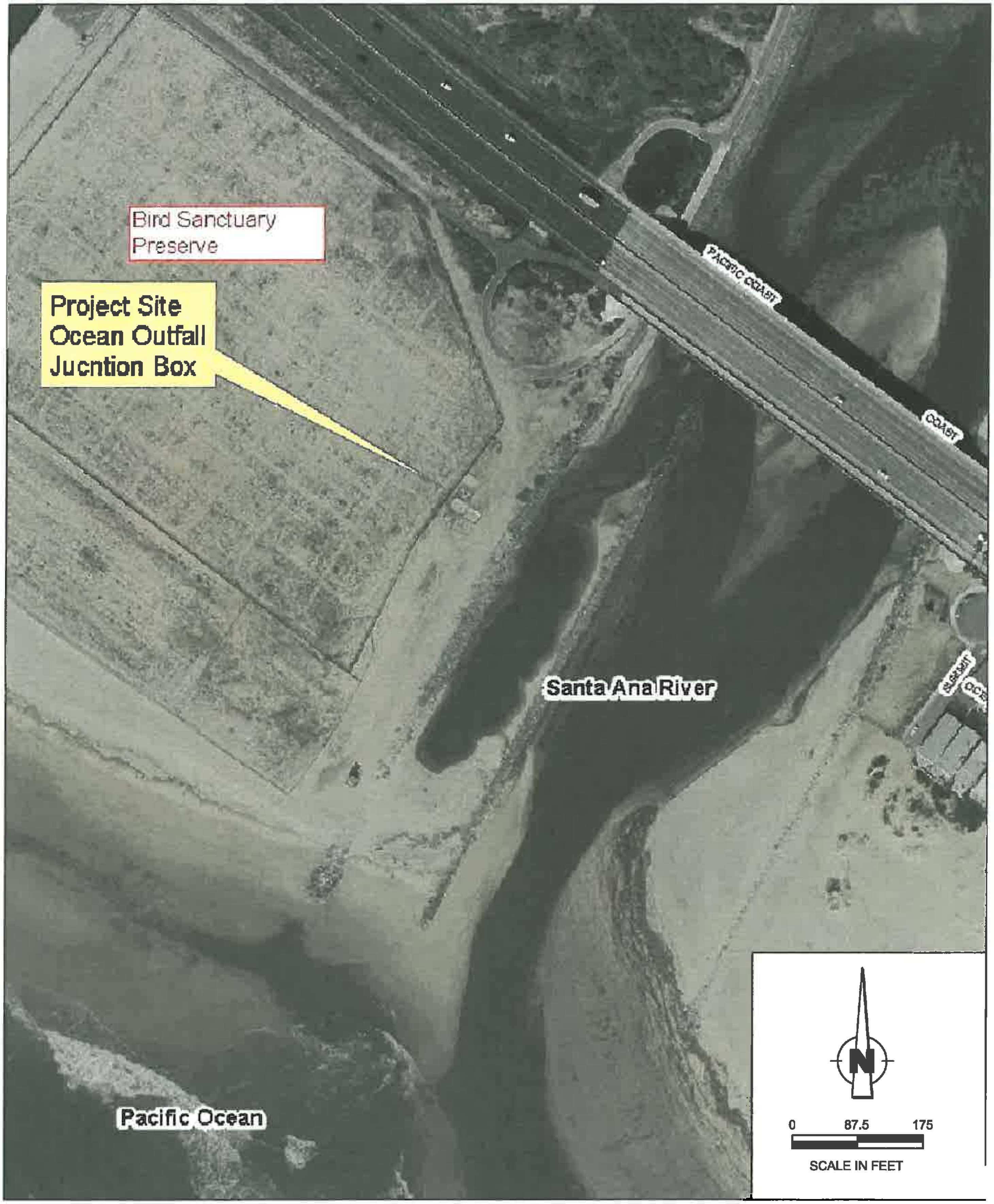
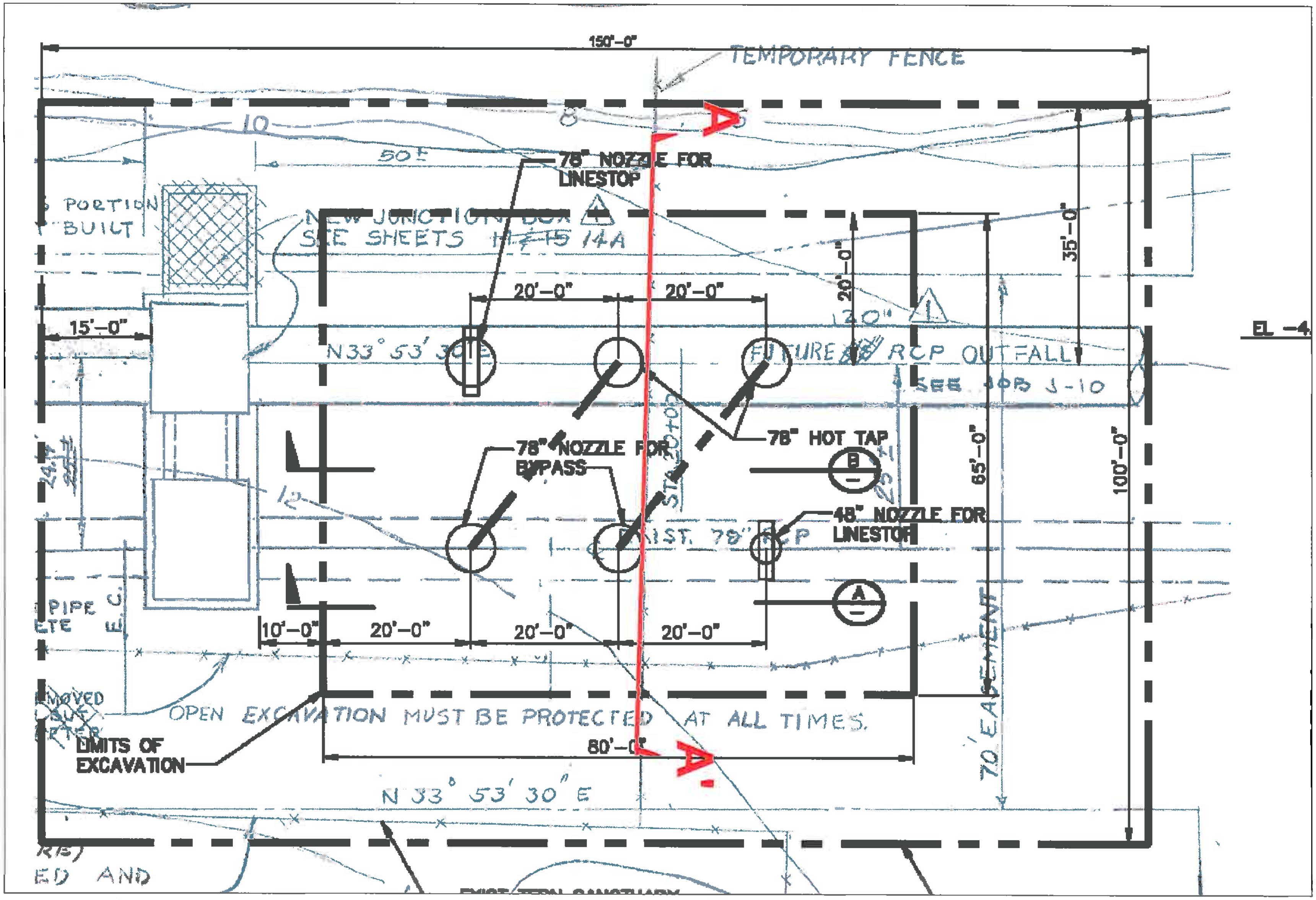


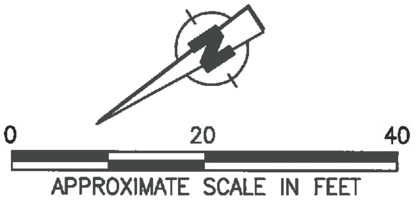
SITE LOCATION MAP

Converse Consultants

OCSD J-112 REPLACEMENTS
OCEAN OUT FALL JUNCTION BOX SITE
HUNTINGTON BEACH, CALIFORNIA

Project No.	Drawing No.
11-32-151-01	1



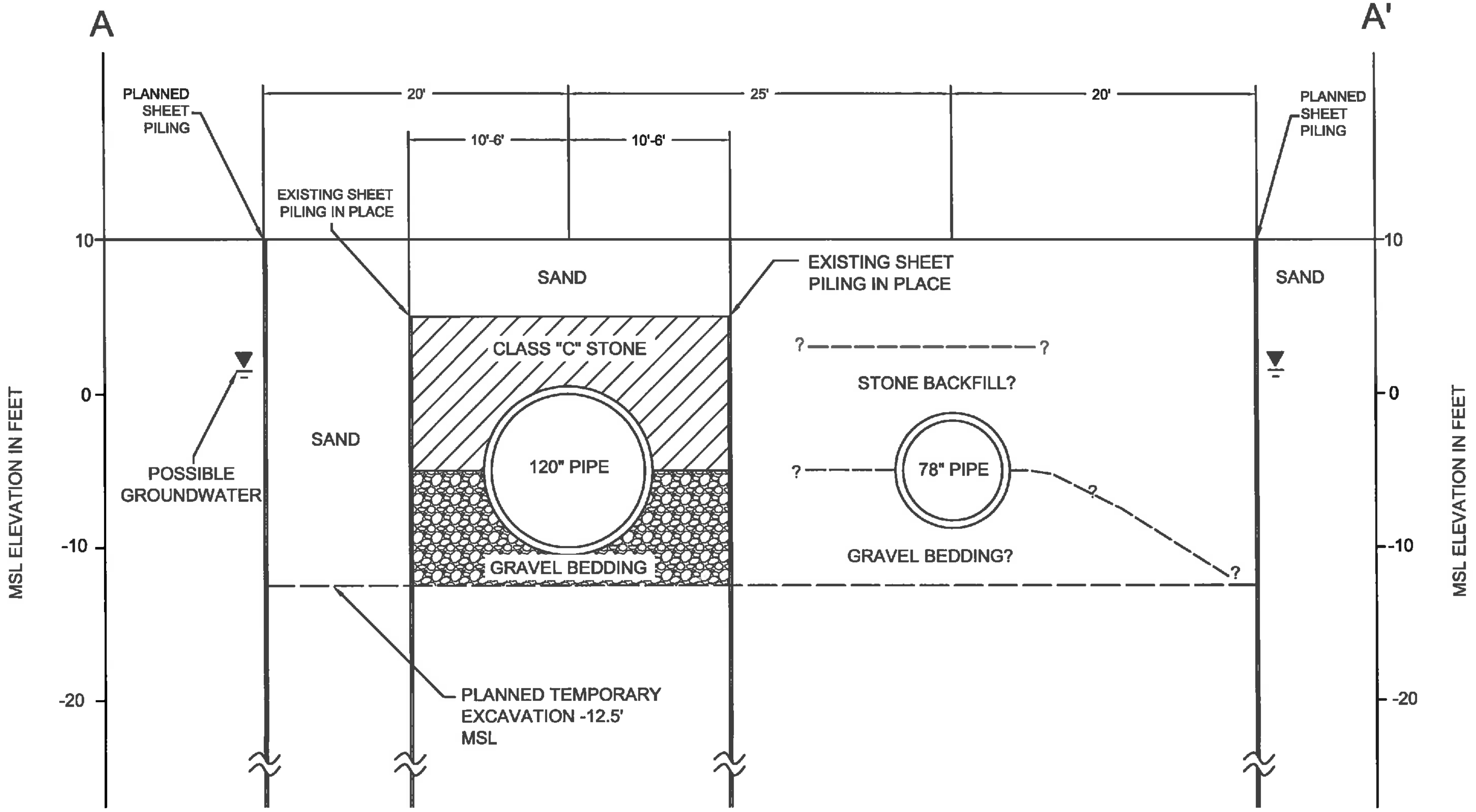


PLOT PLAN

Converse Consultants

OCSD J-112 REPLACEMENTS
OCEAN OUT FALL JUNCTION BOX SITE
HUNTINGTON BEACH, CALIFORNIA

Project No.	Drawing No.
11-32-151-01	2



0 10 20

APPROXIMATE SCALE IN FEET

SCHEMATIC CROSS SECTION A-A'

Converse Consultants

OCSD J-112 REPLACEMENTS
OCEAN OUT FALL JUNCTION BOX SITE
HUNTINGTON BEACH, CALIFORNIA

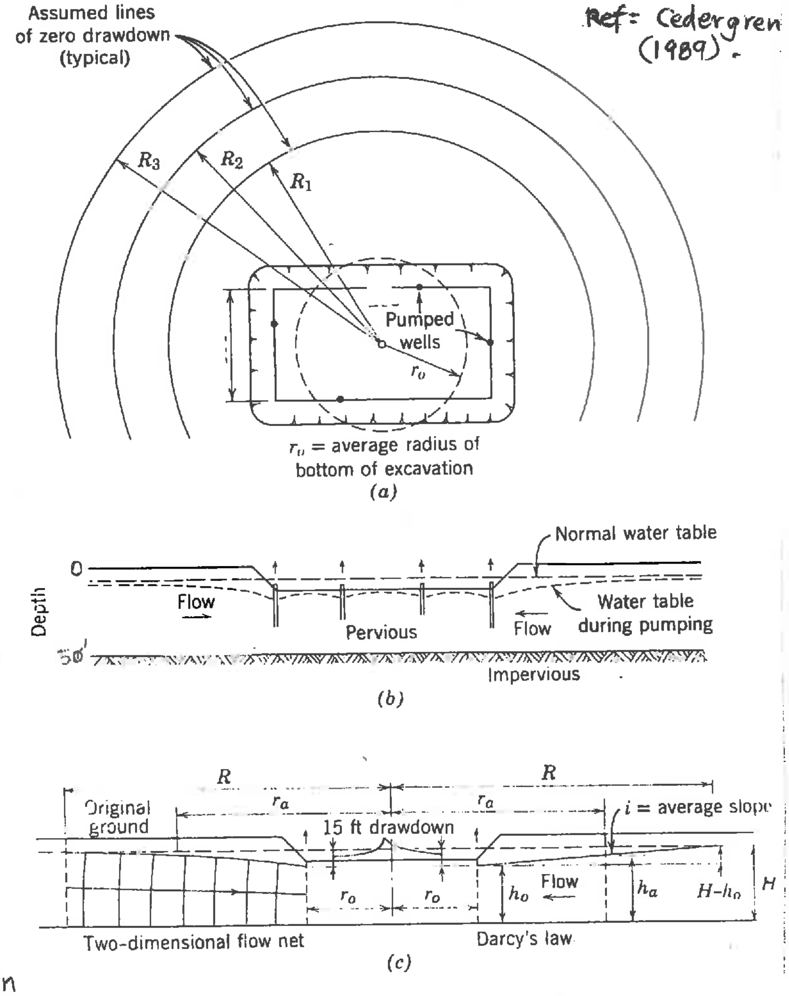
Project No.	Drawing No.
11-32-151-01	3

PROJECT NO.: 11-32-151-01
SHEET NO. 1 OF 1
PROJECT NAME: OCSD J-112
BY: SCL
DATE: 8/31/11
CLIENT: OCSD
CHKD. BY:
DATE:

Estimation of Dewatering Pumping Rates

Well formulas Method

Ref: Cedergren (1989).



Excavation Area = 80' × 65'

Average radius, $r_o = \sqrt{\frac{80' \times 65'}{\pi}}$

$\doteqdot 40'$

Bottom of excavation = 22.5' bgs
Groundwater level = 8' bgs

Assume:

1. An impervious layer = 50' bgs
2. line of zero drawdown, R = 100'

Well formulas: $Q = \frac{\pi \cdot K \cdot (H^2 - h_o^2)}{\ln\left(\frac{R}{r_o}\right)}$

$h_o = 50' - 22.5' = 27.5'$
$H = 50' - 8' = 42'$

Assume permeability coefficient

$K = 0.01$ cm/sec ~ 0.4 cm/sec
$\doteqdot 0.02$ ft/min ~ 0.8 ft/min
for gravelly sand and sandy gravel

When K = 0.02 ft/min

$$Q = \frac{3.14 \times 0.02 \times (42^2 - 27.5^2)}{\ln\left(\frac{100}{40}\right)}$$

$= 69.1$ ft³/min $= 516.9$ gal/min $\boxed{= 7.44 \times 10^5 \text{ gal/day}}$

when K = 0.8 ft/sec

$$Q = \frac{3.14 \times 0.8 \times (42^2 - 27.5^2)}{\ln\left(\frac{100}{40}\right)}$$

$= 2764.$ ft³/min $= 20676.2$ gal/min $= \boxed{2.98 \times 10^7 \text{ gal/day}}$

Appendix E
Hydrology Data

EVALUATION OF EFFLUENT DISCHARGE STRATEGIES DURING RAIN EVENTS

PURPOSE OF ANALYSIS

The Sanitation District (OCSD) is in the process of preparing an Environmental Impact Report (EIR) for the proposed Project entitled Outfall Land Section and OOBS Piping Rehabilitation The EIR includes three alternatives: 1) Bypass -No Use of the Short Outfall; 2) No Bypass – Use of the Short Outfall; and 3) No Project. Based on the current proposed Project schedules for Alternatives 1 and 2, rain is likely to occur during the constructed periods. The construction period for Alternative 1 is estimated to be January to February with vegetation restoration occurring in March. The construction period for Alternative 2 is estimated to be September to October.

One of the tasks in the EIR is to determine if there would be any potential for discharge of effluent out both the 5-mile primary Outfall (Long Outfall) and 1-mile emergency Outfall (Short Outfall) during rain events for Alternative 1 or to the Santa Ana River (SAR) during rain events for Alternative 2. For either Alternative, these strategies would only be considered if the capacity of the Outfalls was exceeded and other mitigation measures could not be implemented.

In order to determine the potential for discharge to the ocean or the SAR during rain events,

- Historical rainfall and effluent flow data were analyzed
- Outfall capacities were confirmed for each alternative
- OCSD and Orange County Water District (OCWD) operational strategies and mitigation measures were identified
- Potential flows in excess of outfall capacities were evaluated
- Probabilities of discharge to either the ocean or the SAR were determined

GENERAL HISTORICAL RAINFALL AND EFFLUENT FLOW DATA

Rainfall

Rainfall data for the last 20 years was reviewed (i.e., July 1991 – June 2011). The data was obtained from the County of Orange. The location/identification of the rain gauge is the Newport Beach Harbor Master - Station 88. The data is in inches per day. This station is closest to OCSD's treatment plant in Huntington Beach where OCSD's effluent is discharged into the ocean.

From this data, 2 graphs were created. **Figure 1** shows the number of days per month that this station saw measurable rain for each month over a 20 year period. For example, the average number of rain days per month over the last 20 years for September was 0.60 days, and 2.55 for October. For January and February, the average number of rain days per month was 6.80 and 7.40 days, respectively. **Figure 2** shows the average inches of rain per month over the 20 year period. Average rainfall for the months of September and October was 0.1 inches and 0.6 inches, respectively. For January and February, the average rainfall was 2.4 and 3.0 inches, respectively.

FIGURE 1
DAYS OF RAIN PER MONTH

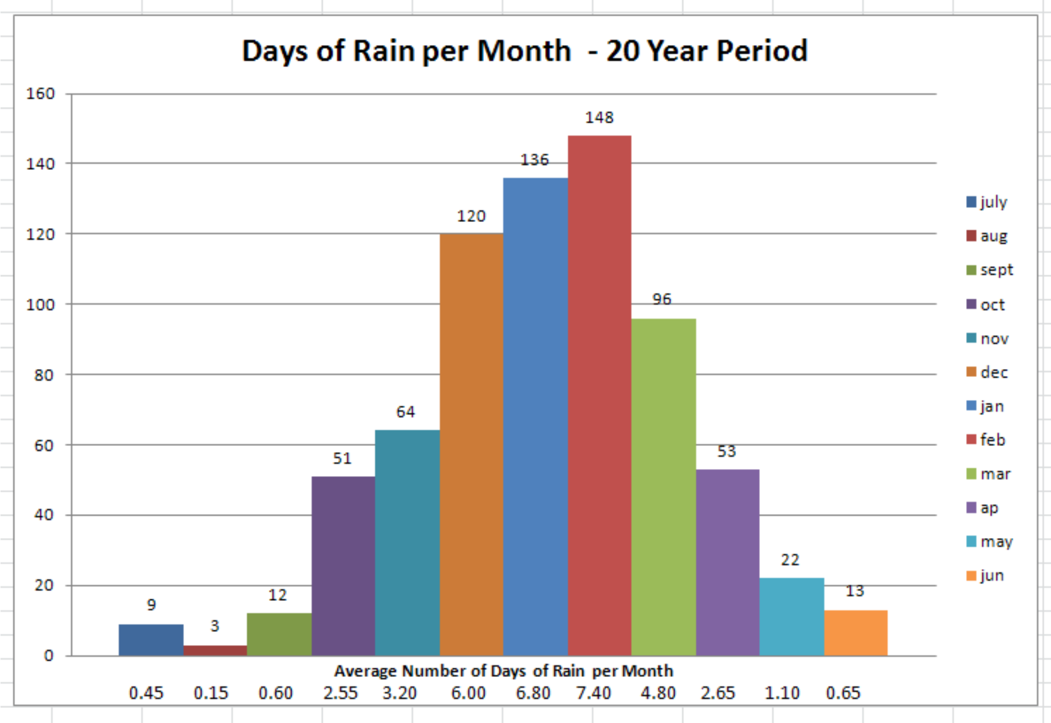
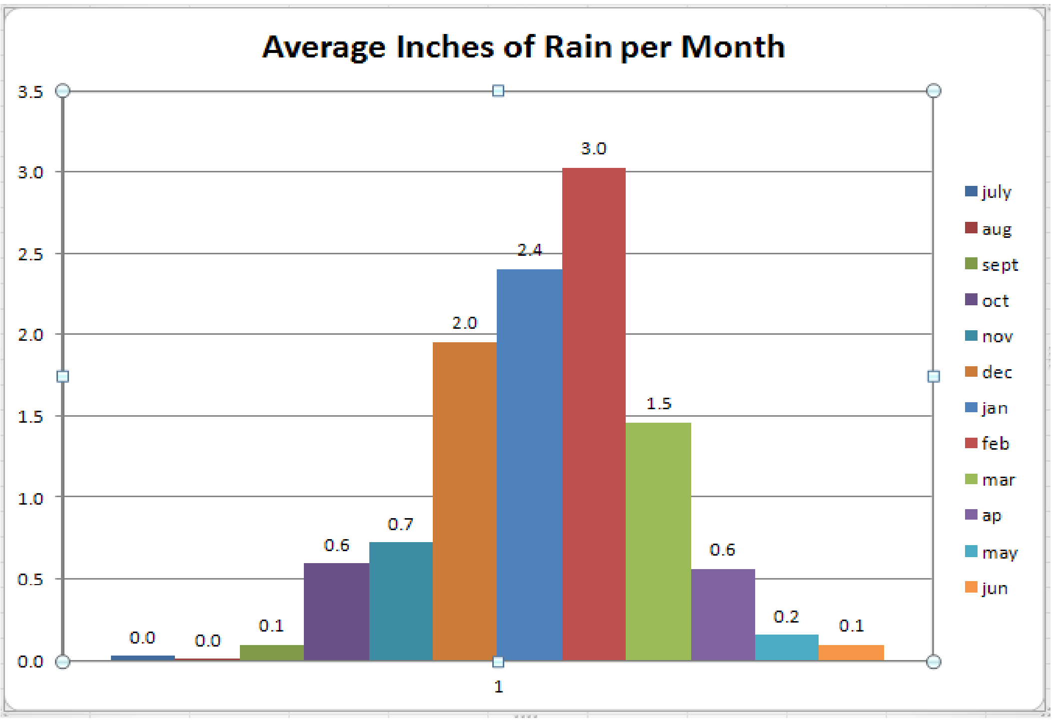


FIGURE 2
INCHES OF RAIN PER MONTH



Effluent Flow

Annual average flow data for the last 20 years, obtained from the 2010 Operations and Maintenance Annual Report, is presented in **Table 1** and shown graphically in **Figure 3**. It should be noted that, over the last several years, there has been a continuous decline in the combined influent to both plants. This is likely due to water conservation efforts.

TABLE 1

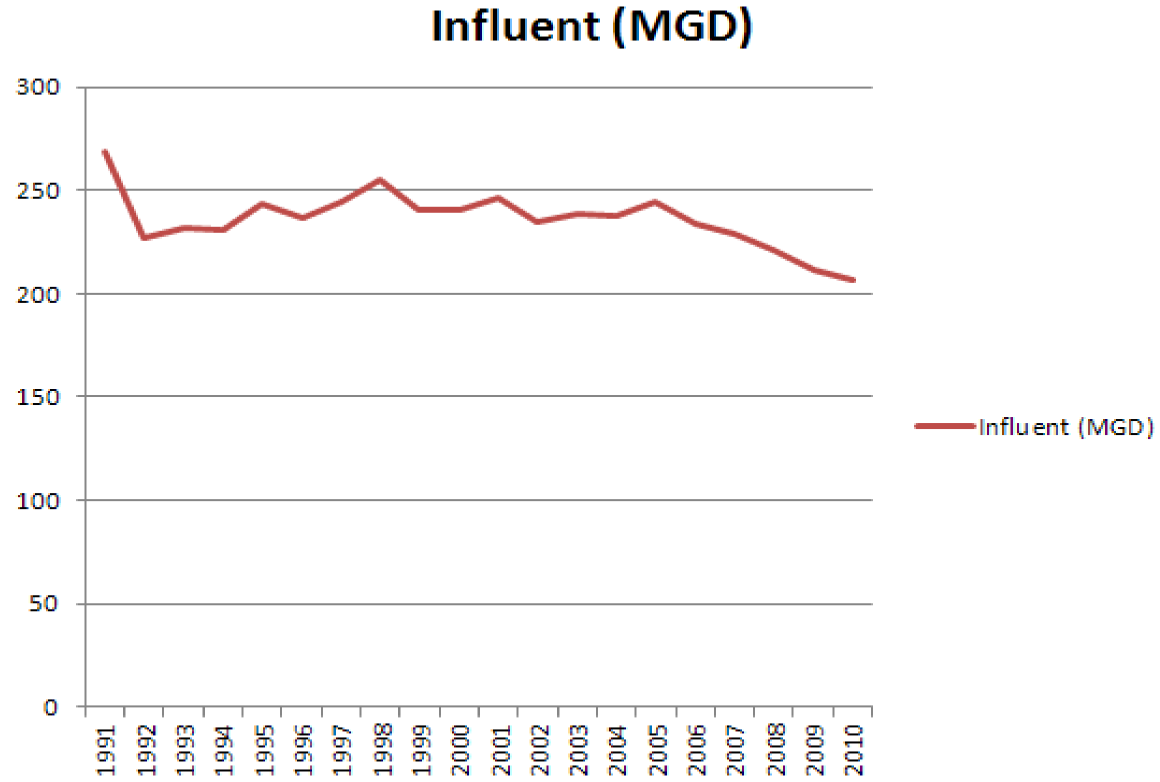
AVERAGE DAILY INFLUENT AND EFFLUENT FLOW IN MILLION GALLONS PER DAY (MGD) FOR FISCAL YEARS 1991 TO 2010

Fiscal Year	Influent MGD	Effluent MGD	Fiscal Year	Influent MGD	Effluent MGD
1991	269	262	2001	246	244
1992	227[a]	221	2002	235	231
1993	232	225	2003	239	235
1994	231	233[b]	2004	238	238
1995	243	244[b]	2005	244	247[b]
1996	237	232	2006	234	235[b]
1997	244	242	2007	229	232[b]
1998	255[c]	255	2008	221[a]	212[d]
1999	241	239	2009	211[a]	167[d]
2000	241	236	2010	207	152[d]

a Decrease due to drought, less infiltration due to drier soils and business recession.
b There was more effluent than influent due to in-plant construction dewatering that was discharged downstream of influent metering.
c El Niño (wet year)
d Increased flow to Groundwater Replenishment System.

FIGURE 3

HISTORICAL FLOW

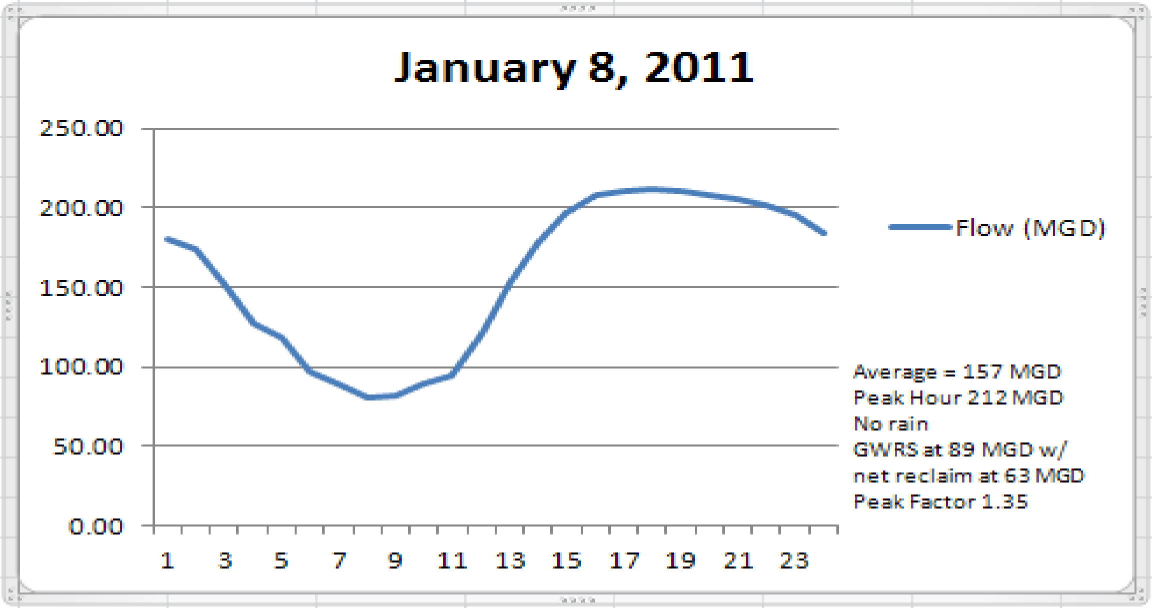


It is reasonable to assume that the flows for previous years would have been reduced based on the water conservation seen today, resulting in reduced plant influent flows. In order to compare past and current flow data on the same basis, a flow reduction factor was applied to historical data to bring it in line with the 2010 average daily flow data. For example, **Figure 3** shows an average daily influent flow of 244 MGD in 2005 and 207 MGD in 2010. For 2005, the flow reduction factor applied to the hourly flow rates was, therefore, calculated to be 0.85 (i.e., 207/244). If this flow factor was applied to a flow of 255 MGD in 2005, the resultant adjusted flow would be 216 MGD (i.e., 255 x 0.85). The validity of this methodology was confirmed when looking at an average daily flow of 207 MGD for the period January through August of 2011 (source: Sanitation District's Monthly Summary of Operations - MSO). This flow factor was used in the evaluation of effluent discharge strategies.

Figure 4 shows a typical 24 hour period of effluent flow on a day with no rain and OCWD's Groundwater Replenishment System (GWRS) in operation with a net average influent flow of 63 MGD (source: MSO) . The diurnal pattern is typical, and the peaking factor for this particular day was 1.34 (212/157). The purpose of this graph is to show that during certain times of the day, there is much more flow in the Long Outfall than at other times.

FIGURE 4

TYPICAL DAILY FLOW PATTERN



OUTFALL CAPACITIES

The design capacity of the Long Outfall is 480 MGD.

The capacity of the Short Outfall was tested and documented in November of 1987. Based on this test, the maximum flow achieved at the Short Outfall was 259 MGD (tide conditions and height of the water in the surge tower affect flow capacity). In 1989, a portion of the 78-inch pipe (795 feet) was replaced with 120-inch pipe. This would theoretically bring the capacity of the Short Outfall up to 274 MGD. However, studies of the design pressure of the pipe show that the maximum capacity should be limited to the height of the original surge tower overflow elevation of 68.9 feet. Therefore, the maximum capacity of the Short Outfall for this evaluation was assumed to be 264 MGD to protect the pipe from excessive pressure.

The Capacity of the Bypass Outfall System for Alternative 1 is 352 MGD. This is based on discharging flow through the Short Outfall upstream of the Beach Box, through the bypass structure downstream of the Beach Box, and then into the Long Outfall.

OCSD AND OCWD OPERATIONAL STRATEGIES

OCSD has the ability to reduce its instantaneous effluent discharge to the ocean by diverting flow to OCWD or store it in the treatment process basins at both treatment plants and the collection system.

OCSD Diversion to OCWD

On an average daily basis, OCSD can send up to approximately 93 MGD of treated flow to OCWD's GWRS and approximately 7.5 MGD to OCWD's Green Acres Project (GAP). The main treatment processes at GWRS include microfiltration (MF), reverse osmosis (RO) and Ultraviolet Disinfection (UV) with hydrogen peroxide. The daily flow of 93 MGD is based on the capacity of the RO process to produce up to 70 MGD of product water. The product water out of GWRS is discharged to spreading basins, reclaimed water use, and groundwater barrier protection.

The agreement between OCSD and OCWD allows a total diversion of up to 104 MGD of treated wastewater from OCSD to OCWD under normal operating conditions.

The combined reject flows from GWRS's MF and RO processes is about 23 MGD. This reject stream is returned to the OCSD treatment plant in Fountain Valley. This equates to a net flow to OCWD of approximately 70 MGD (i.e., 93 MGD minus 23 MGD). The instantaneous flow varies over the day and is lowest during the night. OCWD also accepts treated wastewater from OCSD for the GAP project during the non-rainy season which is typically May to September. Since Alternatives 1 and 2 construction schedules are basically outside of this period, this diversion was not considered in the analysis.

OCWD is also permitted to discharge disinfected microfiltration effluent to the SAR under its current NPDES permit should reuse options become unavailable. To date, this has not been done. In this instance, GWRS has the capacity to receive 128 MGD of OCSD flow, treat it through the MF and UV and discharge 100 MGD to the SAR. The reject flows of up to 28 MGD would be returned to OCSD.

Storage

OCSD's has the ability to store wastewater in its treatment plants and collection system to reduce the instantaneous effluent flow to the Long or Short Outfall. This can be done utilizing empty basins and available trunk line capacity, pre-pumping to low levels, and varying wetwell levels. The Operations staff has estimated that a total of 36 MG can be made available for storage. This may typically be needed when a large storm is anticipated. The stored wastewater is treated and released into the outfall when the storm flows subside.

OCSD would modify plant operations to maximum storage in the treatment processes and collection system at the expected beginning of each potential storm during the construction period for Alternatives 1 or 2, as needed.

Operational Scenarios to Evaluate

OCSD has the capability to discharge up to 480 MGD of peak wet weather flow through the Long Outfall to the ocean. Alternative 1 reduces the capacity of the Long Outfall to 352 MGD and is referred to as the Bypass Outfall System in this evaluation. Alternative 2 considers the use of the Short Outfall in lieu of the Long Outfall which would reduce the effluent discharge capacity to 264 MGD

The purpose of this evaluation is to determine if it is possible to mitigate the impacts of rain events on the proposed reduction in outfall capacities for Alternatives 1 and 2 by:

- Rehabilitating the Long Outfall during non-rain periods
- Maximizing the use of plant and collection system storage to hold back instantaneous peak flows and reintroduce them into the outfalls slowly.
- Maximizing the discharge to OCWD. It is important to note that OCWD may shut down for unplanned equipment maintenance that would increase the effluent discharge to the ocean.

In order to evaluate these mitigation measures, it was important to understand historical rainfall events during the construction periods and how often OCWD may shut down for unplanned maintenance.

The scenarios examined for each alternative were the following:

- Scenario 1 - Typical storm flows that may exceed the alternative outfall capacities based on historical data and probability of occurrence assuming GWRS is in service at a maximum capacity of 93 MGD
- Scenario 2 - Typical storm flows that may exceed the alternative outfall capacities and probability of occurrence assuming GWRS is out of service (worst case scenario)

For either scenario, the analysis looked at the ability to utilize plant and collection storage to handle the flows in excess of the revised outfall capacities.

<u>OCSD Flows during Rain Events</u>

The purpose of reviewing historical OCSD flow data during the period 1999 to 2011 was to identify rain events and determine how these events affected OCWD effluent flows. This information was then used to predict future rain events and determine their impact on plant operations and the ability of the outfalls to convey effluent to the ocean. Since plant operations have changed over this period, it was necessary to adjust flows to allow evaluation of flows on a common basis. The critical factors that have changed over the years include water conservation and the diversion of flows to GWRS.

In the following Alternatives analysis, the raw flow data was adjusted for water conservation as previously discussed and for the startup of GWRS. The water conservation factor used in the evaluation was 0.85. Past flows were multiplied by this factor to determine influent flows that take water conservation into account.

In the evaluation of effluent flows, it was assumed that GWRS was in operation during the period 2008 to 2011. Since GWRS was not in existence prior to 2008, the effluent flows during the period 1997 to 2007 were adjusted to make a comparison of all rain data assuming GWRS is in operation at full capacity. To accomplish this, a total flow of 70 MGD was removed from the actual metered flow data for the years prior to GWRS being in operation (i.e., 1999 to 2007) to represent total theoretical effluent flows that would be seen today. For the 2008-2010 flow data, the difference between 70 MGD and the actual GWRS flows were removed from the effluent to represent GWRS being fully on-line (i.e., there have been many times when GWRS has not actually operated at full capacity). For example, if an historical day's effluent was 250 MGD, and GWRS was only operating at 50 MGD for that day instead of the full RO capacity of 70 MGD, an additional 20 MGD (i.e., 70 MGD minus 50 MGD) was removed from the metered effluent flow number, to yield a new effluent value of 230 MGD.

The adjusted flows were evaluated to determine the number of times and at what flow rate past effluent flows would have exceeded the capacity of the outfalls during rain events, assuming that GWRS was fully on-line. This data is presented in **Tables 2 and 3.**

Impacts of GWRS Operation

Based on a review of GWRS shutdown data during the period February 2010 to May 2011, GWRS had 27 unplanned shutdowns over this 16 month period which is an average of 1.7 shutdowns per month. The average length of shut down was 3.6 hours. OCSD Operations staff estimates a more realistic number to be twice per month which represents a shutdown probability of 1 in 100 (i.e., 2 shutdowns/mo X.3 6 hours/(30days/mo X 24 hrs/day)).

At 70 MGD, the volume of flow to be stored over a 3.6 hour period per shut down would be 10.5 MG (i.e., 70 MGD x 3.6 hr x 1 day/24 hrs). This is a very conservative assumption for the analysis as it was observed that shutdowns for unplanned maintenance did not always require a complete stoppage of flow. Partial shutdowns would allow some flow to be sent to GWRS. However, it was not possible to determine a more realistic pattern of partial shutdown flows because the existing OCSD and GWRS flow data was so variable. In addition, the number of hours per shutdown and the reasons for shutdowns was also highly variable. Due to the variability of the data, the worst case was assumed for the evaluation.

ANALYSIS OF ALTERNATIVES

Alternative 1 – Bypass – No Direct Use of the Short Outfall

Analysis of Historical Effluent Flow Data

Historical flow data for the months of January and February during the period 2000 to 2011 was reviewed to determine the number and duration of storms that would have exceeded the Bypass Outfall System capacity associated with Alternative 1. During this 12 year period, using the flow reduction factor and 70 MGD GWRS flow diversion assumptions previously discussed, the capacity of the Bypass Outfall System would have been exceeded 3 days for a duration of 5 hours**.** **Table 2,** below, shows the dates, flow rate and total quantity of flow per exceedance.

TABLE 2
JANUARY-FEBRUARY FLOW EXCEEDANCE

Date	Time	Flow (MGD)	Hourly Exceedance over 352 (MGD)	Total Flow [1] Exceedance (MG)
Feb. 6, 2010 *	6 pm	358	4	0.2
Jan. 9, 2005 *	8 pm	359	7	0.3
	9 pm	370	18	0.8
	10 pm	370	18	0.8
			Total	2.2
Feb. 21, 2005 *	2 pm	354	2	0.1

* Days that had measurable rain

[1] Total Flow assumes that the flow measured at the hour continued for the full hour.

Scenario 1

The highest exceedance occurred on January 9, 2005 as shown in **Table 2** which would have been 18 MGD higher than the capacity of the Bypass Outfall System. If it is assumed that this would be the worst case in the future, the maximum storage required to stay within the capacity of the Bypass Outfall System would be 2.2 MG as shown in **Table 2** which can be easily stored at the treatment plants, thus avoiding a discharge out both outfalls.

Based on the analysis of historical flow data over the last 12 years (i.e., 59 days for January and February), and factoring in GWRS flows of 70 MGD and the flow reduction factor, the probability of exceeding the Bypass Outfall System capacity for a five hour duration is 1 in 3,398 (i.e., 5/(12 X59 X24)).

Scenario 2

If GWRS were to go out of service during a storm like the one on January 9, 2005, then the total flow to OCSD would have been 440 MGD (370 MGD+70 MGD) and the capacity of the Bypass Outfall System in the future would have been exceeded by 88 MGD without the use of storage. If this exceedance is assumed in the future, using a rain duration of 5 hours and a GWRS outage of 3.6 hours, the total volume of wastewater to be stored would be 12.7 MG (i.e., 2.2 MG rain+ 10.5 MG flow from return of GWRS flows to OCSD) which is still less than the maximum available storage, thus avoiding a discharge out both outfalls.

The total probability of having a rain storm and GWRS going out of service during this period would be found by multiplying the two probabilities of occurrence (i.e., (1/100) x (1/3398)) = 1 in 339,800.

It is, therefore, concluded that there is essentially a zero chance that both events would occur at the same time and, based on previous data, storage would be available to handle the situation.

Alternative 2 – No Bypass - Use of the Short Outfall

Analysis of Historical Effluent Flow Data

Historical flow data for the months of September and October from 1999 to 2010 was reviewed to determine the number and duration of storms that would have exceeded the Short Outfall capacity associated with Alternative 2. During this 12 year period, using the flow reduction factor and 70 MGD GWRS flow diversion assumptions previously discussed, the capacity of the Short Outfall would have been exceeded on 4 days for a duration of 8 hours**.** **Table 3,** below, shows the dates, flow rate, and total quantity of flow per exceedance.

TABLE 3
SEPTEMBER-OCTOBER FLOW EXCEEDANCE

Date	Time	Flow (MGD)	Hourly Exceedance over 264 (MGD)	Total Flow [1] Exceedance (MG)
Sep. 11, 2008	12 midnight	277	13	0.5
Oct. 14, 2008	11 pm	267	3	0.1
Sep. 4, 2004	4 pm	298	34	1.4
Oct. 20, 2004 *	9 am	287	23	1.0
	10 am	295	31	1.3
	11 am	318	54	2.2
	12 noon	313	49	2.0
	1 pm	287	23	1.0
			Total	7.5

[1] Total Flow assumes that the flow measured at the hour continued for the full hour.

* Days that had measurable rain

Scenario 1

The highest exceedance occurred on October 20, 2004 as shown in **Table 3** which would have been 54 MGD higher than the capacity of the Short Outfall. If it is assumed that this will be the worst case in the future, the maximum storage required to stay within the capacity of the outfall would be 7.5 MG which can be easily stored at the treatment plants, thus avoiding a discharge to the SAR.

Based on the analysis of historical flow data over the last 12 years (i.e., 61 days for September and October), and factoring in GWRS flows of 70 MGD and the flow reduction factor, the probability of exceeding the Short Outfall capacity for a six hour duration is 1 in 2,928 (i.e., 5/(12 X61 X24)).

Scenario 2

If GWRS were to go out of service during a storm like the one on October 20, 2004, then the total flow to OCSD would have been 388 MGD (i.e., 318 MGD+70 MGD) and the capacity of the Short Outfall in the future would have been exceeded by 124 MGD. If this exceedance is assumed in the future, using a rain duration of 6 hours and a GWRS outage of 3.6 hours, the total volume of wastewater to be stored would be 18.0 MG (i.e., 7.5 MG rain+ 10.5 MG flow from return of GWRS flows to OCSD) which is still less than the maximum available storage, thus avoiding a discharge to the SAR.

The total probability of having a rain storm and GWRS going out of service during this period would be found by multiplying the two probabilities of occurrence (i.e., (1/100) x (1/2928)) = 1 in 292,800.

It is, therefore, concluded that there is essentially a zero chance that both events would occur at the same time and, based on previous data, storage would be available to handle the situation.

SUMMARY

The following conclusions can be made regarding the evaluation of effluent discharge strategies:

- This analysis indicates that storage is available to contain flows in excess of the outfall capacities defined under Alternatives 1 and 2, thus avoiding the need to discharge out both outfalls for Alternative 1 and the SAR for Alternative 2.
- For Alternative 1, the probability of requiring a discharge to both outfalls during rain events ranges from 1 in 3,398 (rain only) to 1 in 339,800 (rain plus no GWRS flow) based on hourly data.
- For Alternative 2, the probability of requiring a discharge to the SAR during rain events ranges from 1 in 2,928 (rain only) to 1 in 292,800 (rain plus no GWRS flow) based on hourly data.
- The analysis is based on conservative assumptions related to GWRS being totally out of service during unplanned maintenance. At times, there will be some GWRS flow which will provide a bigger cushion of reliably storing flows.
- It is recognized that the OCSD and OCWD influent flows are variable in nature. The analysis was done based on the assumption that a net maximum flow of 70 MGD would be diverted to OCWD. There will be times of the day when this will not be possible, mainly at night when the flows are low. Given the fact that flows are low, there is substantial storage available, the probably of occurrence of rainstorms is very low, and GWRS going down is low, OCSD believes it will not be necessary to discharge out both outfalls for Alternative 1 or to the SAR for Alternative 2 when the GWRS influent flow is less than 70 MGD.

Appendix F
Marine Environment Data

- Statistical Analysis of Multi-Year Currents at Inshore Locations in San Pedro Bay
- Summary of Surface Currents off Orange County, California
  January 2008 to December 2009
- Shallow Water Diffuser Plume Modeling
- Receiving Water Quality in the Vicinity of the Orange County Sanitation District's 78-inch Ocean Outfall
- Anticipated Biological Response to Extended Discharge from a Nearshore Shallow Outfall
- J-112 Effluent Bacteria Reduction Demonstration Project
  July 25, 2011 – August 15, 2011

Statistical Analysis of Multi-Year Currents at Inshore Locations in San Pedro Bay

Final Report

Prepared for:

Orange County Sanitation District

Prepared by:

Science Applications International Corporation

October 2011

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Figure 2 Mooring data coverage for the Inshore location by year. Note there is an overlap with the previous December. 3

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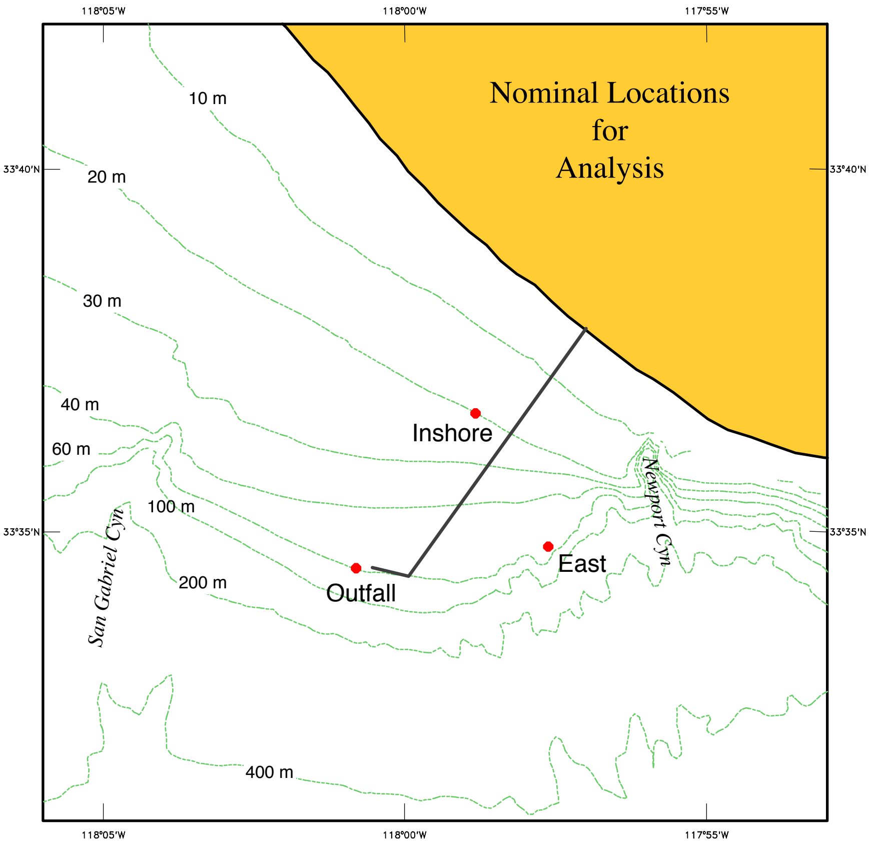
1. INTRODUCTION

The Orange County Sanitation District (District) requires a statistical characterization of the currents and circulation in the vicinity of their short, 78-inch outfall for which the diffuser depth is about 17-m. This information is needed to support predictions of the fate of treated effluent discharges from the short outfall for a limited time period when the 120-inch outfall will be taken offline for maintenance and repair. The District has maintained a bottom-mounted acoustic Doppler current profiler (ADCP) mooring on the 20-m isobath, known as M20, near the terminus of the outfall since 2004. Prior to that, between 2001 and 2003, various moorings, denoted by the number 5, were deployed cooperatively by the District and United States Geological Survey (USGS) on the 25-m isobath. In 1999 and 2000, the District deployed a mooring, named “R”, on the 15-m isobath, and in 1986 to 1988, moorings, denoted by the number 1, were deployed in the vicinity of the 25-m isobath. Prior to 2004, the moorings were conventional with a surface float and discrete instruments that made point measurements, usually at near-surface, mid-depth and near-bottom depths. Instruments included temperature, salinity, and current velocity sensors. By comparison, the USGS moorings were complex; consisting of bottom-mounted tripods with upward looking ADCP’s as well as surface moorings. Collectively, these moorings from 1986 to the present provide time series data for a region referred to as the “Inshore” location.

Previous statistical characterizations of the currents and circulation from similar multi-year observations were based on data records that extended through 2008, and the emphasis was on the main outfall location at the 60-m isobath (SAIC 2009). However, currents at the inshore location and at a separate location east of the primary outfall were also included in the statistical characterizations, even though the observations were not as extensive as those at the 60-m outfall location. This report extends the analysis for the inshore location through 2010 using the ADCP current and temperature measurements taken at M20. Figure 1 shows the mooring locations and deployment time lines for each of the three locations. The time lines show the extension of the observations at the inshore location beyond April 2008 that was the cut-off date for the previous analysis. (Note that measurements have been made at the outfall location post April 2008, but they are not included in this report). Figure 2 shows the observational coverage at the inshore location by year. More details on the moorings and data return by instrument are given in SAIC (2009). The ADCP records at M20 after April 2008 are configured identically to the 2007–2008 deployments, as described in SAIC (2009), and they represent current velocity measurements at 1-m intervals through the water column from near-bottom to near-surface, along with temperature at the bottom.

The report is organized as follows: Section 2 presents the results of the statistical analyses of the currents throughout the water column at the inshore location;



Summary of Current Observations 1986 - 2010

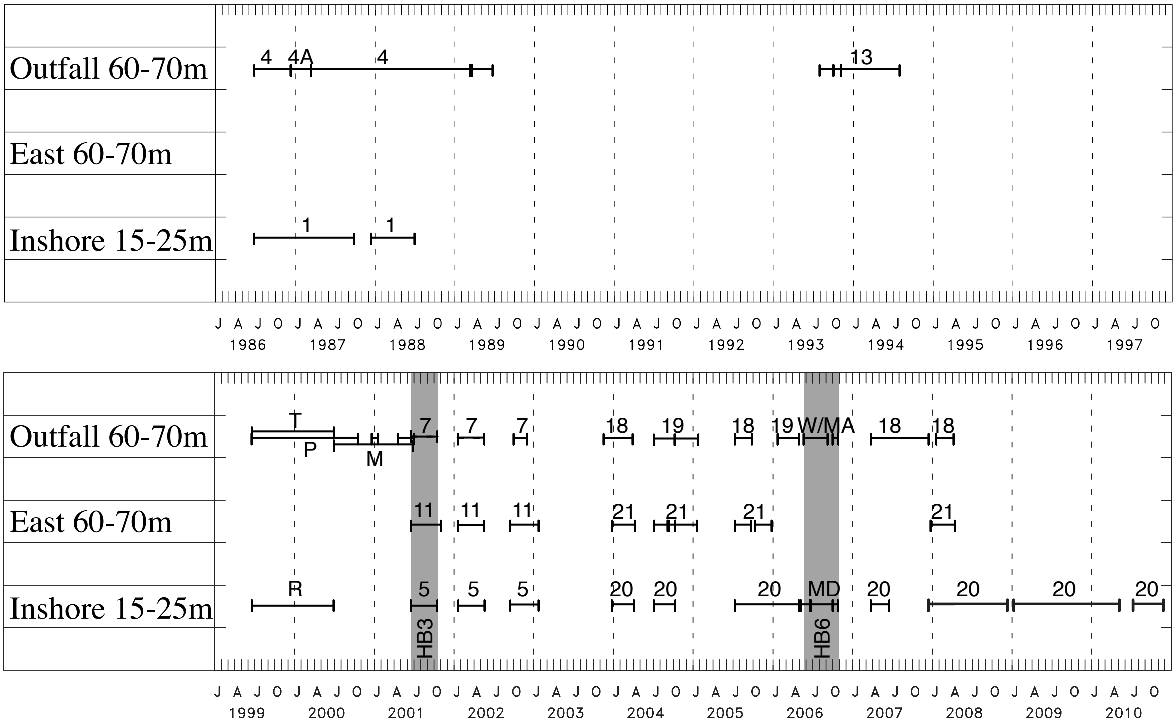


Figure 1. Upper panel: Nominal analysis locations. Lower panel: Mooring deployment intervals for the three nominal locations from 1986 to 2010. Shaded areas show the times of the two intensive summer studies. Notation above the time lines refer to mooring ID's. Note that in the missing year (1998) of the time line plots, no observations were made.

Inshore 15-25 m Currents: Seasonal Summary

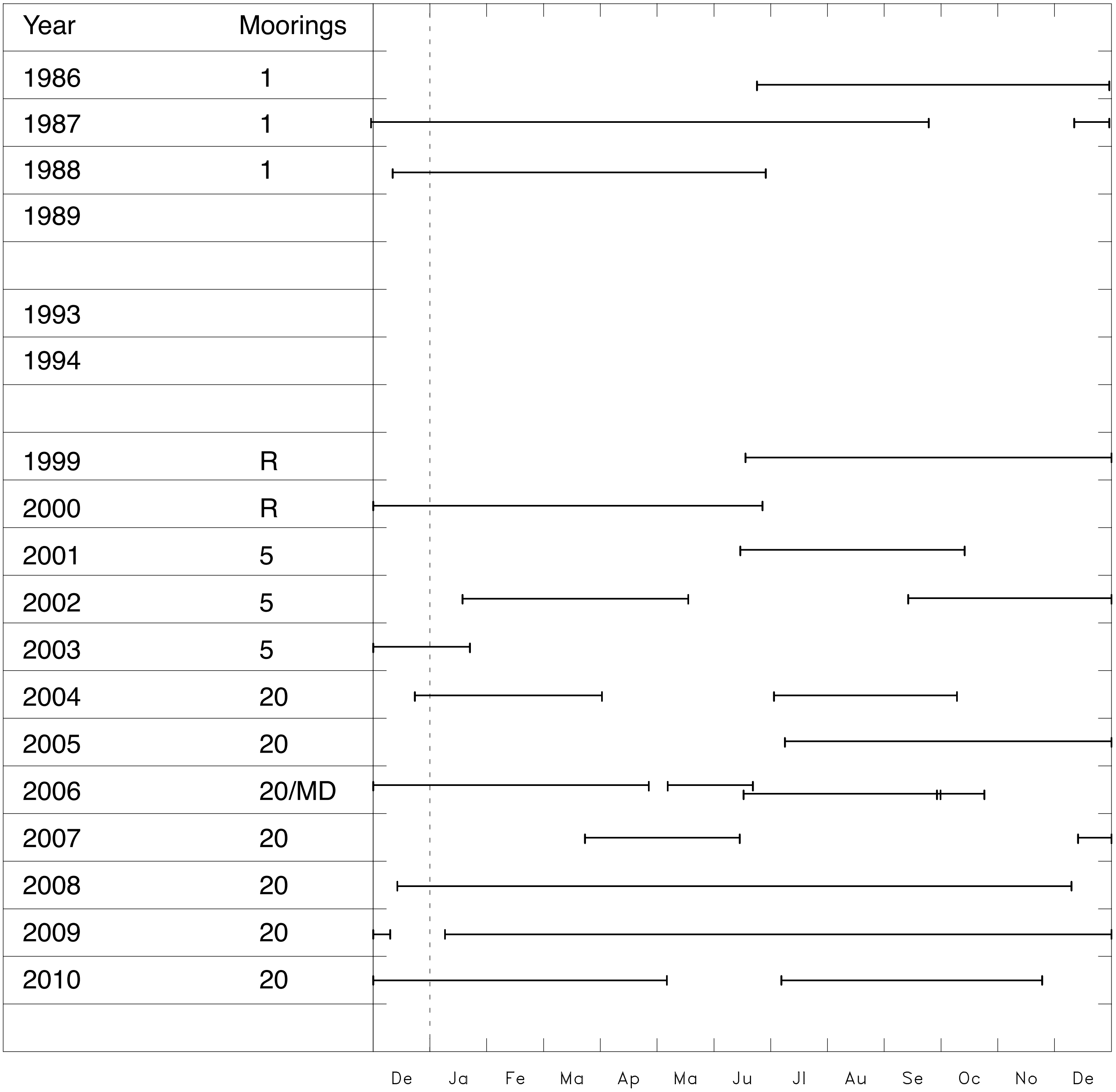


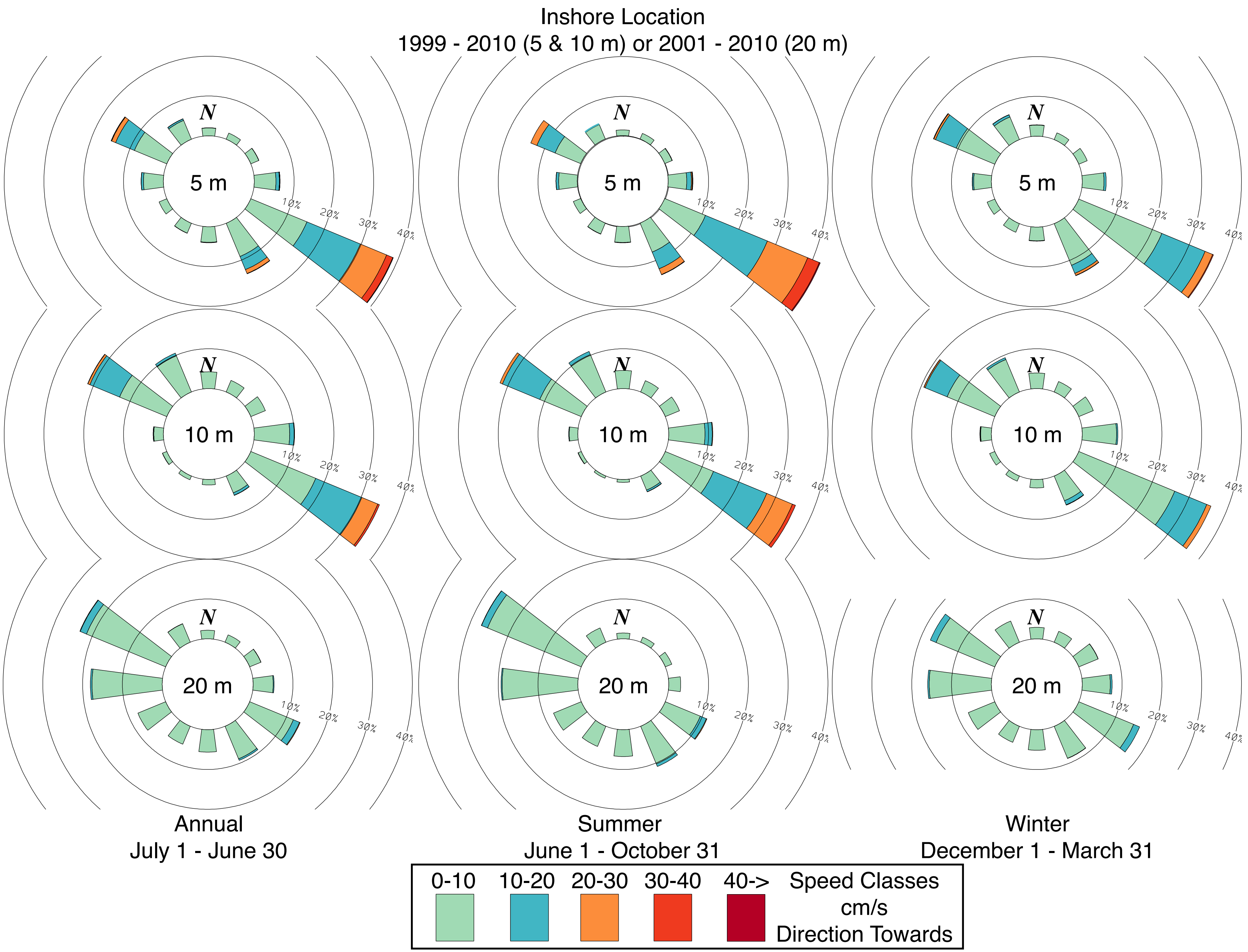
Figure 2. Mooring data coverage for the Inshore location by year. Note there is an overlap with the previous December.

Section 3 discusses the monthly anomalies and mean seasonal cycles of the circulation; Section 4 briefly describes tidal variability; followed by the summary (Section 5) and Appendix A (Speed and Direction Statistics Tables).

2. CURRENT STATISTICS

The velocity and temperature data from the inshore moorings were merged into continuous records with the gaps flagged. The velocity coordinate axes were rotated so that the alongshore component (v) is directed up-coast at 300°T (i.e., towards Palos Verdes), parallel to the general trend of the isobaths and coastline. With this rotation, a positive cross-shelf component (u) is directed towards the coast and perpendicular to the isobaths. Because of the varying distribution of measurements through the water column, three nominal depths were used - 5, 10 and 20 m - corresponding to near-surface, mid-water column, and near-bottom, respectively. The actual near-bottom data were from elevations about 1 to 3 m above the seabed, which corresponded to depth ranges from 15 to 25 m, although the majority were from 20 m. The records were filtered with a 40-hour low pass kernel, and decimated to 6-hour intervals, to suppress tidal period (25 hours and less) fluctuations. This is because tidal period oscillations on the San Pedro shelf produce very small net transports, and mainly cause periodic cross-shelf fluctuations in the position of the plume that average out over 1 to 2 day intervals (Noble and Xu 2004). By contrast, transport by low-frequency (subtidal) currents that include wind-forced flows is the most effective mechanism for dispersing effluent after initial mixing. Therefore, suppression of the tidal period fluctuations provides a clearer picture of the predominant low-frequency current patterns that are most important for understanding the fate of the effluent plume.

Using the merged 40-HLP records, current roses for the 1999-2010 period were constructed for each of the three depths (Figure 3). Current roses are graphical representations of histograms of current speed and direction. Current data were available for near-bottom depths during 1986-1988, but not for shallower depths, and near-bottom current data were not available for 1999 and 2000. Therefore, current roses for near-bottom currents are compared for the 1986-2010 and 2001-2010 intervals in Figure 4. Current roses were constructed for the annual interval using all available data, as well as for the summer, strongly-stratified season, which is defined as June to October, and the winter, weakly-stratified season, defined as December to March. Spring and fall transition periods are quite short (1-2 months) and, therefore, not included as separate seasons. Current directions shown In Figures 3 and 4 are relative to true north (0°T). The equivalent values used to generate Figures 3 and 4 are given in Appendix A, where the current directions are relative to 300°T (i.e., in along- and across-shore coordinates). The annual cycle for current patterns is discussed in the next section.



Inshore Location
1999 - 2010 (5 & 10 m) or 2001 - 2010 (20 m)

Annual
July 1 - June 30

Summer
June 1 - October 31

Winter
December 1 - March 31

Figure 3. Current roses annual (left), summer (center) and winter (right) periods for three depths at the Inshore location where speed classes are given by the color bar, and the radial scale gives the percentage of the record in each direction bin. Currents are relative to true north. Values used to generate the current roses are provided in Appendix A.

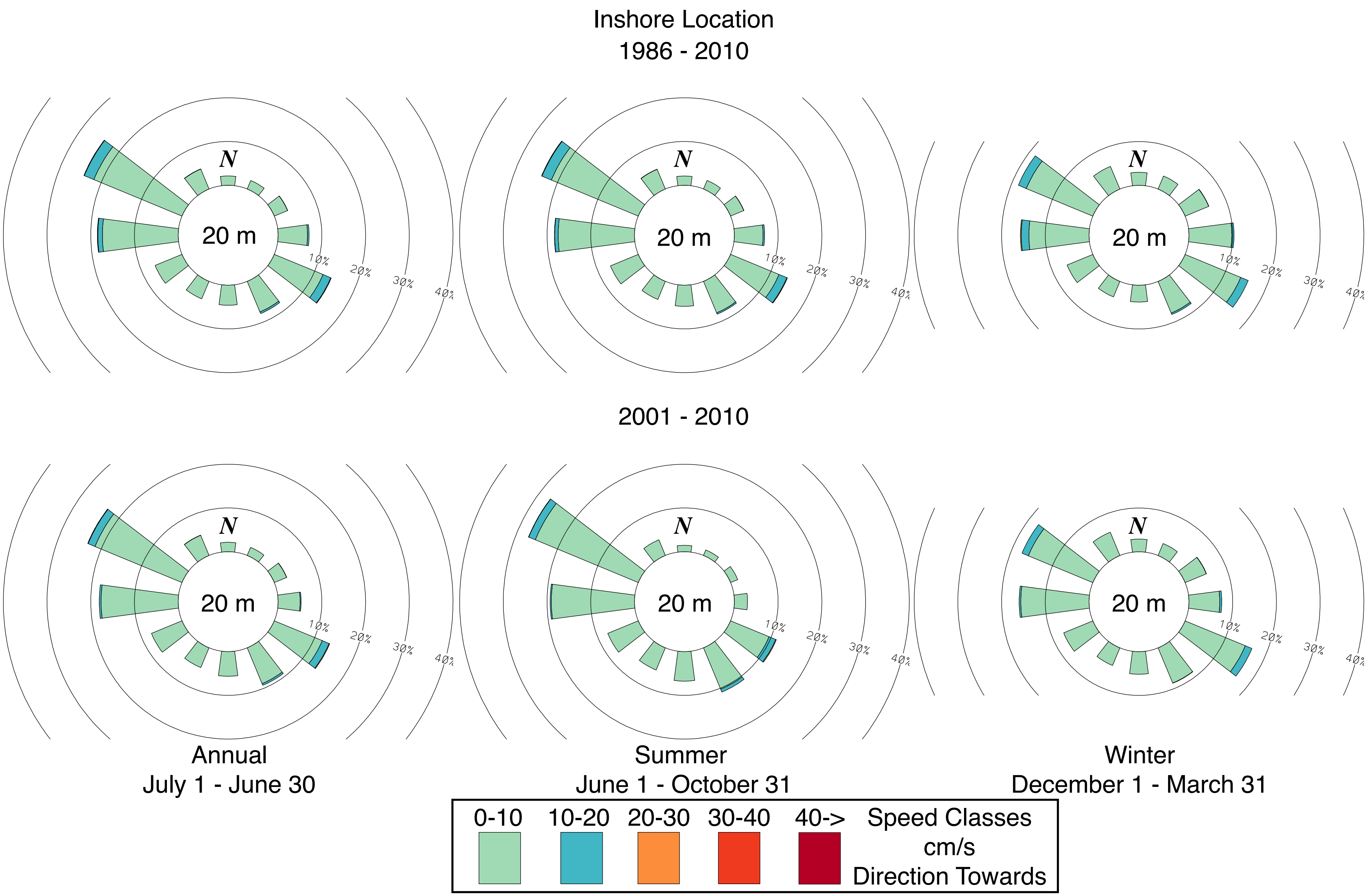


Figure 4. Current roses annual (left), summer (center) and winter (right) periods for 20 m depths at the Inshore location where speed classes are given by the color bar, and the radial scale gives the percentage of the record in each direction bin. Top row includes velocities from 1986 to 1988. Currents are relative to true north. Values used to generate the current roses are provided in Appendix A.

Hamilton et al. (2006) and SAIC (2009) analyzed subtidal flows on the San Pedro shelf and concluded that current patterns on the outer shelf are dominated by remotely-forced continental shelf waves, similar to those previously described by Hickey et al. (2003), whereas currents on the inner shelf are dominated by locally wind-forced flows. The transition between the inner and outer shelf regimes occurs around the 15 to 20-m isobaths (Hamilton et al. 2006). Tidal and internal tidal oscillations that affect these current regimes are discussed further in Section 4.

The prevailing flows at depths of 5 and 10 m are down-coast. At the shallower depth, currents have larger velocities, whereas currents at the 10-m level exhibit slightly higher prevalence of up-coast flows, for all three seasons (annual, summer and winter; Figure 3). The annual distribution is similar to those in summer and winter, but with stronger flows in summer and weaker flows in winter. Onshore-offshore components are small, although the 5-m currents exhibit a slight preference for an offshore component (i.e., 150°T direction bin), while the 10-m currents exhibit an onshore component (90°T). These patterns are consistent with those of upwelling systems driven by prevailing northwesterly local winds, and they are particularly evident during the summer season. At near-bottom depths of 20 m, flows are more up-coast than down-coast for the annual and summer seasons, whereas near-bottom flows in winter have approximately equal up- and down-coast probabilities. Again, the summer flows are stronger than the annual mean, while the winter flows are weaker than the annual means. Onshore components are weak for all seasons, whereas offshore components are important, particularly in summer. During the winter season, the frequencies of the on- and offshore components are roughly equivalent. Figure 4 shows the distribution of the 20-m currents using velocity data from 2001 to 2010 and from 1986 to 2010. The latter period has a similar number of valid data points as the 1999 to 2010 data record that was used for the shallower levels. Previous analysis of currents near the shelf-break (i.e., terminus of the 120-inch outfall) determined that currents during the 1980's had more prevalent up-coast flows than during the first decade of the 21st century (SAIC 2009). In contrast, it is evident that for the inshore 20-m currents there is no significant difference in the statistics for the two velocity time series. This implies that the statistics using 8 to 10-year time series are robust.

Table 1: Mean 40-HLP Velocities along 300°T (cm/s)

Depth	Annual	Number of Days†	Summer	Number of Days	Winter	Number of Days
5-m	-4.9±0.5	2354(57%)	-6.9±0.8	1071(59%)	-2.7±0.7	766(57%)
10-m	-2.2±0.4	2354(57%)	-2.9±0.7	1071(59%)	-1.6±0.6	766(57%)
***20-m**	+0.9±0.2	2575(29%)	+1.3±0.3	1180(31%)	+0.4±0.4	827(28%)

* Using the 1986 to 2010 records.

† Percent of total number of days in analyzed interval given in parentheses.

Table 1 gives the mean alongshore (v) component currents using the complete velocity time series. Positive and negative values correspond to up- and down-coast mean flows, respectively. These data are also provided in the summaries in Appendix A. Standard errors are calculated using a conservative estimate of 5 days for the integral time scale to estimate the degrees of freedom. As expected from Figure 3, mean flows are down-coast at the upper two levels and up-coast at near-bottom depths, with larger and smaller means in summer and winter, respectively, compared to annual means. The relative increase and decrease in vertical shears for summer and winter is related to the annual cycle of stratification, where strongly-stratified conditions occur in summer, and mostly unstratified conditions occur during winter. The temperature and stratification cycle on the inner San Pedro shelf reflect oceanographic conditions throughout the larger Southern California Bight (SAIC 2009).

The persistence of up- and down-coast (positive and negative v-components, respectively) events is a useful measure for predicting transport pathways for the discharged effluent. SAIC (2009) analyzed similar patterns for the shelf-break currents at depths of around 39 m (the average depth of the plume after initial mixing) for three, long, continuous, measurement periods. Table 2 presents the duration statistics for 10-m currents at the inshore location for three intervals - 1999-2000, 2007-2008, and 2009-2010 - that lasted a year or longer. The 10-m level was used as the estimate of the expected rise height of the effluent plume at the terminus of the short outfall. At the shelf-break location, there was an approximately 50% likelihood of either up- or down-coast flows at plume depths during La Niña conditions in 1999-2000, and 2007. The average duration of these events in either direction was 5 to 7 days (Table 3-4; SAIC 2009). During 1987-1988, which was a very strong La Niña year compared to the later intervals, however, events were biased 70 to 30% in favor of up-coast flows. These events persisted for an average of about 8 days. By comparison, for the inshore location, down-coast flows were more prevalent by about 6 to 20%, with average durations of about 4 days.

The 1999-2000 interval corresponded to La Niña conditions, whereas the two later intervals were in El Niño conditions, with the 2009-2010 being fairly strong. The difference between the La Niña and El Niño intervals appeared to be that the La Niña currents were not as strong as in the two later intervals, with no alongshore currents greater than 15 cm/s in either direction, compared to between ~ 4 to 6% that exceeded 20 cm/s in the down-coast direction (Table 2). The shorter average durations of persistent flows compared with those on the outer shelf indicate the dominance of shorter period, wind-forced flows on the inner shelf.

Table 2: Duration Analysis of 40-HLP V-component (300°T) Current at 10 m for Inshore Location using ~ 1 to 1.5 year long records

```
    FREQUENCY DISTRIBUTION     DURATION INTERVAL (PERCENT OF TOTAL RECORD)
    6.00 HOURLY DATA          STATION: OC-R-3   40 HRLP             SPANNING  6/21/1999  TO  6/21/2000  ( 8790 HOURS)

     V CPNT                                                                                 NUMBER OF   DURATION(HOURS)
     cm/s                                                                                      EVENTS   AVG   MAX TOTAL
   BELOW  0      51.5  45.0  34.0  22.7  11.1   6.5   3.5   0.0   0.0   0.0   0.0               54    83   306  4524
   BELOW -5.0:   16.0   5.2   2.7   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0               41    34   132  1404
   BELOW-10.0:    0.9   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                4    19    24    78
   BELOW-15.0:    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                0     0     0     0

   0 & ABOVE     48.5  42.0  32.2  13.1   5.3   2.9   0.0   0.0   0.0   0.0   0.0               54    79   252  4266
   ABOVE  5.0:   13.9   7.0   2.9   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0               31    39   138  1218
   ABOVE 10.0:    3.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0               10    28    48   282
   ABOVE 15.0:    0.5   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                4    12    24    48

 DURATION          0     48    96   144   192   240   288   336   384   432   480
 (GREATER THAN
 HOURS)
```

```
    FREQUENCY DISTRIBUTION     DURATION INTERVAL (PERCENT OF TOTAL RECORD)
    6.00 HOURLY DATA          STATION: OC-20A-9 40 HRLP             SPANNING 12/17/2007  TO 12/ 5/2008  ( 8502 HOURS)

     V CPNT                                                                                  NUMBER OF   DURATION(HOURS)
     cm/s                                                                                       EVENTS   AVG   MAX TOTAL
   BELOW  0      62.3  56.3  46.5  43.9  37.8  22.5  16.1   9.2   4.7   0.0   0.0                49   108   396  5298
   BELOW -5.0:   42.9  34.4  28.4  27.1  19.2  11.7   8.6   8.6   0.0   0.0   0.0                40    91   378  3648
   BELOW-10.0:   26.3  19.9  15.3   8.4   2.3   0.0   0.0   0.0   0.0   0.0   0.0                34    65   198  2232
   BELOW-15.0:   13.1  10.1   4.6   2.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                22    50   168  1116
   BELOW-20.0:    5.6   1.9   1.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                17    28   102   480
   BELOW-25.0:    1.9   0.9   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 5    32    78   162
   BELOW-30.0:    0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 2     6     6    12
   BELOW-35.0:    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 0     0     0     0

   0 & ABOVE     37.7  30.1  20.7  13.1  10.9   3.5   3.5   0.0   0.0   0.0   0.0                48    66   300  3204
   ABOVE  5.0:   21.7  14.4   9.7   4.3   0.0   0.0   0.0   0.0   0.0   0.0   0.0                34    54   192  1848
   ABOVE 10.0:   10.4   4.7   1.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                22    40   102   888
   ABOVE 15.0:    2.9   0.9   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 9    27    78   246
   ABOVE 20.0:    0.9   0.8   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 2    39    66    78
   ABOVE 25.0:    0.6   0.6   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 1    54    54    54
   ABOVE 30.0:    0.4   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 1    30    30    30
   ABOVE 35.0:    0.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 1    18    18    18

 DURATION          0     48    96   144   192   240   288   336   384   432   480
 (GREATER THAN
 HOURS)
```

Table 2: Duration Analysis of 40-HLP V-component (300°T) Current at 10 m for Inshore Location using ~ 1 to 1.5 year long records

```
     FREQUENCY DISTRIBUTION     DURATION INTERVAL (PERCENT OF TOTAL RECORD)
     6.00 HOURLY DATA          STATION: OC-20A-9 40 HRLP              SPANNING  1/12/2009  TO  5/ 1/2010  (11382 HOURS)

      V CPNT                                                                                NUMBER OF   DURATION(HOURS)
      cm/s                                                                                     EVENTS   AVG   MAX TOTAL
   BELOW  0      53.4  48.3  40.3  22.5  12.4   4.9   2.7   0.0   0.0   0.0   0.0                65    93   312  6078
   BELOW -5.0:   33.4  25.9  13.5   9.8   4.3   2.5   0.0   0.0   0.0   0.0   0.0                58    65   288  3798
   BELOW-10.0:   18.6  15.3   7.2   3.8   2.4   2.4   0.0   0.0   0.0   0.0   0.0                34    62   270  2112
   BELOW-15.0:   10.0   4.3   3.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                27    42   132  1140
   BELOW-20.0:    3.8   1.4   0.9   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                11    39   102   432
   BELOW-25.0:    1.6   0.6   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 7    26    72   186
   BELOW-30.0:    0.5   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 2    27    48    54
   BELOW-35.0:    0.3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 1    30    30    30

   0 & ABOVE     46.6  41.0  29.3  21.5  10.0  10.0   7.8   0.0   0.0   0.0   0.0                64    82   300  5304
   ABOVE  5.0:   25.6  17.3   8.8   1.6   0.0   0.0   0.0   0.0   0.0   0.0   0.0                55    53   180  2916
   ABOVE 10.0:   13.2   5.7   2.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                39    38   132  1500
   ABOVE 15.0:    4.3   1.2   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                21    23    78   492
   ABOVE 20.0:    1.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 6    19    30   114
   ABOVE 25.0:    0.3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 2    15    24    30
   ABOVE 30.0:    0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0                 0     0     0     0

 DURATION          0    48    96   144   192   240   288   336   384   432   480
 (GREATER THAN
 HOURS)
```

3. INTRA AND INTERANNUAL VARIABILITY

The mean annual cycle for currents at the inshore location is illustrated in Figure 5. The annual cycle was constructed from monthly mean values, which were then averaged across all available years for each month (e.g., all the valid Januarys between 1986 and 2010, etc.). A valid month had at least 25% data coverage. The statistics for the mean annual cycle are given in Table 3, where anomalies are the deviations from the mean (e.g., for a given January, the anomaly is the value of the variable minus the mean for all the Januarys, etc.). The mean temperature cycle reflects weak stratification in January and February. However, the coldest mean temperatures for bottom waters do not occur until May, which is similar to conditions in the lower water column at the shelf break and is the result of the temperature cycle of the offshore waters of the Southern California Bight. Surface waters warm rapidly between May and June and, consequently, the maximum stratification of the lower half of the water column occurs in June. This strong stratification is maintained through the summer until the warming of bottom waters and cooling of the surface layer reduce the top to bottom temperature differences in October and November. This is a slightly different situation from the shelf break location where maximum stratification occurs in August and September, and the lower half of the water column is always stratified (SAIC 2009). Stratification is important for determining the plume rise height from a multi-port outfall. In weakly stratified conditions, the plume would likely rise to the surface at the inshore location, whereas strongly-stratified conditions reduce the potential for the plume to rise to the sea surface.

The annual cycle for currents in the upper half of the water column shows consistent down-coast flows with a maximum in summer (August; Figure 5). Mean bottom currents are generally weak and directed up-coast, and velocities reach a maximum in the fall (October and November) as the surface-layer, down-coast, current velocities decrease. This cycle is similar to that observed at the shelf-break, except for the down-coast surface layer flows not reversing in the fall and winter. Again, these seasonal patterns are a reflection of the shelf-wide circulation in San Pedro Bay.

The time series of monthly anomalies are given in Figure 6. The monthly anomalies for the sea level record for Los Angeles Harbor are also shown because they are a good analogue of the El Niño Southern Oscillation (ENSO) index, where positive and negative anomalies correspond to El Niño (anomalously warm) and La Niña (anomalously cold) conditions in the Southern California Bight (Clarke and Dottori 2008). The sea-level monthly anomalies have been smoothed using the Trenberth (1984) interannual filter. It is evident from the figure that there is some correspondence between the temperature anomalies and the smoothed sea-level anomalies, particularly for the longer time series of bottom temperature data. Thus, the entire water column at the inshore location tends to warm and cool with the ENSO cycles.

Table 3: Monthly Means and Monthly Anomaly Statistics for the Inshore Location (1986-2010)

Station	*Variable/ Depth (m)*	*Variable*	*Jan*	*Feb*	*Mar*	*April*	*May*	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Inshore	Temp	**Mnth-Mean**	**14.07**	**13.74**	**12.71**	**12.23**	**12.25**	**13.23**	**13.34**	**14.06**	**14.30**	**14.52**	**14.59**	**14.40**
	20 m	**# Months**	9	8	8	8	6	8	9	10	11	10	8	7
		Std. Dev.	0.652	0.587	0.905	0.669	0.508	0.454	0.527	1.170	1.271	1.128	0.935	0.775
		Max Anom.	1.005	1.158	1.786	0.923	0.780	0.443	0.872	2.208	1.506	2.495	1.712	1.100
		Min Anom.	-0.752	-0.655	-1.379	-0.980	-0.582	-0.905	-0.885	-2.359	-2.074	-1.511	-1.228	-1.028
Inshore	U-cmpt	**Mnth-Mean**	**-0.40**	**-0.16**	**-0.53**	**-0.30**	**-0.75**	**-0.18**	**-0.65**	**-1.11**	**-0.85**	**-1.03**	**-1.11**	**-0.51**
	5 m	**# Months**	8	7	7	7	6	7	8	8	9	8	6	5
		Std. Dev.	0.714	0.287	0.753	0.636	0.687	0.989	1.328	0.744	0.871	0.748	0.723	0.585
		Max Anom.	1.622	0.496	1.143	1.323	1.231	0.740	1.834	1.618	1.710	1.414	0.993	0.998
		Min Anom.	-1.102	-0.279	-0.972	-0.907	-0.851	-2.317	-1.761	-0.982	-1.192	-0.930	-1.077	-0.808
Inshore	V-cmpt	**Mnth-Mean**	**-1.93**	**-2.83**	**-3.89**	**-6.92**	**-3.69**	**-7.12**	**-8.40**	**-9.53**	**-6.39**	**-2.64**	**-1.35**	**-2.13**
	5 m	**# Months**	8	7	7	7	6	7	8	8	9	8	6	5
		Std. Dev.	2.053	1.914	2.782	4.541	2.150	4.131	7.400	3.987	4.941	2.400	1.648	1.150
		Max Anom.	1.965	2.085	4.443	5.721	3.633	5.842	9.869	7.006	5.308	3.773	2.974	1.308
		Min Anom.	-3.513	-3.933	-4.284	-8.233	-2.846	-5.799	-13.88	-6.207	-10.18	-3.703	-2.147	-1.672
Inshore	U-cmpt	**Mnth-Mean**	**-0.34**	**0.24**	**1.09**	**0.79**	**1.14**	**0.57**	**1.06**	**0.62**	**1.13**	**0.52**	**0.41**	**-0.18**
	10 m	**# Months**	8	7	7	7	6	7	8	8	9	8	6	5
		Std. Dev.	0.525	0.328	0.437	0.537	1.098	0.688	0.516	0.600	0.434	0.621	0.644	0.174
		Max Anom.	0.739	0.670	0.571	1.024	2.032	1.409	0.794	0.702	0.899	1.150	1.107	0.196
		Min Anom.	-0.843	-0.426	-0.704	-0.723	-1.492	-1.014	-0.868	-0.989	-0.706	-0.677	-0.911	-0.213
Inshore	V-cmpt	**Mnth-Mean**	**-1.32**	**-2.27**	**-1.85**	**-4.54**	**-0.60**	**-3.76**	**-3.97**	**-4.90**	**-1.97**	**-0.03**	**0.59**	**-1.04**
	10 m	**# Months**	8	7	7	7	6	7	8	8	9	8	6	5
		Std. Dev.	1.841	1.608	2.900	4.206	1.913	4.374	6.347	3.453	5.102	2.470	2.137	0.949
		Max Anom.	2.539	1.470	4.267	4.756	3.193	5.464	8.547	4.449	5.209	3.430	3.544	0.824
		Min Anom.	-2.880	-3.788	-5.601	-6.792	-2.028	-6.652	-12.32	-6.379	-11.51	-3.512	-2.189	-1.760
Inshore	U-cmpt	**Mnth-Mean**	**-0.25**	**-0.12**	**-0.35**	**-0.26**	**-0.83**	**-1.05**	**-1.08**	**-0.93**	**-0.73**	**-0.65**	**-0.28**	**-1.11**
	20 m	**# Months**	8	8	8	8	7	7	9	9	10	7	6	5
		Std. Dev.	0.635	0.733	0.819	0.563	0.815	0.564	0.822	0.714	0.563	0.389	0.310	1.048
		Max Anom.	1.329	1.451	1.181	0.965	1.331	0.575	1.651	1.886	1.333	0.679	0.576	1.242
		Min Anom.	-0.688	-1.372	-1.874	-0.736	-1.267	-1.282	-1.103	-0.662	-0.693	-0.535	-0.300	-1.524
Inshore	V-cmpt	**Mnth-Mean**	**0.31**	**0.02**	**0.63**	**-0.16**	**0.97**	**0.82**	**0.74**	**0.91**	**2.04**	**2.30**	**2.16**	**0.79**
	20 m	**# Months**	8	8	8	8	7	7	9	9	10	7	6	5
		Std. Dev.	1.824	1.218	1.792	2.136	1.786	1.738	1.967	1.474	2.655	1.175	1.125	1.732
		Max Anom.	2.728	2.034	2.316	3.144	1.631	2.123	3.026	2.008	2.966	2.263	2.152	3.260
		Min Anom.	-3.627	-2.041	-4.179	-4.139	-3.986	-3.197	-4.088	-2.099	-6.380	-1.444	-1.300	-1.625

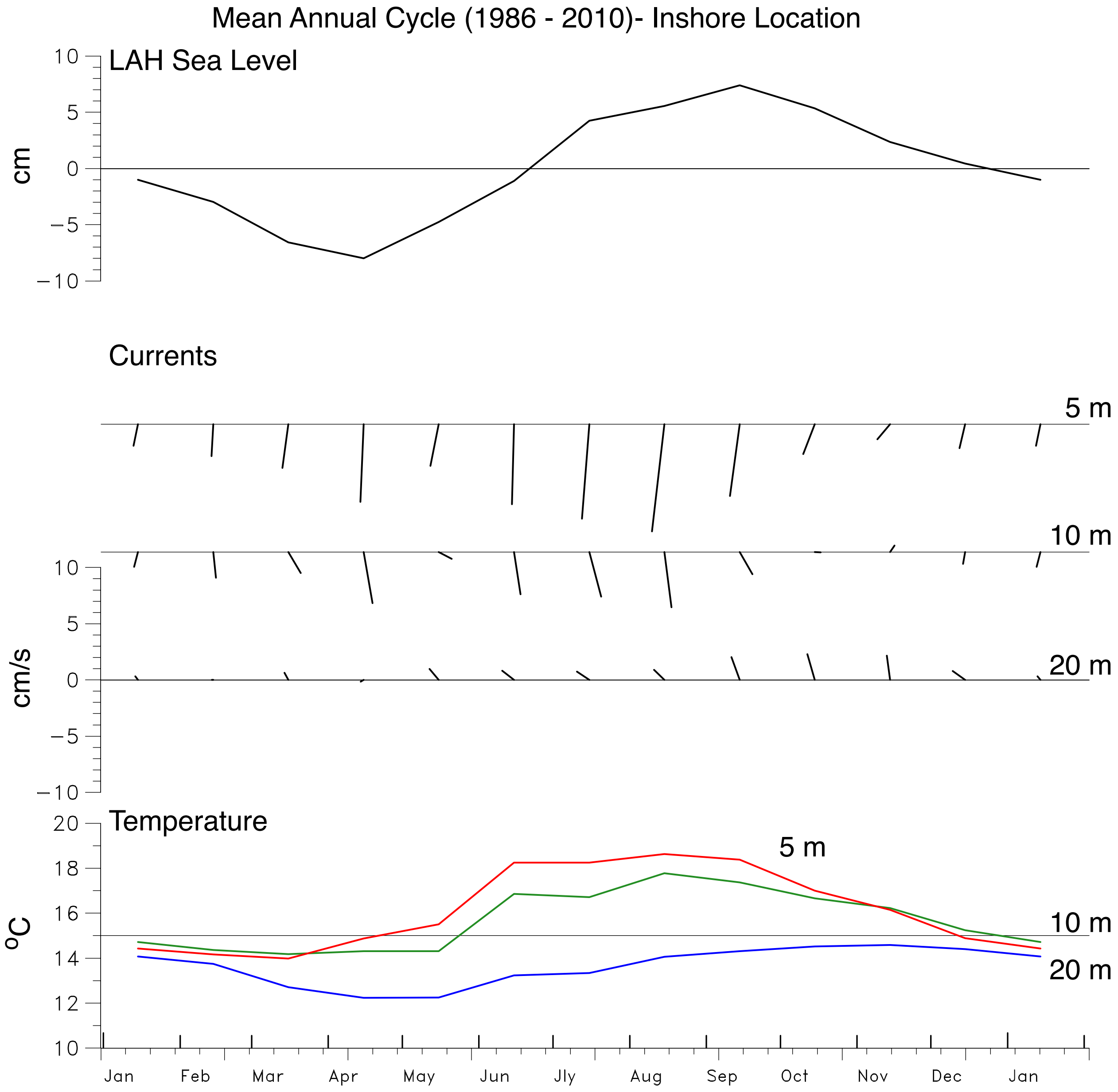


Figure 5. Average of all available monthly values of temperature and velocities, for the inshore location at the indicated depths, for 1986 to 2010. Nominal measurement depths are given on the RHS of the plots. For the velocity records, positive is directed upcoast at 300°T. The mean annual cycle for sea level at Los Angeles harbor (LAH) is relative to the overall 1986 to 2010 mean sea-level.

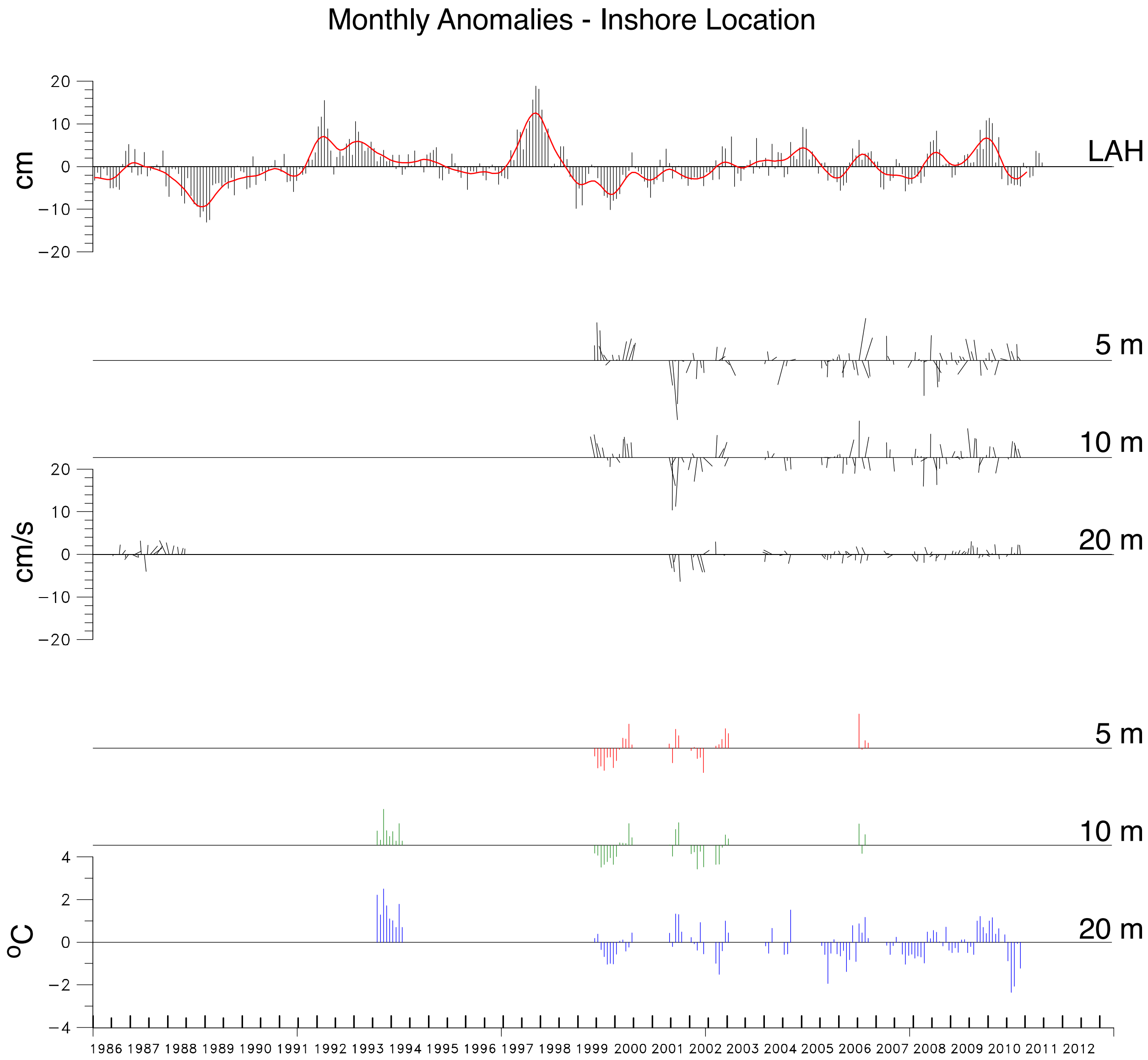


Figure 6. Monthly anomalies from the mean annual cycle for the indicated temperature and velocity records at the inshore location for all available observations between 1986 and 2011. For the velocity records, positive is directed upcoast at 300°T. The Los Angeles harbor (LAH) sea level anomalies are given in the top panel, where the red line is the anomalies smoothed by the Trenberth (1984) interannual filter.

Figure 7 shows an expanded view of the 1999 to 2010 anomalies where data coverage is most dense. As noted in SAIC (2009), there is little direct relation between the current patterns and sea level anomalies (Clarke and Dottori 2008); however, the anomalies are similar throughout the water column, although the anomalies for the 20-m level have comparatively lower magnitudes. Note that a positive anomaly does not necessarily mean up-coast flows, as that will only happen if the magnitudes exceed the down-coast means (see also Table 3). For example, positive anomalies occurred during the strong 1999-2000 La Niña period, but also for the 2009-2010 El Niño period. At present, the physical causes of the inter- and intra-annual flow variability on the San Pedro shelf are not understood.

4. INTERNAL TIDES

The largest cross-shelf velocity components result from semi-diurnal, internal tides, in which flows in the upper part of the water column are in the opposite direction to the near-bottom flows, with periodicities of ~ 12.5 hours. These on- and off-shore excursions may bring effluent close to shore under certain circumstances. Local current patterns also experience one-day period fluctuations, driven by the sea breeze, that are important in the upper part of the water column at the shelf break, but have only small cross-shelf components on the inner shelf (SAIC 2009). The semi-diurnal, internal tide produces a sloshing of the interface between the upper and lower parts of the water column such that cold water can be transported into the near-shore region, while warm, upper-layer water can move seaward along the bottom. Internal tidal on- and off-shore motions require a stratified water column. Therefore, large excursions on the inner portion of the shelf are more likely to occur in summer. Onshore-offshore velocity amplitudes can exceed 10 cm/s on occasions, which would produce a water parcel excursion of ~ 3 km over the 12.5 hour semi-diurnal tidal period. There is no direct relationship between the amplitude of the semi-diurnal internal tide and amplitude of the surface tide (Noble and Xu 2004; SAIC 2009). Thus, the spring-neap cycle of the surface tide is not directly related to the strength of the onshore-offshore excursions of the currents and temperature surfaces in the water column. The reasons for the internal tide amplitude variability that is distinct from the deterministic forcing of the astronomical surface tide are unknown at this time.

The complex demodulation method of extracting the amplitude and phase of the across-shelf u-component of the current at a given periodicity was given in SAIC (2009). For the inshore location, data records from two, long, continuous, intervals during 2007-2008 and 2009-2010 were available so that the annual variability of the internal tide can be examined. Figures 8 and 9 show the amplitudes of the near-surface and near-bottom velocities at the M_2 period, as well as the phase differences between the near-surface and near-bottom levels. If the phase differences are approximately ±180°, then the upper and lower across-shelf velocity fluctuations are in opposition. If the phase differences are

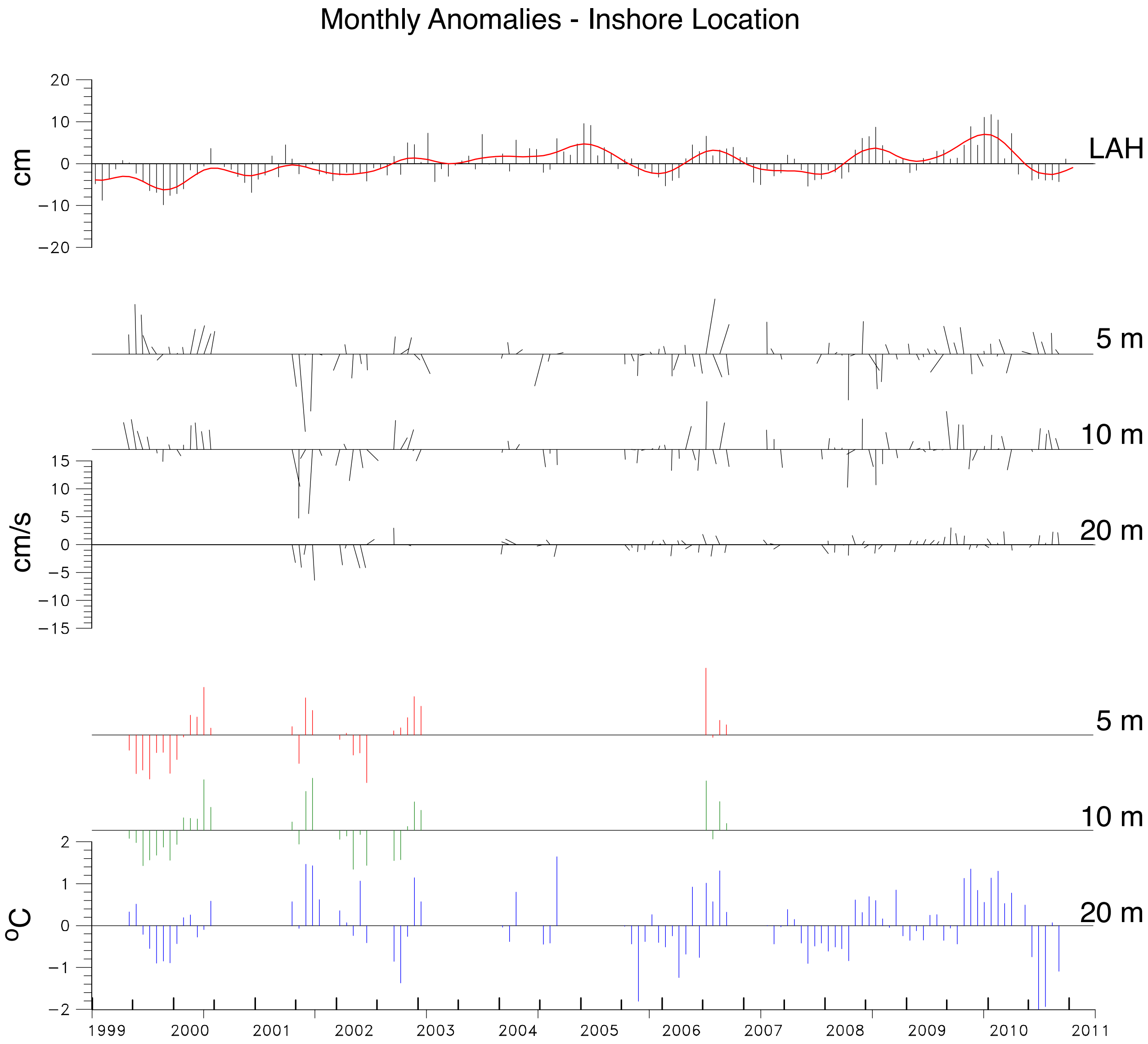


Figure 7. Monthly anomalies from the mean annual cycle for the indicated temperature and velocity records at the inshore location for all available observations between 1999 and 2011. For the velocity records, positive is directed upcoast at 300°T. The Los Angeles harbor (LAH) sea level anomalies are given in the top panel, where the red line is the anomalies smoothed by the Trenberth (1984) interannual filter.

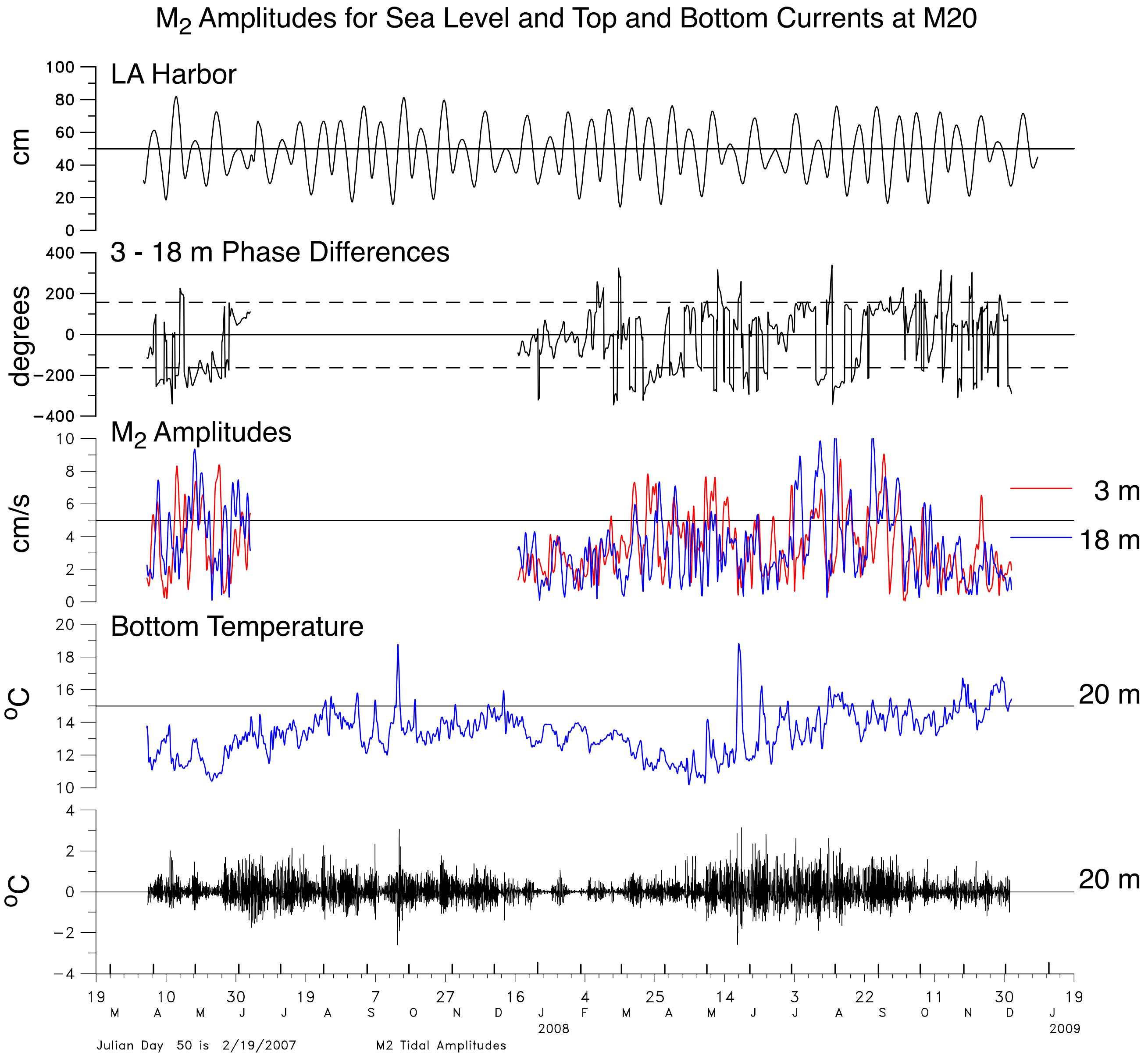


Figure 8. Tidal time series from the inshore location for 2007 and 2008. From the top the panels are M_2 Amplitudes for sea level, top - bottom phase differences for M_2 across-shelf (u) component current velocities, M_2 across-shelf velocity component amplitudes, 40-HLP bottom temperature, and 40-HHP bottom temperature.

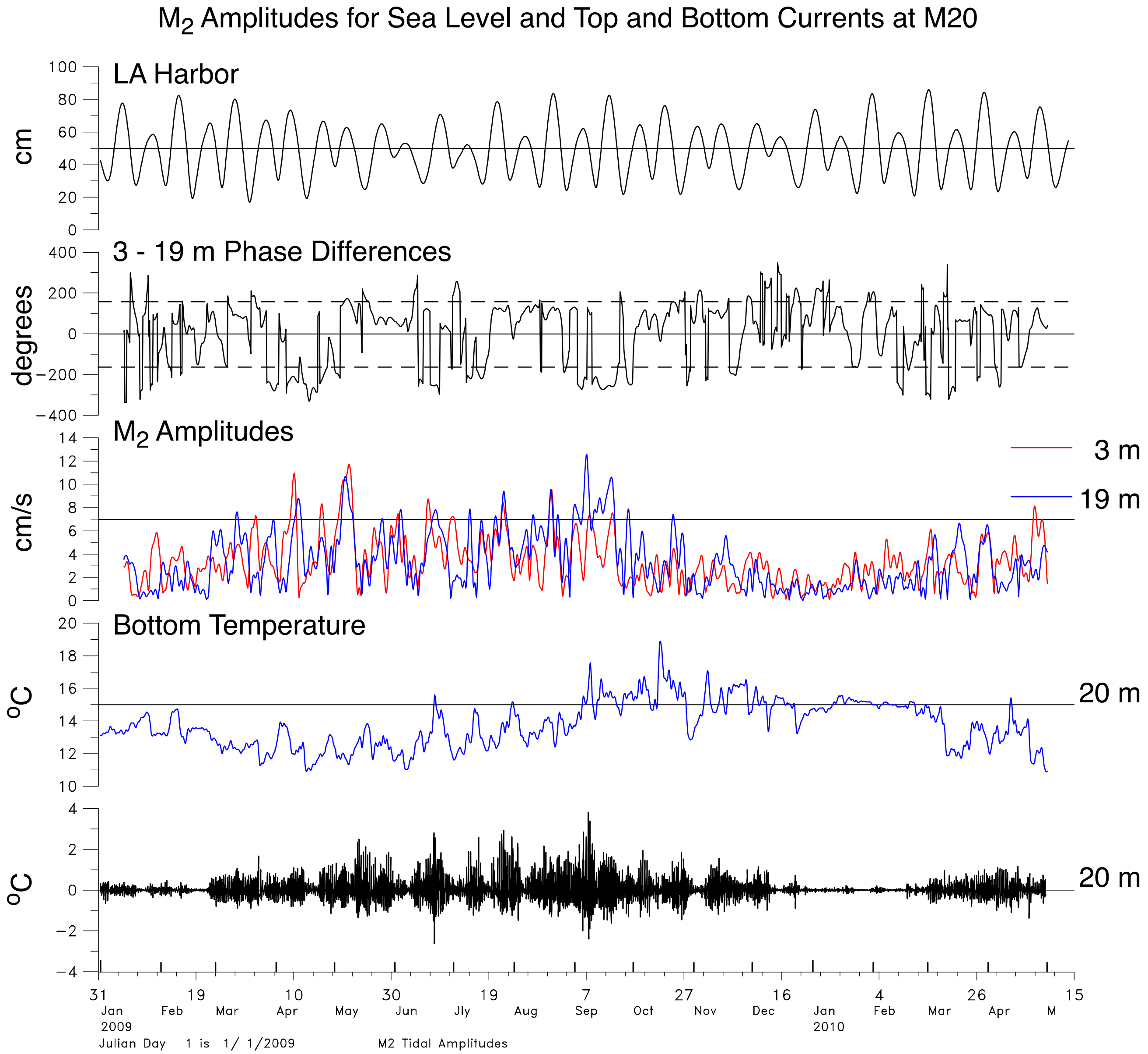


Figure 9. Tidal time series from the inshore location for 2009 and 2010. From the top the panels are M$_2$ Amplitudes for sea level, top - bottom phase differences for M$_2$ across-shelf (u) component current velocities, M$_2$ across-shelf velocity component amplitudes, 40-HLP bottom temperature, and 40-HHP bottom temperature.

closer to 0 or ±360°, then the fluctuations are in phase and internal tides are either not present or weak. If the out-of-phase motions occur with large amplitudes then a strong internal tide is present. It is apparent from Figures 8 and 9 that when velocity amplitudes are large, they are usually out of phase and, quite often, the near-bottom current amplitudes exceed those for the near-surface. It is also apparent that during summer, when the velocity amplitudes are energetic and strong stratification conditions support the occurrence of internal tides, there is little correspondence with the regular fortnightly spring-neap cycle of the surface tide, as represented by sea-level at the Los Angeles Harbor gauge.

The bottom two panels of Figures 8 and 9 show the subtidal 40-HLP and high pass (40-HHP) filtered versions of the bottom water temperature. Combined, they represent the total variability of the bottom layer temperature signal at ADCP mooring 20. The 40-HHP record shows the fluctuations in the 20 m temperatures caused by tidal period, resulting primarily from across-shelf velocity fluctuations, which practically disappear in January and February when stratification is weak or non-existent (see Figure 6). In January and February 2008, tidal temperature fluctuations are very small, but cross-shelf velocity amplitudes are about 2-4 cm/s; however, the top to bottom phase difference is around 0°, indicating no internal tide activity. Here the velocity fluctuations can be largely attributed to being forced by the surface tide. Subtidal events of high temperatures, lasting a few days to a week, are often accompanied by large amplitude, tidal period, bottom layer, temperature fluctuations in the summer stratified seasons. Examples include September 2007, May-June 2008 (Figure 8), and summer (June-October) 2009 (Figure 9). Some of these events occurred when there were large internal tidal currents (June –September 2009), but some did not (May 2008). Bottom waters with temperatures below ~ 14 °C, present during the summer, likely originated farther offshore and below the thermocline, whereas waters with temperatures above ~ 16 °C likely originated in the nearshore region or above the thermocline. A possible explanation for these patterns is the large amplitude, across-shelf sloshing of the upper and lower layers that transports warm, surface water shoreward and near-shore water towards the bottom at the 20-m isobath. This process would result in weak stratification of the water column for short periods because the internal tide would be accompanied by large onshore-offshore tidal excursions of the surface and bottom water parcels.

5. SUMMARY

This report presents the results of statistical analyses of the current and temperature data collected by the District at the inshore location, corresponding to the 20-m isobath on the San Pedro shelf. These analyses extend the time series to 2010 beyond the previous study's limit of 2008 (SAIC 2009) for this location. The overall annual mean velocities are directed down-coast in the upper water column with weak, up-coast, near-bottom flows. This mean profile is maintained but strengthened and weakened in the summer and winter seasons.

Subtidal event durations tend to be shorter inshore when compared with the shelf break, with an average time-scale of about 4 days. This is more consistent with local, wind-forced circulation than the remotely-forced, longer-period fluctuations observed at the shelf break (Hamilton et al. 2006).

The mean seasonal cycles and monthly anomalies were recalculated for the extended data series. The water column temperature anomalies are closely connected to the ENSO events that are the cause of major interannual climate variability in the Southern California Bight. Current anomalies could not be related directly to the ENSO events, and at present have no good explanation. However, some patterns of flow seem to establish themselves over 1 to 2 year intervals. Thus, there were higher probabilities of up-coast events in 1999-2000 and 2009-2010, whereas down-coast anomalies were large in 2001 and 2002.

Tidal period fluctuations were also analyzed for two of the longer ~ 1 to 1.5 year continuous records for the M20 site between 2007 and 2010. Results indicate that, even on the inner shelf, onshore-offshore excursions of water parcels are dominated by the semi-diurnal, internal tide, which is strongest in the stratified summer season and almost non-existent in the weakly stratified winter. As previously discussed for the outer shelf in Noble and Xu (2004) and SAIC (2004), there is no direct relation with the fortnightly spring-neap cycles of the surface astronomical tide. Onshore-offshore velocity amplitudes can exceed 10 cm/s on occasions, which would produce a water parcel excursion of ~ 3 km over the 12.5 hour semi-diurnal tidal period.

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APPENDIX A SPEED AND DIRECTION STATISTICS TABLES

Table

A-1 Histograms for the Inshore Location at 5 m – Annual Analysis
A-2 Histograms for the Inshore Location at 5 m – Summer Analysis
A-3 Histograms for the Inshore Location at 5 m – Winter Analysis
A-4 Histograms for the Inshore Location at 10 m – Annual Analysis
A-5 Histograms for the Inshore Location at 10 m – Summer Analysis
A-6 Histograms for the Inshore Location at 10 m – Winter Analysis
A-7 Histograms for the Inshore Location at 20 m – Annual Analysis
A-8 Histograms for the Inshore Location at 20 m – Summer Analysis
A-9 Histograms for the Inshore Location at 20 m – Winter Analysis
A-10 Histograms for the Inshore Location at 20 m – Extended Annual Analysis
A-11 Histograms for the Inshore Location at 20 m – Extended Summer Analysis
A-12 Histograms for the Inshore Location at 20 m – Extended Winter Analysis

Table A-1: Histograms of Current Speed and Direction for the Inshore Location at 5 m – Annual Analysis

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FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA  INSHORE 5-m  SPANNING  7/ 1  TO  6/30 YEARS: 1999 - 2011  9416 DATA POINTS - 56.6 PERCENT OF TOTAL

DIRECTION TOWARDS†                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                              SPEED   SPEED  SPEED

  0- 30     3.6  4.1  2.1  1.1  0.6  0.1  0.0  0.0  0.0  0.0                11.5       8.67    0.10   37.98       6.17
 30- 60     2.3  0.6  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 3.0       3.75    0.20   11.94       2.72
 60- 90     1.4  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 1.6       2.74    0.05    9.35       2.15
 90-120     1.8  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 2.0       2.70    0.47   13.51       2.16
120-150     2.1  0.8  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 3.0       4.03    0.05   12.63       2.88
150-180     4.7  6.0  3.5  2.2  1.4  0.7  0.3  0.1  0.0  0.0                19.0      11.00    0.03   42.64       7.78
180-210     5.4  8.5  7.2  5.5  4.1  2.1  0.9  0.4  0.1  0.0                34.1      13.56    0.10   44.77       8.50
210-240     3.9  2.3  0.5  0.1  0.0  0.0  0.0  0.0  0.0  0.0                 6.8       5.10    0.02   22.78       3.81
240-270     2.3  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 2.7       3.13    0.03    8.78       2.05
270-300     1.9  0.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 2.2       2.95    0.21   11.32       2.24
300-330     2.4  0.9  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 3.3       3.84    0.10   18.33       2.94
330-360     3.6  3.8  2.1  0.6  0.3  0.1  0.0  0.1  0.0  0.0                10.7       8.31    0.01   40.41       6.27

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    35.4 27.9 15.8  9.5  6.4  3.1  1.3  0.6  0.2  0.0              100.00
CUM PRCT  100.0 64.6 36.8 21.0 11.5  5.2  2.1  0.8  0.2  0.0
MEAN DIR    185  184  185  176  176  187  189  194  189    0
STD DEV     100   96   89   76   69   56   46   67   69    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   9.56 cm/s MAXIMUM =  44.77 cm/s   MINIMUM =   0.01 cm/s  RANGE =  44.76 cm/s
                         STANDARD DEVIATION = 7.71 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.67 cm/s           STANDARD DEVIATION =  2.63 cm/s
MEAN Y COMPONENT =  -4.91 cm/s           STANDARD DEVIATION = 10.92 cm/s
```

†Direction bins are relative to 300°T

Table A-2: Histograms of Current Speed and Direction for the Inshore Location at 5 m – Summer Analysis

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FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA   INSHORE 5-m   SPANNING  6/ 1  TO 10/31 YEARS: 1999 - 2010  4284 DATA POINTS - 59.0 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                          PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                                SPEED   SPEED  SPEED

  0- 30     2.9  3.2  1.8  1.3  0.8  0.2  0.0  0.0  0.0  0.0                 10.1      9.80    0.29   28.80      6.61
 30- 60     1.6  0.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.2      3.92    0.66   11.59      2.60
 60- 90     1.1  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.2      2.81    0.05    6.67      1.52
 90-120     1.8  0.2  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.0      3.06    0.19   13.51      2.53
120-150     1.7  1.0  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.8      4.68    0.05   11.88      2.66
150-180     3.4  5.0  4.1  3.0  2.2  1.3  0.7  0.3  0.1  0.0                 20.2     13.74    0.37   42.64      8.75
180-210     3.8  6.8  7.6  7.1  5.9  3.2  1.5  0.8  0.2  0.0                 36.9     15.96    0.71   42.32      8.79
210-240     3.4  2.5  0.6  0.1  0.1  0.0  0.0  0.0  0.0  0.0                  6.7      5.70    0.02   22.78      4.27
240-270     2.4  0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.9      3.47    0.11    8.78      1.72
270-300     2.0  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.4      3.32    0.21   11.32      2.33
300-330     2.0  0.9  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.0      4.05    0.23   11.86      2.54
330-360     2.5  3.5  2.1  0.8  0.4  0.3  0.0  0.0  0.0  0.0                  9.7      9.22    0.05   29.65      6.27

 SPEED        0    5   10   15   20   25   30   35   40   43
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   43   43

PERCENT    28.7 24.5 16.4 12.4  9.5  5.0  2.3  1.1  0.3  0.0                100.00
CUM PRCT  100.0 71.3 46.8 30.5 18.1  8.6  3.6  1.4  0.3  0.0
MEAN DIR    188  191  187  178  177  186  183  181  177    0
STD DEV      99   95   83   73   66   58   33   46   58    0
                                                   SUMMARY STATISTICS

MEAN SPEED =  11.54 cm/s MAXIMUM =  42.64 cm/s   MINIMUM =   0.02 cm/s   RANGE =  42.62 cm/s
                         STANDARD DEVIATION =   8.63 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.85 cm/s           STANDARD DEVIATION =  2.94 cm/s
MEAN Y COMPONENT =  -6.89 cm/s           STANDARD DEVIATION = 12.28 cm/s
```

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†Direction bins are relative to 300°T

Table A-3: Histograms of Current Speed and Direction for the Inshore Location at 5 m – Winter Analysis

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FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA  INSHORE 5-m SPANNING 12/ 1  TO  3/31 YEARS: 1999 - 2010  3062 DATA POINTS -  57.4 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                              SPEED   SPEED  SPEED

  0- 30     3.9  5.0  2.7  0.8  0.3  0.0  0.0  0.0  0.0  0.0                 12.7      7.85    0.20   37.98      5.51
 30- 60     2.9  0.9  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  4.1      4.02    0.20   11.94      3.16
 60- 90     1.9  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.4      3.07    0.38    9.35      2.44
 90-120     1.7  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.8      2.25    0.67    6.39      1.75
120-150     2.6  0.5  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.2      3.43    0.29   12.63      2.68
150-180     6.2  7.2  2.5  1.2  0.5  0.0  0.0  0.0  0.0  0.0                 17.6      7.66    0.03   25.31      5.00
180-210     7.6 12.6  7.3  3.3  1.4  0.7  0.3  0.0  0.0  0.0                 33.2      9.62    0.16   33.92      6.38
210-240     4.6  1.6  0.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.5      3.90    0.21   13.43      3.05
240-270     2.1  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.2      2.42    0.03    6.04      1.85
270-300     2.0  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.1      2.35    0.27    8.35      1.97
300-330     2.5  0.5  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.2      3.32    0.10   18.33      3.49
330-360     4.3  3.7  2.3  0.5  0.2  0.0  0.0  0.0  0.0  0.0                 11.0      7.42    0.01   40.41      5.73

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    42.5 32.8 15.4  5.8  2.4  0.8  0.3  0.1  0.0  0.0                100.00
CUM PRCT  100.0 57.5 24.8  9.3  3.5  1.1  0.4  0.1  0.0  0.0
MEAN DIR    184  174  179  176  180  192  194  177  358    0
STD DEV      97   93   99   84   77   51   24  238    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   7.21 cm/s MAXIMUM =  40.41 cm/s   MINIMUM =   0.01 cm/s   RANGE =  40.40 cm/s
                         STANDARD DEVIATION =   5.56 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.41 cm/s           STANDARD DEVIATION =  2.25 cm/s
MEAN Y COMPONENT =  -2.72 cm/s           STANDARD DEVIATION =  8.38 cm/s
```

†Direction bins are relative to 300°T

Table A-4: Histograms of Current Speed and Direction for the Inshore Location at 10 m – Annual Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA  INSHORE 10-m  SPANNING  7/ 1  TO  6/30 YEARS: 1999 - 2011      9416 DATA POINTS -  56.6 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                              SPEED   SPEED  SPEED

  0- 30     6.4  8.3  4.3  1.4  0.2  0.0  0.0  0.0  0.0  0.0                 20.6      7.79    0.11   31.73      4.82
 30- 60     4.7  1.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.0      3.68    0.15   13.19      2.08
 60- 90     3.0  0.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.3      2.72    0.32    7.42      1.71
 90-120     3.1  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.5      2.89    0.14    8.22      1.91
120-150     3.7  1.4  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  5.3      4.16    0.23   17.79      2.78
150-180     6.3  8.5  4.8  2.6  1.1  0.6  0.1  0.0  0.0  0.0                 23.9      9.56    0.17   31.99      6.40
180-210     5.7  6.4  3.6  3.2  1.9  0.9  0.3  0.1  0.0  0.0                 22.0     10.97    0.12   39.92      7.80
210-240     1.7  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.9      2.90    0.15   14.36      2.53
240-270     1.2  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.2      1.89    0.11    7.33      2.21
270-300     0.9  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.0      1.91    0.06   10.59      2.33
300-330     1.3  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.4      2.64    0.17   10.90      2.86
330-360     3.1  3.1  2.3  0.9  0.3  0.1  0.0  0.0  0.0  0.0                  9.8      8.74    0.48   36.38      6.00

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    41.1 30.0 15.2  8.2  3.5  1.6  0.4  0.1  0.0  0.0                100.00
CUM PRCT  100.0 58.9 28.9 13.7  5.6  2.1  0.5  0.1  0.0  0.0
MEAN DIR    144  142  156  171  186  186  187  221    0    0
STD DEV      99  101  108   90   68   52   62   83    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   7.93 cm/s MAXIMUM =  39.92 cm/s   MINIMUM =   0.06 cm/s   RANGE =  39.87 cm/s
                         STANDARD DEVIATION =   6.24 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =   0.59 cm/s           STANDARD DEVIATION =  1.98 cm/s
MEAN Y COMPONENT =  -2.24 cm/s           STANDARD DEVIATION =  9.62 cm/s
```

†Direction bins are relative to 300°T

Table A-5: Histograms of Current Speed and Direction for the Inshore Location at 10 m – Summer Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA  INSHORE 10-m SPANNING  6/ 1  TO 10/31 YEARS: 1999 - 2010  4284 DATA POINTS -  59.0 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                              SPEED   SPEED  SPEED

  0- 30     6.2  8.1  5.0  2.2  0.3  0.0  0.0  0.0  0.0  0.0                 21.9      8.43    0.11   25.10      5.18
 30- 60     4.7  1.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.4      3.92    0.15   13.19      2.20
 60- 90     3.1  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.5      2.94    0.35    7.42      1.83
 90-120     2.8  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.2      2.94    0.29    8.22      1.95
120-150     3.8  1.8  0.2  0.1  0.0  0.0  0.0  0.0  0.0  0.0                  5.9      4.61    0.31   17.79      3.02
150-180     4.5  8.1  5.6  3.3  1.8  1.3  0.2  0.0  0.0  0.0                 24.8     11.29    0.27   31.99      7.19
180-210     4.4  4.7  3.5  4.0  2.8  1.4  0.5  0.1  0.0  0.0                 21.4     13.20    0.33   37.17      8.38
210-240     1.2  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.3      2.64    0.15   14.36      2.53
240-270     0.7  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  0.7      1.88    0.11    7.33      2.48
270-300     0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  0.5      2.13    0.06   10.59      3.37
300-330     1.0  0.2  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.2      3.15    0.17   10.90      3.55
330-360     2.5  2.5  2.6  1.3  0.3  0.0  0.0  0.0  0.0  0.0                  9.2      9.47    0.48   25.93      5.72

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    35.2 28.1 17.1 10.9  5.1  2.7  0.7  0.1  0.0  0.0                100.00
CUM PRCT  100.0 64.8 36.7 19.6  8.7  3.5  0.8  0.1  0.0  0.0
MEAN DIR    133  133  155  165  180  180  183  184    0    0
STD DEV      97  100  110   95   65   34   37   70    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   9.16 cm/s MAXIMUM =  37.17 cm/s   MINIMUM =   0.06 cm/s   RANGE =  37.12 cm/s
                         STANDARD DEVIATION =   6.94 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =   0.77 cm/s           STANDARD DEVIATION =  2.11 cm/s
MEAN Y COMPONENT =  -2.89 cm/s           STANDARD DEVIATION = 10.89 cm/s
```

†Direction bins are relative to 300°T

Table A-6: Histograms of Current Speed and Direction for the Inshore Location at 10 m – Winter Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA   INSHORE 10-m  SPANNING 12/ 1  TO  3/31 YEARS: 1999 - 2010  3062 DATA POINTS -  57.4 PERCENT OF TOTAL

DIRECTION TOWARDS†                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                SPEED   SPEED  SPEED

  0- 30     6.1  7.4  3.3  0.3  0.1  0.0  0.0  0.0  0.0  0.0                 17.1      6.81    0.47   24.06      4.09
 30- 60     4.8  0.9  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  5.8      3.47    0.33   11.18      2.02
 60- 90     2.6  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.8      2.49    0.33    6.96      2.03
 90-120     3.4  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.8      2.64    0.23    6.57      2.13
120-150     3.8  0.9  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  4.7      3.47    0.23   10.17      2.24
150-180     8.6  9.6  2.7  1.2  0.1  0.0  0.0  0.0  0.0  0.0                 22.2      6.82    0.17   21.38      4.23
180-210     8.3 10.1  3.9  2.3  1.0  0.2  0.0  0.0  0.0  0.0                 25.7      8.20    0.20   27.14      5.66
210-240     2.5  0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.0      3.24    0.55   10.95      2.34
240-270     1.7  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.8      1.71    0.23    6.01      2.08
270-300     1.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.2      1.76    0.50    2.98      1.80
300-330     1.6  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.7      2.12    0.29    5.89      2.37
330-360     3.6  3.2  2.3  0.7  0.2  0.1  0.0  0.0  0.0  0.0                 10.1      8.18    0.53   30.52      5.57

 SPEED         0    5   10   15   20   25   30   35   40   45
 cm/s          !    !    !    !    !    !    !    !    !    !
               5   10   15   20   25   30   35   40   45   45

PERCENT    48.1 33.4 12.3  4.4  1.3  0.3  0.0  0.0  0.0  0.0                  100.00
CUM PRCT  100.0 51.9 18.4  6.1  1.6  0.3  0.0  0.0  0.0  0.0
MEAN DIR    156  154  168  200  201  249  347    0    0    0
STD DEV      96   94  112   77   84   87    0    0    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   6.34 cm/s MAXIMUM =  30.52 cm/s   MINIMUM =   0.17 cm/s   RANGE =  30.35 cm/s
                         STANDARD DEVIATION =   4.65 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =   0.27 cm/s           STANDARD DEVIATION =  1.85 cm/s
MEAN Y COMPONENT =  -1.63 cm/s           STANDARD DEVIATION =  7.46 cm/s
```

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†Direction bins are relative to 300°T

Table A-7: Histograms of Current Speed and Direction for the Inshore Location at 20 m – Annual Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA  INSHORE 20-m   SPANNING  7/ 1  TO  6/30 YEARS: 2001 - 2011   7698 DATA POINTS -  56.1 PERCENT OF TOTAL

DIRECTION TOWARDS†                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                SPEED   SPEED  SPEED

  0- 30     6.9  2.4  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  9.6      4.03    0.23   13.63      2.87
 30- 60     2.9  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.1      2.35    0.15    7.55      2.02
 60- 90     1.8  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.8      2.02    0.07    6.43      1.91
 90-120     2.2  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.4      2.40    0.13    9.93      2.32
120-150     3.2  0.5  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.8      3.17    0.06   14.67      2.44
150-180     5.7  4.0  0.9  0.1  0.0  0.0  0.0  0.0  0.0  0.0                 10.7      5.44    0.10   25.04      3.69
180-210     6.9  4.2  1.1  0.1  0.1  0.0  0.0  0.0  0.0  0.0                 12.5      5.39    0.28   26.43      4.00
210-240     5.7  0.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.2      2.89    0.16    8.52      1.63
240-270     4.9  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  5.0      2.26    0.12    6.07      1.53
270-300     5.7  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  5.8      2.40    0.20    6.54      1.30
300-330     9.9  1.7  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 11.6      3.36    0.12   12.26      1.58
330-360    14.1 11.6  1.5  0.2  0.1  0.0  0.0  0.0  0.0  0.0                 27.5      5.35    0.06   27.72      3.39

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    69.6 25.7  4.0  0.5  0.2  0.1  0.0  0.0  0.0  0.0                100.00
CUM PRCT  100.0 30.4  4.7  0.7  0.3  0.1  0.0  0.0  0.0  0.0
MEAN DIR    221  247  231  250  241  266    0    0    0    0
STD DEV     109  108  102   80   89   86    0    0    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   4.22 cm/s MAXIMUM =  27.72 cm/s   MINIMUM =   0.06 cm/s   RANGE =  27.66 cm/s
                         STANDARD DEVIATION =   2.98 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.71 cm/s           STANDARD DEVIATION =  1.74 cm/s
MEAN Y COMPONENT =   0.71 cm/s           STANDARD DEVIATION =  4.76 cm/s
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†Direction bins are relative to 300°T

Table A-8: Histograms of Current Speed and Direction for the Inshore Location at 20 m – Summer Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA   INSHORE 20-m  SPANNING  6/ 1  TO 10/31 YEARS: 2001 - 2010  3671 DATA POINTS -  60.7 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                              SPEED   SPEED  SPEED

  0- 30     6.6  2.8  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  9.6      4.18    0.23   13.61      2.68
 30- 60     1.9  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.0      1.99    0.15    6.96      2.38
 60- 90     1.3  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.4      2.00    0.07    5.17      2.08
 90-120     1.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  1.3      1.57    0.21    3.37      1.97
120-150     2.3  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.4      2.17    0.12    5.34      1.65
150-180     3.9  1.8  0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.3      4.72    0.10   21.01      3.69
180-210     7.1  5.2  1.6  0.2  0.1  0.0  0.0  0.0  0.0  0.0                 14.3      5.86    0.35   23.29      4.06
210-240     6.4  0.8  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  7.3      3.04    0.22    8.11      1.68
240-270     5.6  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  5.8      2.42    0.18    6.07      1.44
270-300     6.0  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.2      2.48    0.20    5.89      1.28
300-330    10.3  1.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 11.9      3.26    0.12   10.65      1.68
330-360    16.0 13.7  1.5  0.1  0.1  0.0  0.0  0.0  0.0  0.0                 31.5      5.27    0.26   21.87      3.08

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    68.9 26.7  3.9  0.4  0.2  0.0  0.0  0.0  0.0  0.0                100.00
CUM PRCT  100.0 31.1  4.5  0.6  0.2  0.0  0.0  0.0  0.0  0.0
MEAN DIR    235  260  241  238  224    0    0    0    0    0
STD DEV     106  108   92   77   87    0    0    0    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   4.24 cm/s MAXIMUM =  23.29 cm/s   MINIMUM =   0.07 cm/s  RANGE =  23.22 cm/s
                         STANDARD DEVIATION =   2.89 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -1.03 cm/s           STANDARD DEVIATION =  1.49 cm/s
MEAN Y COMPONENT =   1.03 cm/s           STANDARD DEVIATION =  4.69 cm/s
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†Direction bins are relative to 300°T

Table A-9: Histograms of Current Speed and Direction for the Inshore Location at 20 m – Winter Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA  INSHORE 20-m  SPANNING 12/ 1  TO  3/31 YEARS: 2001 - 2010   2384 DATA POINTS -  54.6 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                              SPEED   SPEED  SPEED

  0- 30     6.8  1.4  0.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  8.5      3.43    0.30   13.63      2.79
 30- 60     3.9  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  4.0      2.24    0.35    7.55      1.83
 60- 90     2.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.2      1.93    0.32    5.67      1.88
 90-120     3.4  0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.9      2.59    0.13    8.31      2.55
120-150     4.9  1.0  0.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.1      3.65    0.40   14.67      2.84
150-180     7.7  5.8  1.1  0.1  0.0  0.0  0.0  0.0  0.0  0.0                 14.7      5.34    0.23   16.05      3.29
180-210     7.4  3.8  0.7  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 11.9      4.61    0.35   14.23      3.07
210-240     5.8  0.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  6.4      2.92    0.21    7.73      1.53
240-270     4.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  4.1      1.90    0.12    4.44      1.63
270-300     5.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  5.2      2.22    0.45    5.84      1.31
300-330     8.9  1.8  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                 10.7      3.49    0.32   12.26      1.76
330-360    12.0  8.7  1.3  0.3  0.0  0.0  0.0  0.0  0.0  0.0                 22.2      5.23    0.06   16.58      3.39

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    72.1 23.8  3.7  0.4  0.0  0.0  0.0  0.0  0.0  0.0                100.00
CUM PRCT  100.0 27.9  4.1  0.4  0.0  0.0  0.0  0.0  0.0  0.0
MEAN DIR    207  236  219  312    0    0    0    0    0    0
STD DEV     108  101  102   59    0    0    0    0    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   4.00 cm/s MAXIMUM =  16.58 cm/s   MINIMUM =   0.06 cm/s   RANGE =  16.51 cm/s
                         STANDARD DEVIATION =   2.77 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.40 cm/s           STANDARD DEVIATION =  1.91 cm/s
MEAN Y COMPONENT =   0.15 cm/s           STANDARD DEVIATION =  4.46 cm/s
```

†Direction bins are relative to 300°T

Table A-10: Histograms of Current Speed and Direction for the Inshore Location at 20 m – Extended Annual Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA   INSHORE 20-m   SPANNING  7/ 1  TO  6/30 YEARS: 1986 - 2011  10299 DATA POINTS -  28.9 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                            PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                                  SPEED   SPEED  SPEED

  0- 30     7.4  2.6  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     10.4      4.10    0.23   18.43      2.82
 30- 60     3.0  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                      3.2      2.43    0.15   10.85      2.04
 60- 90     1.9  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                      1.9      1.90    0.07    6.43      1.92
 90-120     2.2  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                      2.4      2.30    0.13    9.93      2.26
120-150     3.7  0.7  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                      4.5      3.27    0.06   14.67      2.47
150-180     6.2  4.4  1.1  0.1  0.0  0.0  0.0  0.0  0.0  0.0                     11.8      5.43    0.10   25.04      3.64
180-210     6.5  3.8  1.1  0.3  0.1  0.0  0.0  0.0  0.0  0.0                     11.9      5.51    0.28   26.43      4.14
210-240     4.9  0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                      5.4      2.88    0.16   11.38      1.79
240-270     4.1  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                      4.2      2.22    0.12    6.07      1.54
270-300     4.8  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                      4.9      2.33    0.20    6.54      1.38
300-330     8.5  1.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     10.0      3.34    0.12   12.26      1.71
330-360    13.7 12.5  2.6  0.4  0.1  0.1  0.0  0.0  0.0  0.0                     29.5      5.89    0.06   28.06      3.81

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    66.9 26.6  5.3  0.8  0.2  0.1  0.0  0.0  0.0  0.0                      100.00
CUM PRCT  100.0 33.1  6.5  1.2  0.3  0.1  0.0  0.0  0.0  0.0
MEAN DIR    215  248  251  265  278  298    0    0    0    0
STD DEV     112  110  100   91   90   90    0    0    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   4.47 cm/s MAXIMUM =  28.06 cm/s   MINIMUM =   0.06 cm/s  RANGE =  28.00 cm/s
                         STANDARD DEVIATION =   3.26 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.62 cm/s           STANDARD DEVIATION =  1.79 cm/s
MEAN Y COMPONENT =   0.92 cm/s           STANDARD DEVIATION =  5.11 cm/s
```

†Direction bins are relative to 300°T

Table A-11: Histograms of Current Speed and Direction for the Inshore Location at 20 m – Extended Summer Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA   INSHORE 20-m   SPANNING  6/ 1  TO 10/31 YEARS: 1986 - 2010  4718 DATA POINTS -  31.1 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                           PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                                 SPEED   SPEED  SPEED

  0- 30     7.3  3.4  0.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0                    11.0      4.41    0.23   14.03      2.65
 30- 60     2.3  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     2.4      2.17    0.15   10.85      2.44
 60- 90     1.4  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     1.5      1.84    0.07    5.17      2.08
 90-120     1.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     1.3      1.55    0.21    4.27      1.97
120-150     2.2  0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     2.8      3.09    0.12   11.29      2.81
150-180     4.3  2.8  1.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     8.1      5.39    0.10   21.01      3.75
180-210     6.7  4.0  1.4  0.2  0.1  0.0  0.0  0.0  0.0  0.0                    12.4      5.68    0.35   23.29      4.05
210-240     5.7  0.8  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     6.4      3.03    0.22    8.11      1.77
240-270     4.8  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     5.0      2.38    0.18    6.07      1.44
270-300     5.1  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                     5.3      2.41    0.20    5.89      1.36
300-330     9.3  1.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                    11.0      3.28    0.12   10.65      1.85
330-360    14.9 14.5  2.8  0.4  0.1  0.0  0.0  0.0  0.0  0.0                    32.8      5.88    0.26   26.56      3.68

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    65.3 28.1  5.6  0.7  0.3  0.0  0.0  0.0  0.0  0.0                    100.00
CUM PRCT  100.0 34.7  6.5  1.0  0.3  0.0  0.0  0.0  0.0  0.0
MEAN DIR    227  256  255  291  270  338    0    0    0    0
STD DEV     110  113   97   75   91   99    0    0    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   4.54 cm/s MAXIMUM =  26.56 cm/s   MINIMUM =   0.07 cm/s   RANGE =  26.49 cm/s
                         STANDARD DEVIATION =   3.22 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.88 cm/s           STANDARD DEVIATION =  1.62 cm/s
MEAN Y COMPONENT =   1.34 cm/s           STANDARD DEVIATION =  5.08 cm/s
```

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†Direction bins are relative to 300°T

Table A-12: Histograms of Current Speed and Direction for the Inshore Location at 20 m – Extended Winter Analysis

```
FREQUENCY DISTRIBUTION
 6.00 HOURLY DATA  INSHORE 20-m   SPANNING 12/ 1  TO  3/31 YEARS: 1986 - 2010  3307 DATA POINTS -  28.4 PERCENT OF TOTAL

DIRECTION TOWARDS†                                                        PERCENT    MEAN    MIN    MAX     STD. DEV.
DEGREES                                                                              SPEED   SPEED  SPEED

  0- 30     7.1  1.7  0.2  0.1  0.0  0.0  0.0  0.0  0.0  0.0                  9.1      3.69    0.25   18.43      2.82
 30- 60     3.8  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  4.0      2.51    0.30    7.83      1.72
 60- 90     2.6  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  2.6      1.90    0.32    5.67      1.80
 90-120     3.6  0.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  4.0      2.50    0.13    8.31      2.38
120-150     6.2  1.0  0.2  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  7.4      3.40    0.40   14.67      2.40
150-180     8.6  5.3  1.1  0.1  0.0  0.0  0.0  0.0  0.0  0.0                 15.0      5.07    0.23   16.76      3.29
180-210     6.7  4.0  1.1  0.2  0.0  0.0  0.0  0.0  0.0  0.0                 12.0      5.24    0.35   17.59      3.69
210-240     5.0  0.5  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  5.7      3.02    0.21   11.38      2.09
240-270     3.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  3.3      1.89    0.12    4.44      1.64
270-300     4.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  4.4      2.19    0.45    5.84      1.35
300-330     7.2  1.5  0.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0                  8.7      3.49    0.32   12.26      1.86
330-360    10.6  9.7  2.7  0.7  0.1  0.1  0.0  0.0  0.0  0.0                 23.8      6.27    0.06   28.06      4.19

 SPEED        0    5   10   15   20   25   30   35   40   45
 cm/s         !    !    !    !    !    !    !    !    !    !
              5   10   15   20   25   30   35   40   45   45

PERCENT    68.9 24.4  5.4  1.0  0.1  0.1  0.0  0.0  0.0  0.0                100.00
CUM PRCT  100.0 31.1  6.7  1.2  0.2  0.1  0.0  0.0  0.0  0.0
MEAN DIR    196  238  254  281  339  334    0    0    0    0
STD DEV     108  104   98  104   80  104    0    0    0    0
                                                 SUMMARY STATISTICS

MEAN SPEED =   4.35 cm/s MAXIMUM =  28.06 cm/s   MINIMUM =   0.06 cm/s   RANGE =  27.99 cm/s
                         STANDARD DEVIATION =   3.27 cm/s


IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED  300.00 DEGREES CLOCKWISE FROM TRUE NORTH
MEAN X COMPONENT =  -0.36 cm/s           STANDARD DEVIATION =  2.02 cm/s
MEAN Y COMPONENT =   0.40 cm/s           STANDARD DEVIATION =  5.03 cm/s
```

†Direction bins are relative to 300°T

Summary of Surface Currents[1] off Orange County, California

January 2008 to December 2009

---

[1] Data from the Southern California Coastal Ocean Observation System (SCCOOS)

Introduction

The Southern California Coastal Ocean Observation System (SCCOOS) measures surface currents using high–frequency radar (HFR) along the southern California coast (Figure 1). Details on instrumentation, spatial coverage, data processing, and data products are available at http://www.sccoos.org/data/hfrnet/. Two years of data (2008–2009) were available off Orange County for analysis by SCCOOS. Biannual, seasonal, and monthly mean surface currents were prepared. Additionally, power and principal component analyses for the entire data set were run. Subtidal analysis on current speed and direction were completed using data extracted for a single point (117.9294W, 33.5943N; located on the southeast side of the Newport Canyon, right off the Newport Pier).

Mean Surface Currents

Two-year Average

The two-year average surface currents demonstrated a predominate shore normal, downcoast flow of about 5–8 cm/s along the Orange County coastline north of the Newport submarine canyon (Figure 2 and 3). At the southern end of the San Pedro shelf, a divergence was seen in currents, with nearshore currents directed toward the coast and offshore waters directed away. Spectral (frequency) analysis showed several peaks with frequency ranging from annual to semi-diurnal (Figure 4). The predominant spectral peaks were seen at the diurnal and semi-diurnal frequencies.

Seasonal and Monthly Averages

The average seasonal (September–November) surface currents for both 2008 and 2009 were generally consistent in pattern with downcoast flows inshore along Huntington Beach diverging to offshore flows in deeper waters off the San Pedro shelf (Figure 5). The primary difference seen is that the flows at the Newport Canyon and southeast of the canyon in 2009 were directed offshore. Additionally, 2009 saw very strong northwest surface currents (>25 cm/s) coming into the study area from the southeast.

Individual monthly means for 2008 again showed consistency with the two-year average flows with the main difference seen in current speeds. September had inshore current that ranged from 6–12 cm/s while offshore currents reached speeds of nearly 20 cm/s (Figure 6a). October showed much reduced inshore current speeds (Figure 6b), while November currents were directed much more offshore, even on the San Pedro shelf (Figure 6c); this may have been due to the strong northwest currents entering the area from the southeast. September and October 2009 saw similar patterns of offshore flows on the San Pedro shelf and strong northwest flows (Figures 7a and 7b). November 2009 (Figure 7c) flows more nearly matched the two-year average flows (Figure 2).

Subtidal Flows

While there is considerable variability in both current speed and direction for the data set, predominate flows are to the northeast, toward shore (Figure 8), consistent with both the 2-year mean currents for this location within the Newport Canyon. September–November, 2008 had higher current speeds and more downcoast, shoreward flows, though there was a period of almost a month (starting in mid–October) that showed consistent upcoast/offshore flows (Figure 9). In 2009, current speeds were slower with flows directed more in the offshore direction, reflective of what was seen in average monthly currents. In 2008, there appeared to be some visual coherence (onshore winds with shoreward surface currents) between local winds from OCSD Plant 2 and surface currents off Newport Beach. This was not the case in 2009.

Conclusions

Surface currents on the San Pedro shelf demonstrated consistent monthly, seasonal, and annual alongshore, downcoast flows. Within the Newport Canyon, currents showed a consistent offshore/onshore flow, with the direction being determined by the presence/absence of strong northwest flows entering the area from the southeast. The dominate frequencies were at the diurnal and semidiurnal periods. Local year-to-year wind and subtidal current flow patterns were not consistent.

Figure 1. Locations for Southern California Coastal Ocean Observation System (SCCOOS) high-frequency radar sites and 2008–2009 data extraction location (solid dot).

Orange County Sanitation District, California.

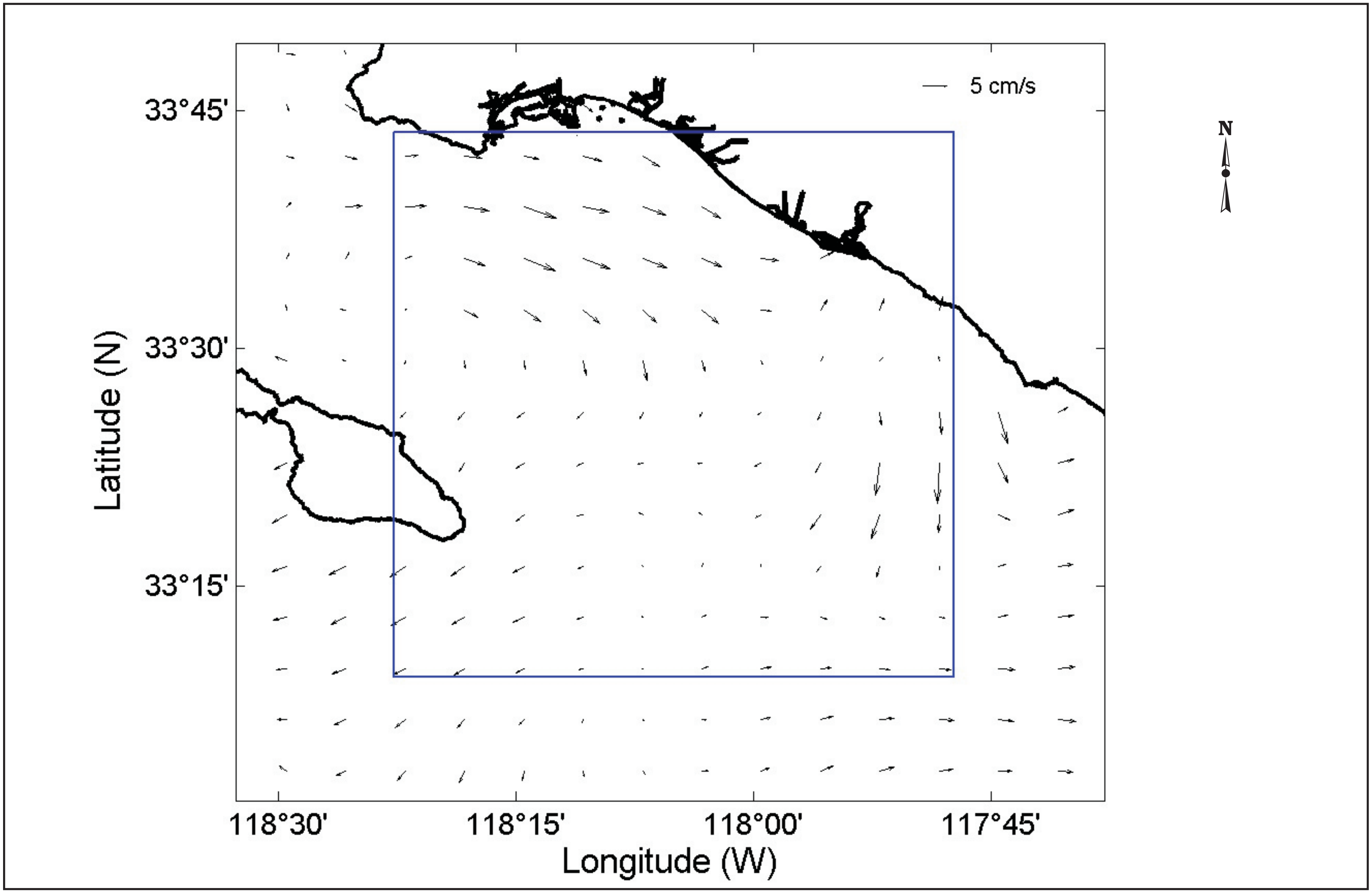

Figure 2. Two-year mean surface currents, January 2008 to December 2009.

Anaysis and graphic supplied by SCCOOS.

Orange County Sanitation District, California.

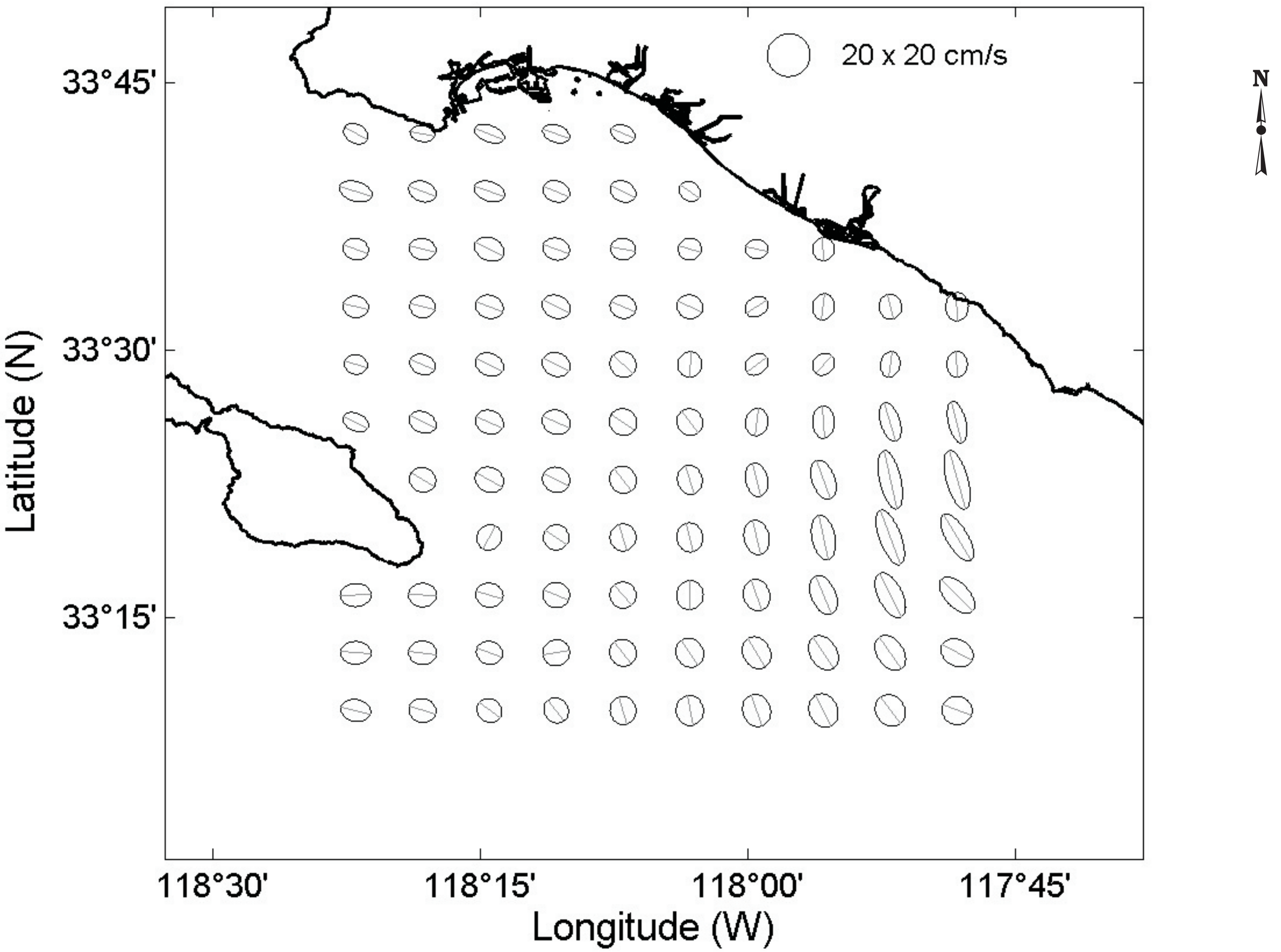

Figure 3. **Surface current two-year principal component axis, January 2008 to December 2009.**

Analysis and graphic supplied by SCCOOS.

Orange County Sanitation District, California.

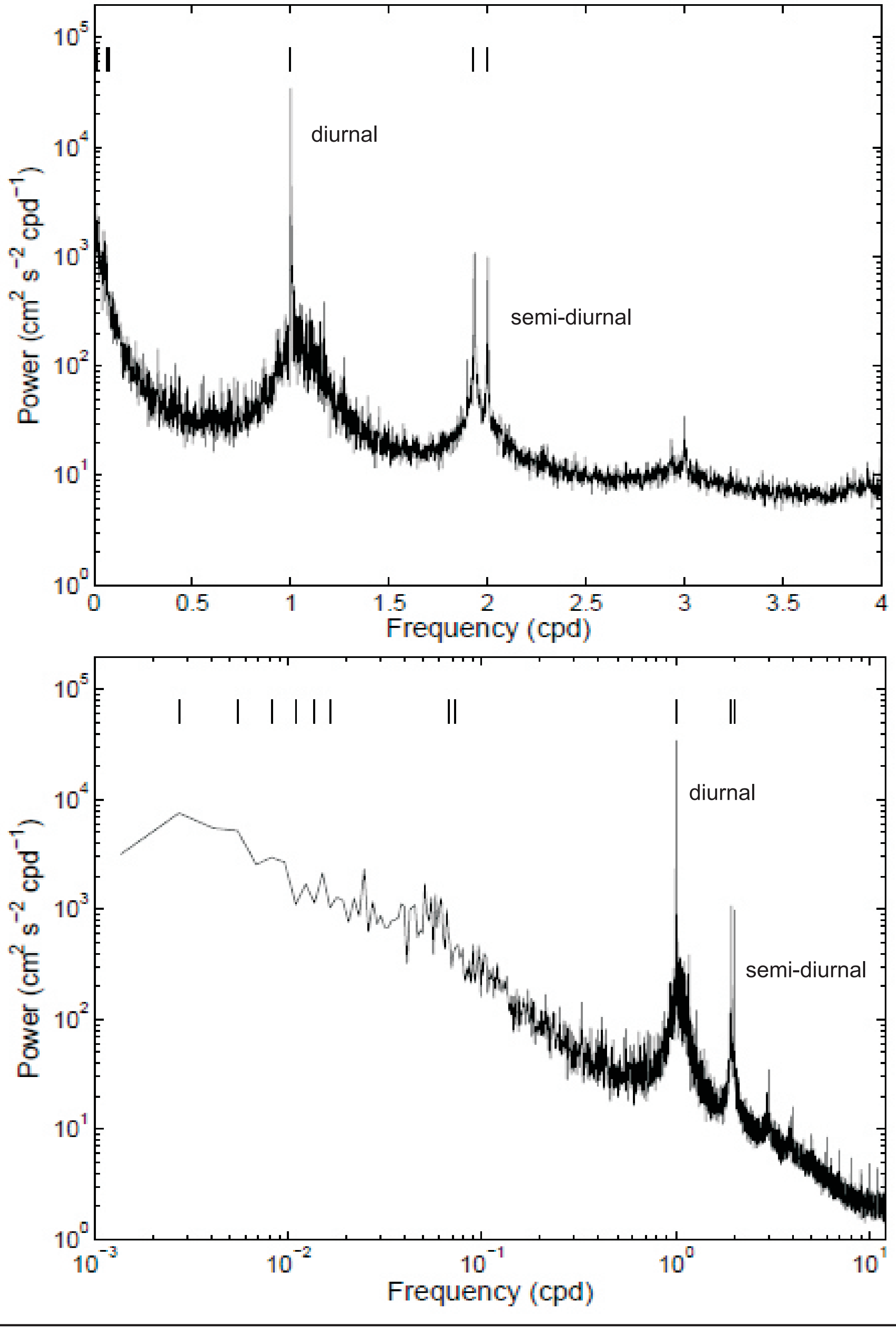

Figure 4. Two-year power spectrum (cycles per day = cpd) of hourly surface currents averaged over the model domain (2008-2009). Six seasonal (SA1-6), spring-neap tide, lunar spring tide, S1(1 cpd), M2 (1.93 cpd), and S2 (2 cpd) frequencies are indicated (”|”) on the figure.

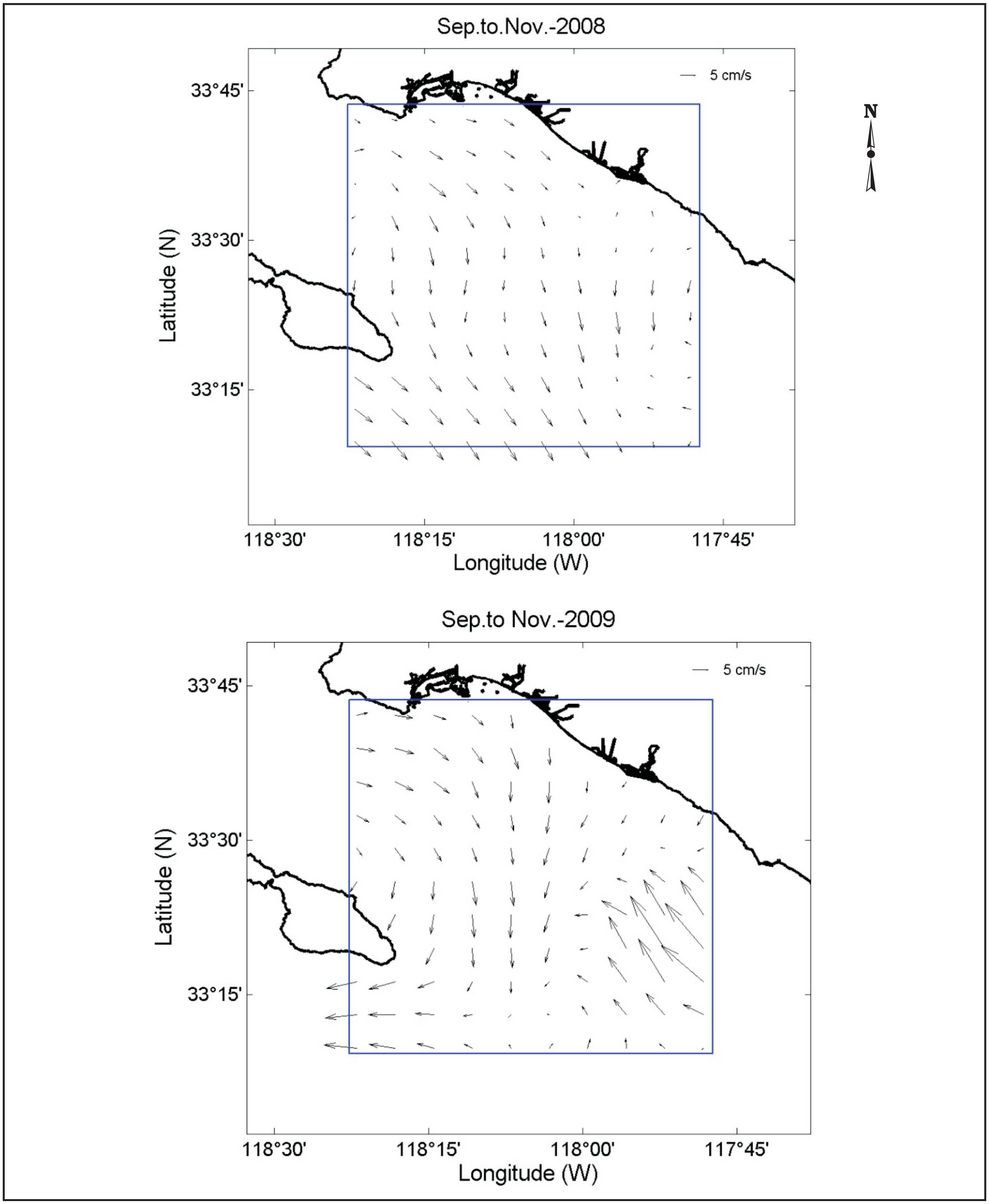

Figure 5. **Seasonal (September- November) mean surface currents for 2008 and 2009. Analysis and graphics supplied by SCCOOS.**

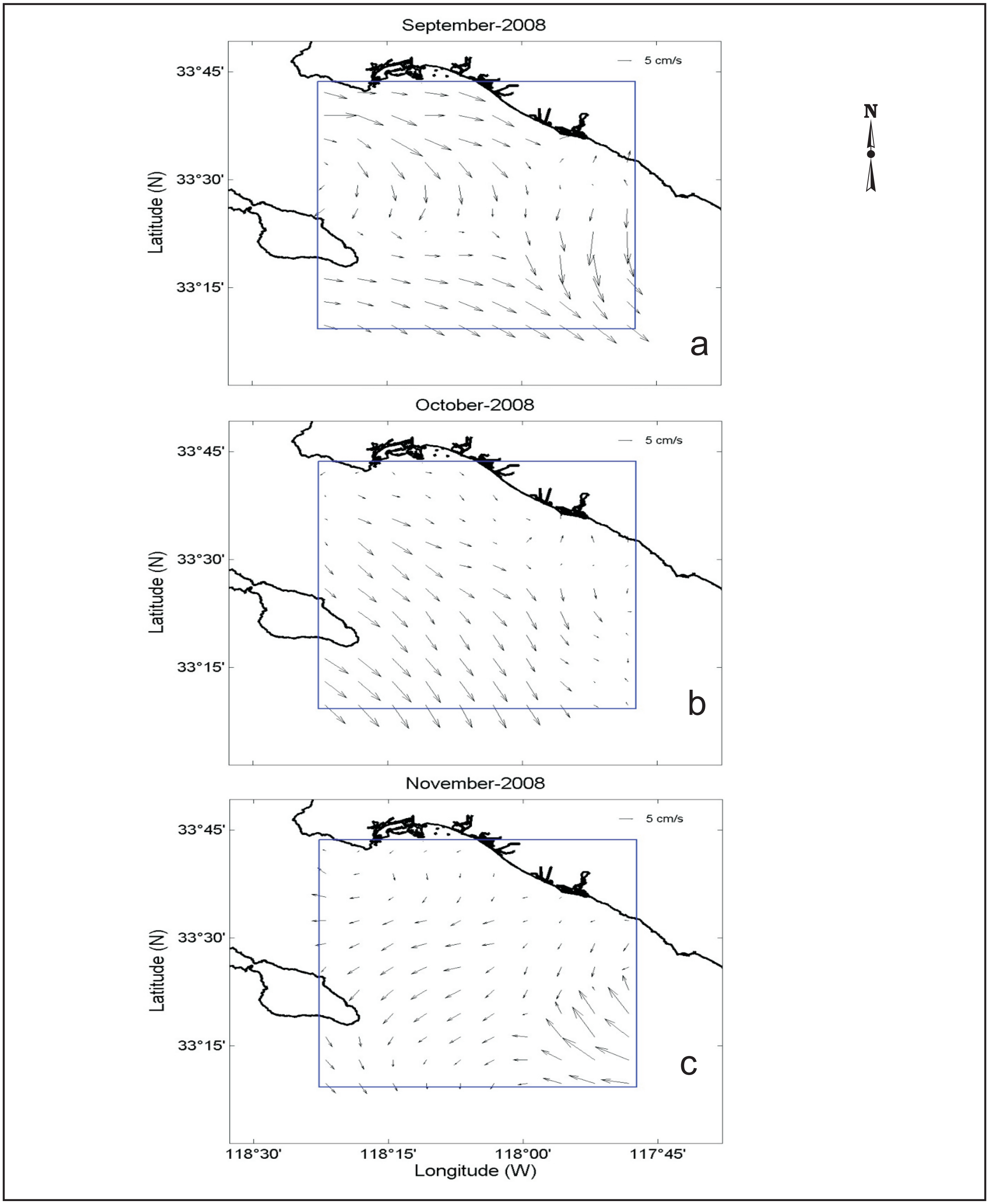

Figure 6. Mean monthly surface currents for September (a), October (b), and November (c), 2008. Analysis and graphics supplied by SCCOOS.

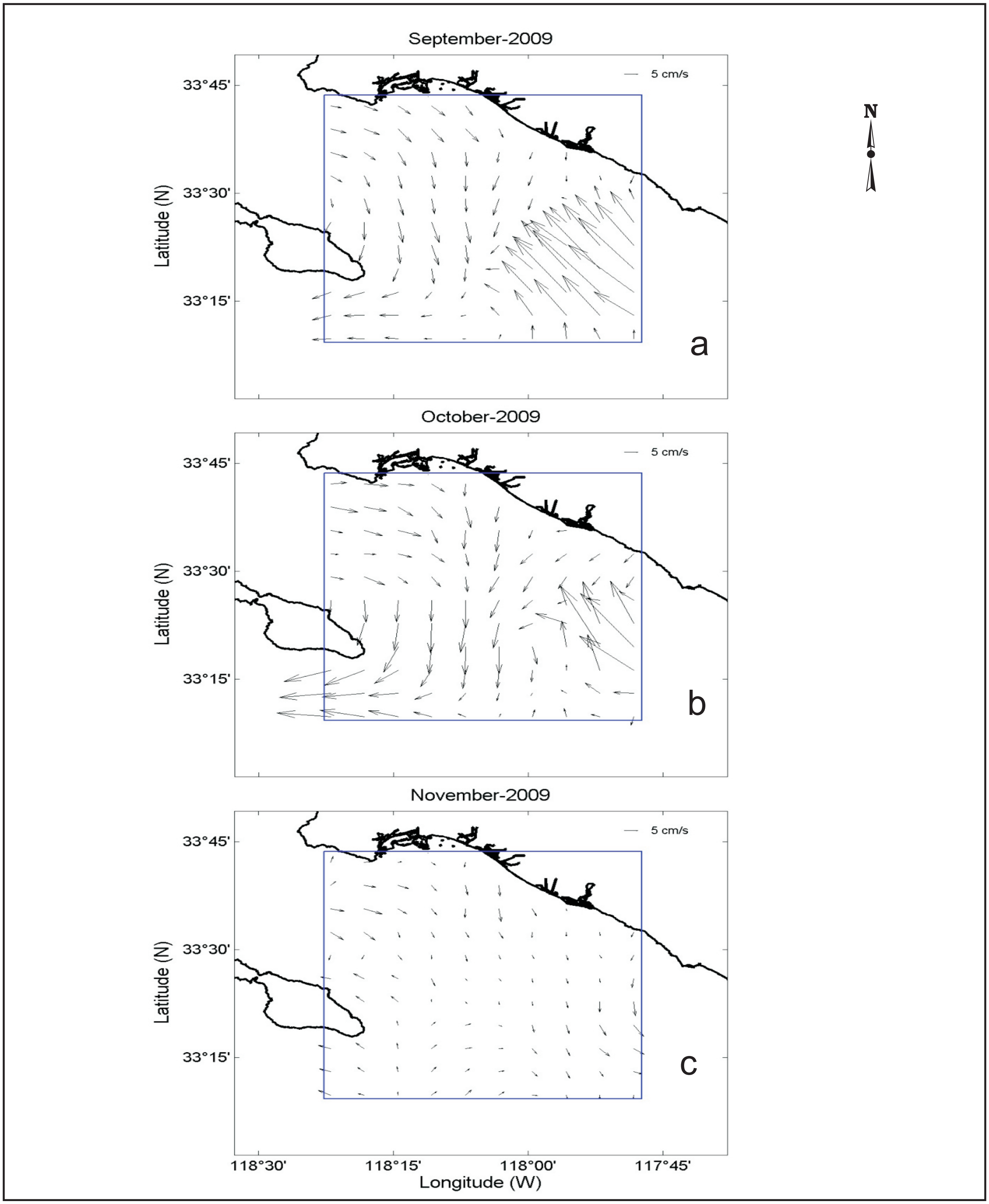

Figure 7. Mean monthly surface currents for September (a), October (b), and November (c), 2009. Analysis and graphics supplied by SCCOOS.

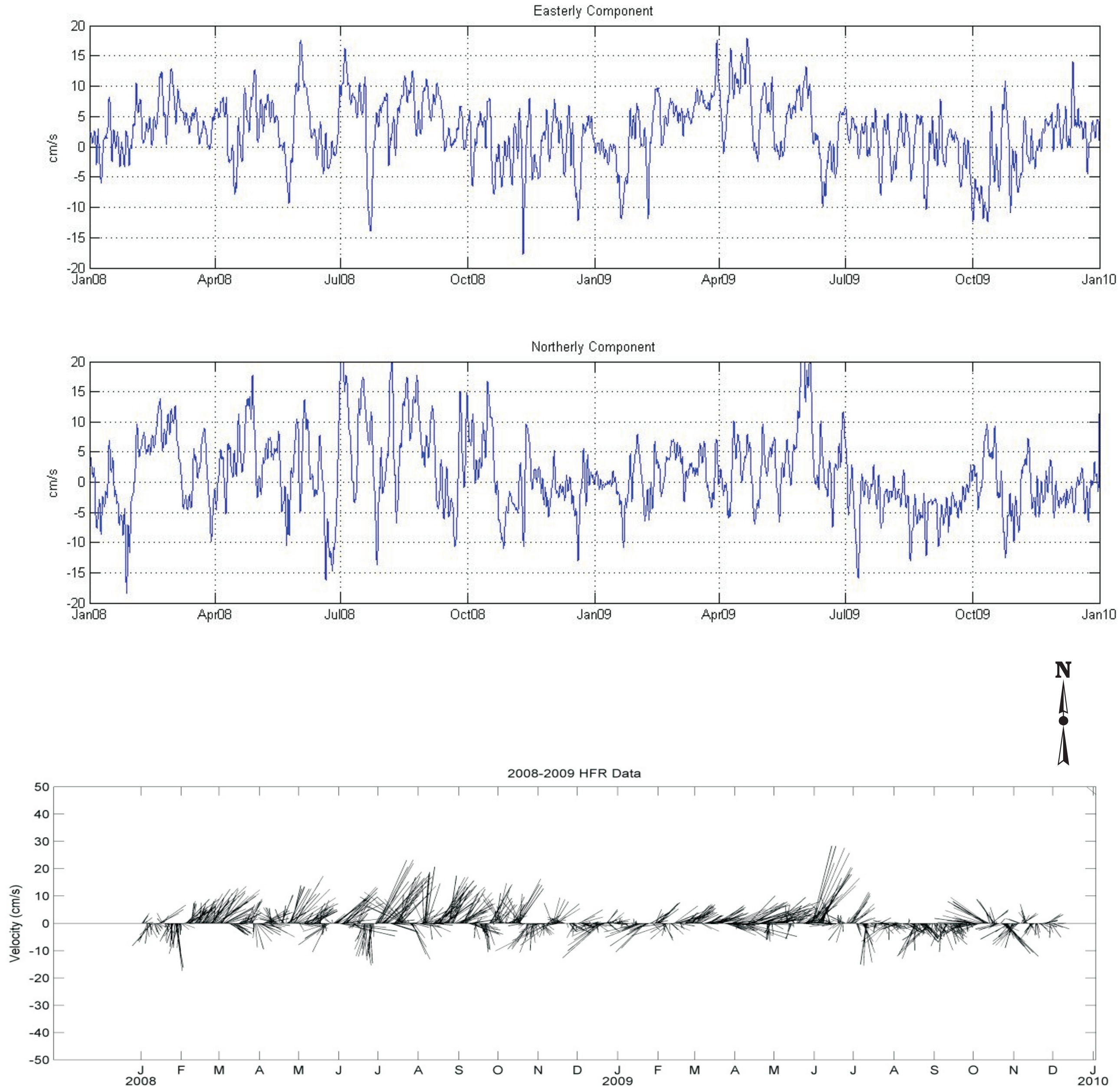

Figure 8. **Subtidal surface currents off Newport Beach, California (117.9294°W, 33.5943°N). Upper figure illustrates Easterly (+) and Northerly (+) components. Bottom figure illustrates resultant vectors.**

Analysis and graphics supplied by SCCOOS.

Orange County Sanitation District, California.

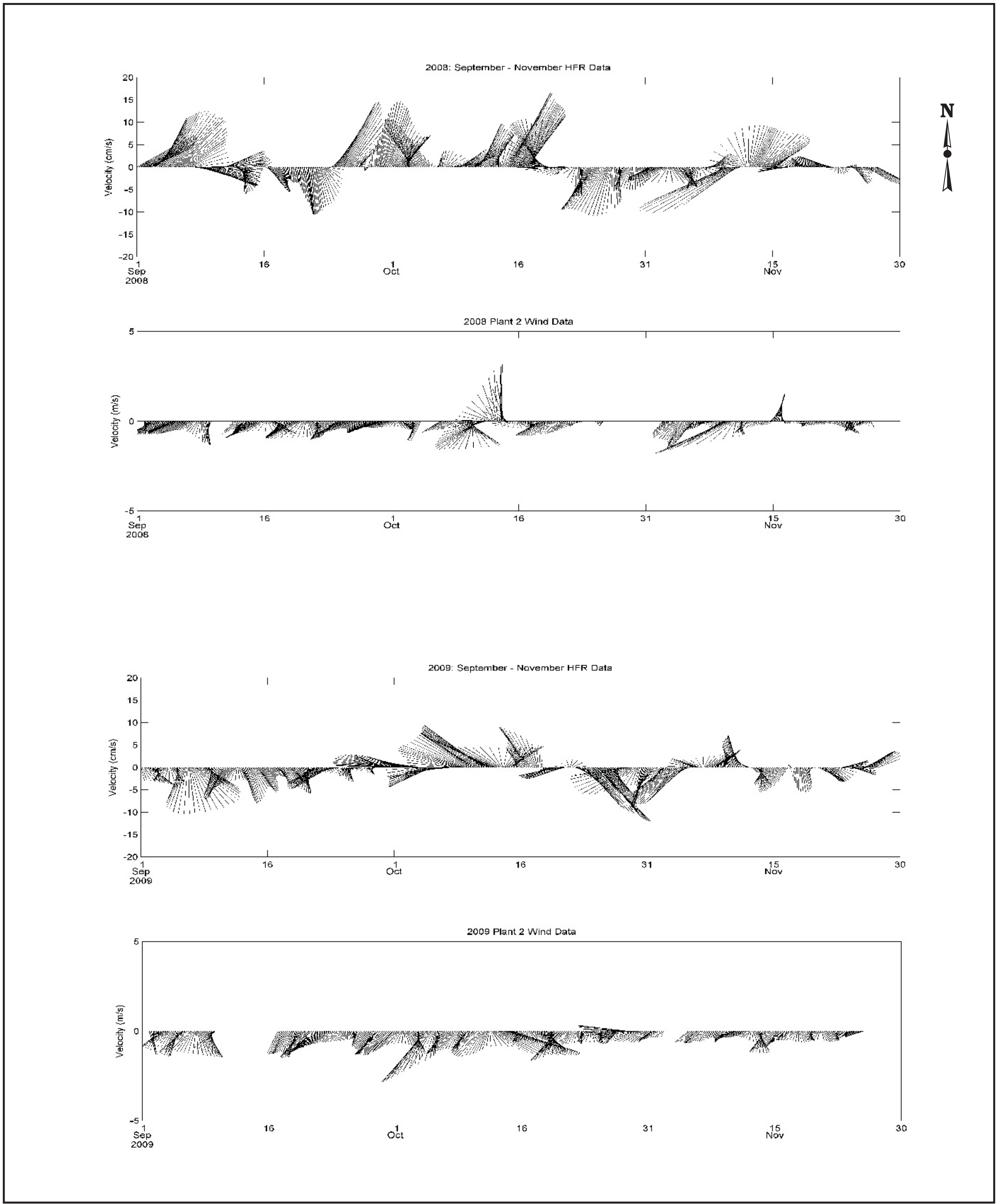

Figure 9. **Subtidal surface currents off Newport Beach, California (117.9294°W, 33.5943°N) and OCSD Plant 2 winds.**

Orange County Sanitation District, California.

ORANGE COUNTY SANITATION DISTRICT OUTFALL MODELING HUNTINGTON BEACH, CA

SHALLOW WATER DIFFUSER PLUME MODELING

FINAL REPORT

Prepared for:

Orange County Sanitation District
10844 Ellis Avenue
Fountain Valley, CA 92728

Prepared by:

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EXECUTIVE SUMMARY

The Orange County Sanitation District (OCSD) is making plans to utilize an existing nearshore outfall to discharge treated wastewater during the fall and early winter months. The nearshore outfall will expand the discharge capacity beyond that available with the currently operating deepwater diffuser. The nearshore outfall is a 2 m diameter pipeline extending 1.6 km offshore and discharging in a water depth of 16.7 m.

The purpose of this report is to present the results of an analysis of the effluent dilution and transport in the coastal region of the outfall. In particular, the analysis addresses expected concentrations of total and fecal coliform and enterococcus in the coastal region extending from Paradise Cove to Huntington Harbor. The investigation focuses on the coastal oceanographic processes during the months of August through November, as this is the season when the outfall will be used.

Initial Dilution Modeling

The first part of the analysis consists of an evaluation of the initial dilution in the near-field area of the diffuser. This is the region where the discharge creates a plume-dominated momentum as the effluent leaves the diffuser ports, and buoyancy as the plume rises in the water column. The plume dynamics in this initial dilution region are dominated by the characteristics of the diffuser and effluent in relationship to the receiving water.

The initial dilution and near-field plume investigation was conducted using CORMIX, which stands for Cornell Mixing Zone Expert System. This modeling system is one of the recommended mixing zone models for environmental impact assessment and regulatory management by U.S. Environmental Protection Agency (USEPA, 1991). It was developed for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into receiving water bodies, such as streams, lakes, estuaries, or coastal waters

The model was configured to represent receiving water properties representative of the months of July through November based on measured temperature profiles in the vicinity of the outfall for these months. The effluent flow rate was taken to be 200 million gallons per day (MGD), which is near the 230 MGD capacity of the nearshore outfall.

The California Ocean Plan calls for calculation of the initial dilution without any ambient current, which produces the least amount of dilution. For this condition, the initial dilution ranged from a minimum of 28 in July when thermal stratification limits the plume height of rise, to a maximum of 37 when the water column is vertically well mixed and the plume rises to the surface. Since there is no ambient current, these initial dilutions are located directly above the diffuser.

For the more typical case of a coastal current, the results show that the near-field region length, pollutant dilution, plume thickness, and well-mixed water depth all increase from July to September. The plume does not penetrate to the surface during this period, but

tends to spread more in the vertical direction with time. In October and November, the unstable interactions lead to upstream intrusion and confine the near-field region closer to the diffuser. The plume rises immediately to the surface and spreads downwardly. In all cases, the dilution was significantly higher than for the cases without ambient current.

Far-field Plume Dispersion Modeling

At the limit of the initial dilution region, the plume is near equilibrium with the receiving water and the oceanographic transport and turbulent mixing mechanisms begin to dominate the effluent concentration and distribution throughout the coastal region rather than the discharge characteristics. This region is the far-field mixing and transport region. The second part of the analysis described in this report consists of a far-field numerical model of the hydrodynamics and water quality mechanisms controlling bacteria concentrations. The far-field model includes the effects of tidal currents, large scale ocean circulation patterns, wind generated waves and currents, wave radiation stress, turbulent mixing, surf zone transport, and bacteria die-off.

The MIKE by Danish Hydraulics Institute (DHI) modeling system was selected as a modeling platform for the project. MIKE is commercial software developed by DHI. It has the capability to model complex processes, such as the interaction between currents and waves, transport and diffusion of various constituents and tracers, sediment transport and morphology, and water quality. MIKE FM (Flexible Mesh) was selected for the project due to the flexibility and numerical efficiency available with its unstructured mesh configuration. The unstructured mesh makes it possible to resolve both large and small scale flows and waves in a single model setup. A finer mesh may be used in the immediate vicinity of the areas of interest and a coarser mesh may be used offshore and away from the site. MIKE FM has the capability to resolve three-dimensional flows; however, for this study a two-dimensional model was used to assess the tidal and wave-induced currents. Also, density variations due to salinity and temperature were not included in the present model.

Three modules of the MIKE suite were used. MIKE 21 FM HD (Hydrodynamic Model) was used to assess hydrodynamic conditions which included tidal, wind, and wave induced currents and superimposed along-shore current which mimics a large scale circulation of Southern California bight. MIKE 21 SW (Spectral Waves Model) was used to model the wave transformation from the offshore edge of the model domain to the beach. The SW model provides forcing into the HD model to generate water levels and currents resulting from the wave shoaling and breaking. MIKE21 SW includes the following physical phenomena: wave growth by action of wind; non-linear wave-wave interaction; dissipation due to bottom friction; dissipation due to depth-induced wave breaking; refraction and shoaling due to depth variations; and wave-current interaction. MIKE 21 AD (Advection-Diffusion Model) utilizes the currents calculated by the HD model and predicts transport and distribution of the effluent in the far-field region of the discharge location.

The model domain extends from Crystal Cove in the south to the Huntington Harbor South jetty in the north. The domain covers a rectangular area of 28 km along-shore and

8.5 km offshore. It includes part of the Santa Ana River and Newport Harbor. The diffuser is located approximately 11.5 km away from the southeast boundary, and 16.5 km away from the northwest boundary. The HD and SW wave models were calibrated against data collected during a field monitoring program during 2000. The waves and currents agree reasonably with these available data.

Long-term wind and wave data were obtained from a 30-year hindcast prepared by Oceanweather, Inc. in their Global Reanalysis of Ocean Waves (GROW) project. The hindcast data consists of wind speed and direction, significant wave heights, peak wave periods, and mean wave directions for both sea and swell components at 3-hour intervals. These data were summarized for the months of interest to provide wind and wave boundary conditions for the model simulations.

The model simulations of bacteria transport from the nearshore outfall included a diurnal variation in the wind speed to simulate the sea breeze pattern which dominates the nearshore area near Huntington Beach. The simulations also included diurnal variations in the effluent flow rate based on OCSD flow rate measurements and a diurnal variation in the bacteria die-off rates.

A total of 12 cases were simulated to produce different transport conditions for the plume dilution modeling. The cases varied the background coastal ocean current from 0.2 m/s towards north and south as well as no current to simulate possible scenarios. These types of coastal currents could occur at any time during the year and cannot be tied to any specific month. The offshore wave height was varied to bracket the average wave heights computed from the wave hindcast for the months of August through November. The wave direction was varied between west and south since these are the prevalent wave windows along this section of the coast. All simulations included the tidal currents and sea breeze wind forcing. The astronomical tidal conditions imply that only astronomical tidal water levels were applied at the boundaries, which did not include any meteorological surges.

The simulations were run for a total of 21 days. The first seven days were considered as model “spin-up” time and were disregarded in the analysis. The initial seven day period was selected to allow the initially discharged effluent to decay. The remaining 14 days of each simulation were used as the base for construction of bacteria concentration distribution maps. The average and maximum values were found for each location from the 14-day hourly time series of model results.

The contour maps of geometric mean and maximum bacteria concentrations are included in the report for all simulation cases. The maps show the distribution of total and fecal coliform bacteria and enterococci in MPN/100mL for each month which varies due to the initial concentrations in the effluent.

Based on the modeling results, the worst case scenario for the potential of high bacteria concentrations close to the beach and spread over a wide area appears to be for the case of waves from the south with the coastal circulation current towards the southeast. This scenario produces a plume along the entire coastline in the model domain. For total coliform with this scenario during September, the concentrations along the shoreline reach as high as 100 MPN/100 mL along an approximately 10 km stretch of coast from the diffuser northward and near 10 MPN/mL southward extending to Crystal Cove near the southeastern extent of the model domain.

The modeling results suggest that the far-field transport of the plume is relatively insensitive to the wave height, although it is very sensitive to the wave direction. In addition, the wave generated radiation stress appears to dominate transport mechanisms compared to the coastal current. The southwest sea breeze produces some southerly forcing near the coastline for all simulations.

There are some limitations to the modeling based on the 2-dimensional nature of the hydrodynamic model. Because the model represents only the horizontal dimensions, the bacteria concentration is averaged over the water column. This is a valid approximation near the discharge based on the initial dilution model results showing the plume reaching close to the water surface during the months of interest. It is also valid for slowly varying depths along the coast or shallower water depths near the beach. However, the assumption tends to breakdown in areas such as the Newport Canyon where the water depths increase rapidly with distance. Because the 2-dimensional model averages the concentrations over the water column, the plume becomes rapidly diluted when passing over the canyon. While there is some vertical mixing that will dilute the plume somewhat, the results suggest excessive dilution when the plume passes over Newport Canyon. For those cases where the plume approaches the shoreline inshore of Newport Canyon, the depth averaged dilution is not a factor. For example, the results for total coliform in the simulation with waves from the south and a coastal current of 0.2 m/sec towards the southeast (Case 3) show the plume located immediately adjacent to the shoreline and penetrating into Newport Harbor, although at low bacteria levels.

A 3-dimensional simulation was conducted for Case 12 (SE current and western waves) to evaluate potential differences in the transport mechanisms. The 3-dimensional model results show the plume extends further south as mixing is limited to the surface water layer. This simulation produced more realistic results over the deep canyon compared to the depth averaged results from 2-dimensional simulations. Additional 3-dimensional model simulations were not conducted since adequate 3-dimensional data were not available for accurately configuring the model parameters or for calibration at this time.

In addition to the impacts associated with Newport Canyon, there is an apparent closed-loop circulation at the NW boundary of the model when no coastal current is superimposed. This is an artifact of the model boundary condition specification which is unavoidable, although the existence of the Huntington Harbor Jetties along this NW boundary may contribute to this closed-loop circulation. Therefore, the location of the plume close to these boundaries in cases without a superimposed current may be inaccurate. In reality, some circulation in Southern California bight almost always exists, and not imposing such circulation in the model is more conservative and unlikely. The results with the superimposed currents show a more accurate representation of the plume in this regards.

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1.0 INTRODUCTION

The Orange County Sanitation District (OCSD) is making plans to utilize an existing nearshore outfall to discharge treated wastewater during the fall and early winter months. The nearshore outfall will expand the discharge capacity beyond that available with the currently operating deepwater diffuser. The deepwater outfall consists of a 3 m diameter pipeline extending approximately 8 km offshore from Huntington Beach, discharging in a water depth of approximately 60 m. The nearshore outfall is a 2 m diameter pipeline extending 1.6 km offshore and discharging in a water depth of 16.7 m. The location of the outfalls is illustrated in Figure 1-1.

The purpose of this report is to present the results of an analysis of the effluent dilution and transport in the coastal region of the outfall. In particular, the analysis addresses expected concentrations of total and fecal coliform and enterococcus in the coastal region extending from Paradise Cove to Seal Beach. The investigation focuses on the coastal oceanographic processes during the months of August through November, as this is the season when the outfall will be used.

The first part of the analysis consists of an evaluation of the initial dilution in the near-field area of the diffuser. This is the region where the discharge creates a plume-dominated momentum as the effluent leaves the diffuser ports, and buoyancy as the plume rises in the water column. The plume dynamics in this initial dilution region are dominated by the characteristics of the diffuser and effluent in relationship to the receiving water. The results of the initial dilution evaluation are presented in Section 2 of this report.

At the limit of the initial dilution region, the plume is near equilibrium with the receiving water, and the oceanographic transport and turbulent mixing mechanisms begin to dominate the effluent concentration and distribution throughout the coastal region rather than the discharge characteristics. This region is the far-field mixing and transport region. The second part of the analysis described in this report consists of a far-field numerical model of the hydrodynamics and water quality mechanisms controlling the bacteria concentration distributions. The far-field model includes the effects of tidal currents, large scale ocean circulation patterns, wind generated waves and currents, turbulent mixing, surf zone transport, and bacteria die-off.

Section 3 of this report discusses the development of the far-field hydrodynamic and water quality models. Section 4 of this report presents the results of the model calibration based on field monitoring data. Section 5 of the report presents the results of various simulations conducted to compute bacteria distribution for various scenarios consistent with coastal oceanographic properties in the months of August through November.

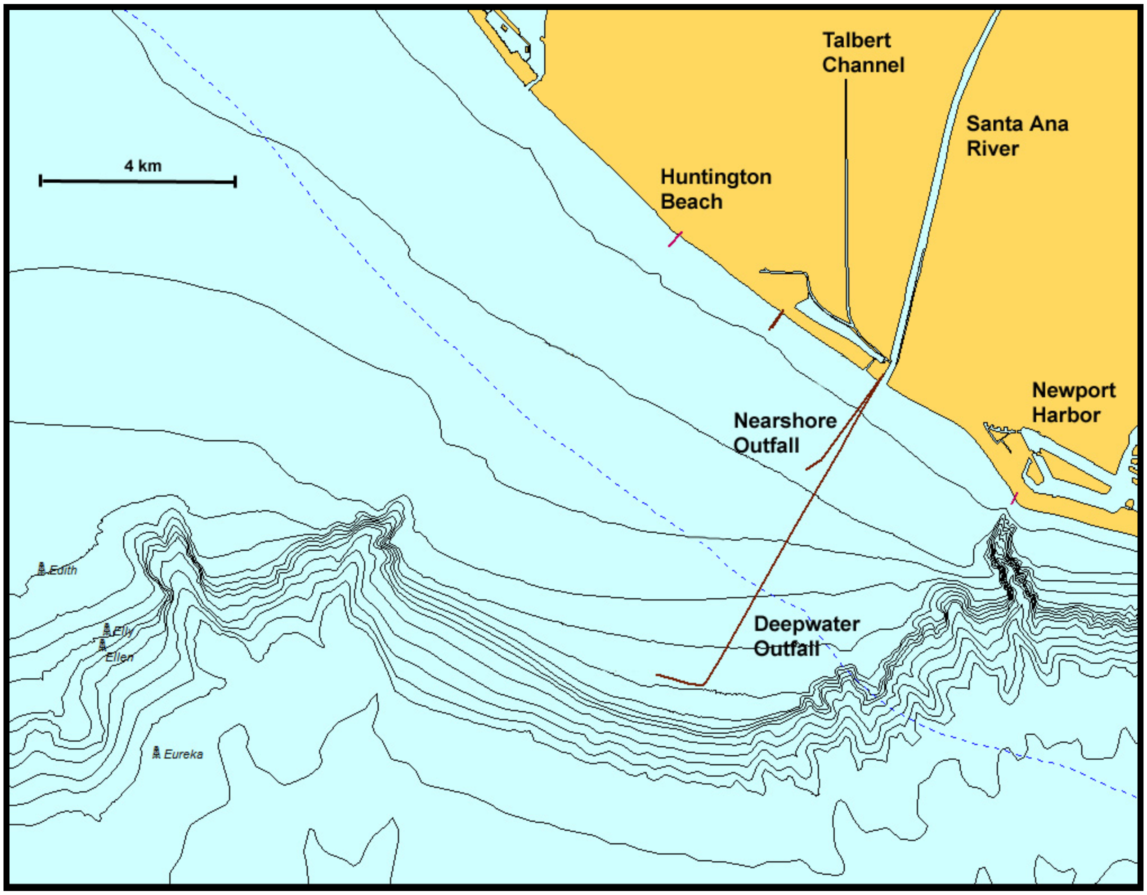

Figure 1-1: Location of Orange County Sanitation District Ocean Outfalls

2.0 NEAR-FIELD PLUME MODELING

Moffatt & Nichol (M&N) selected CORMIX for the near-field plume investigation. CORMIX, which stands for Cornell Mixing Zone Expert System, is one of the recommended mixing zone models for environmental impact assessment and regulatory management by U.S. Environmental Protection Agency (USEPA, 1991). It was developed for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into receiving water bodies, such as streams, lakes, estuaries, or coastal waters (Doneker and Jirka, 2007).

The analysis in this section focuses on the near-field region (NFR) where the initial effluent characteristics, outfall geometry, and ambient current condition all influence the mixing. In the far-field region (FFR), only ambient current and turbulence control the mixing.

2.1 Model Setup

The modeling approach uses the CORMIX 2, submerged multiport diffusers module. The input parameters for the model are as follows.

2.1.1 Effluent Data

The effluent section inputs pollutant type, effluent concentration and density, and discharge flow rate.

OCSD conducted a disinfection demonstration project during the period of July 25, 2011 through August 15, 2011. The results of this demonstration project indicate that the geometric mean of the of the three indicator bacteria concentrations are 632 MPN/100mL for total coliforms, 178 MPN/100mL for fecal coliforms, and 30 MPN/100mL for enterococci. These concentrations are used for both the near-field and the far-field modeling purposes.

OCSD also provided the effluent density of 997.9 kg/m^3 and hourly measurements of discharge flow rate, as shown in Figure 2-1. Hourly discharge varies mainly between 70 million gallons per day (MGD) to 180 MGD. For the modeling, a constant flow rate of 200 MGD was considered conservative, although the design capacity at the outfall is 230 MGD.

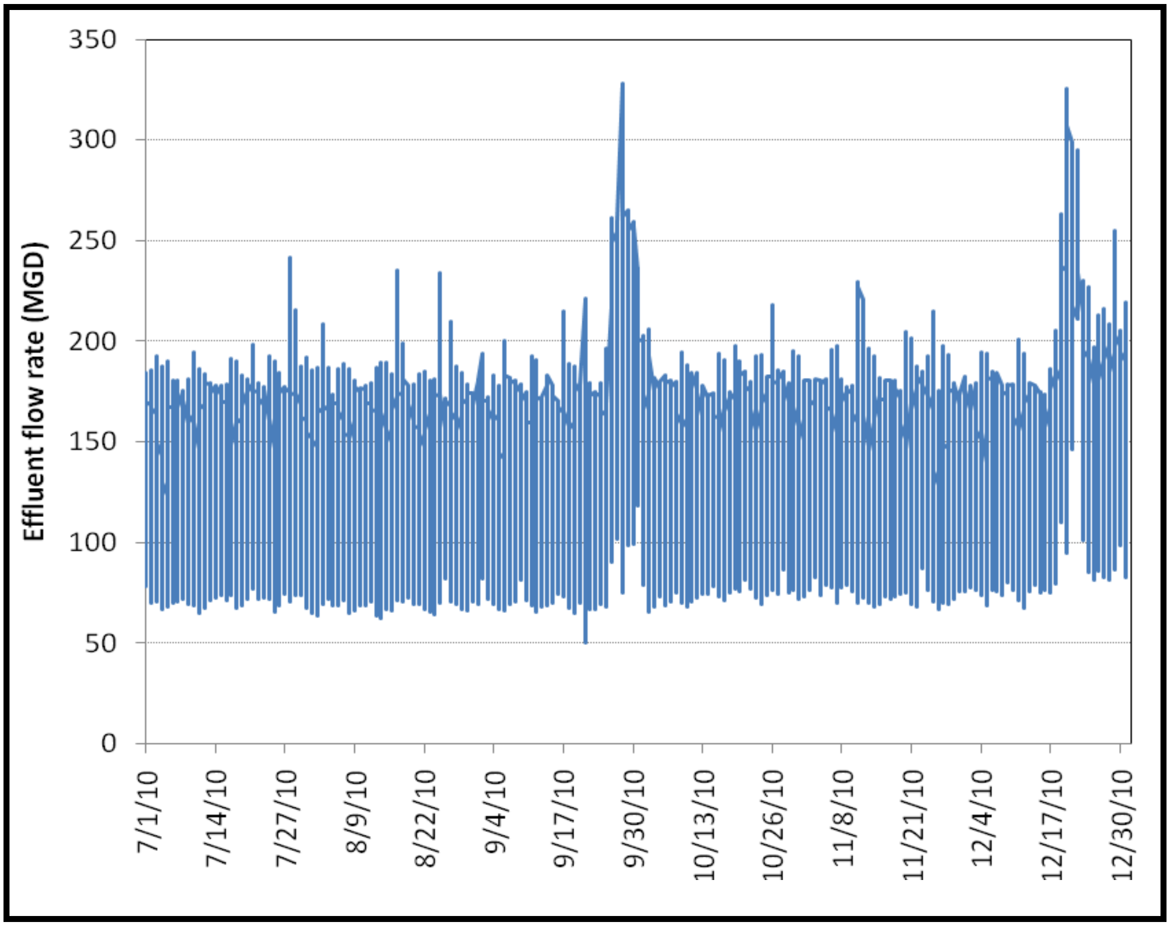

Figure 2-1: Hourly Measurements of Effluent Flow Rate from OCSD (Unit in MGD)

2.1.2 Ambient Condition

CORMIX ambient environment inputs are: water depth at discharge, wind and current speed, water body type (bounded or unbounded), frictional roughness, and ambient density type and values.

The water depth is 16.7 m at the District's shallow water diffuser. As the diffuser is located along the open coast, an unbounded water body with a typical Manning's roughness of 0.025 was used in the model. Wind is not important for near-field mixing so zero wind speed was used throughout the calculation.

As part of the monitoring program in "Huntington Beach Near Shore Experiment" project during summer 2006 (HB06), a bottom-mounted Acoustic Doppler Current Profiler (ADCP) at Station HB-MD-6 (shown as blue MD in Figure 2-2) provided 18 days of current speed and direction measurements in October. This joint monitoring was conducted by OCSD, Science Applications International Corporation (SAIC), U.S. Geological Survey (USGS), University of Southern California (USC), Scripps Institution of Oceanography (SIO), and Stanford University. Figure 2-3 illustrates the current speed at several water depths. For the near-field plume modeling, three representative current speed cases were selected: 0.2 m per second (m/s) with northwest alongshore flow direction, 0.2 m/s with southeast alongshore flow direction, and stagnant (zero current speed) for the most critical mixing condition.

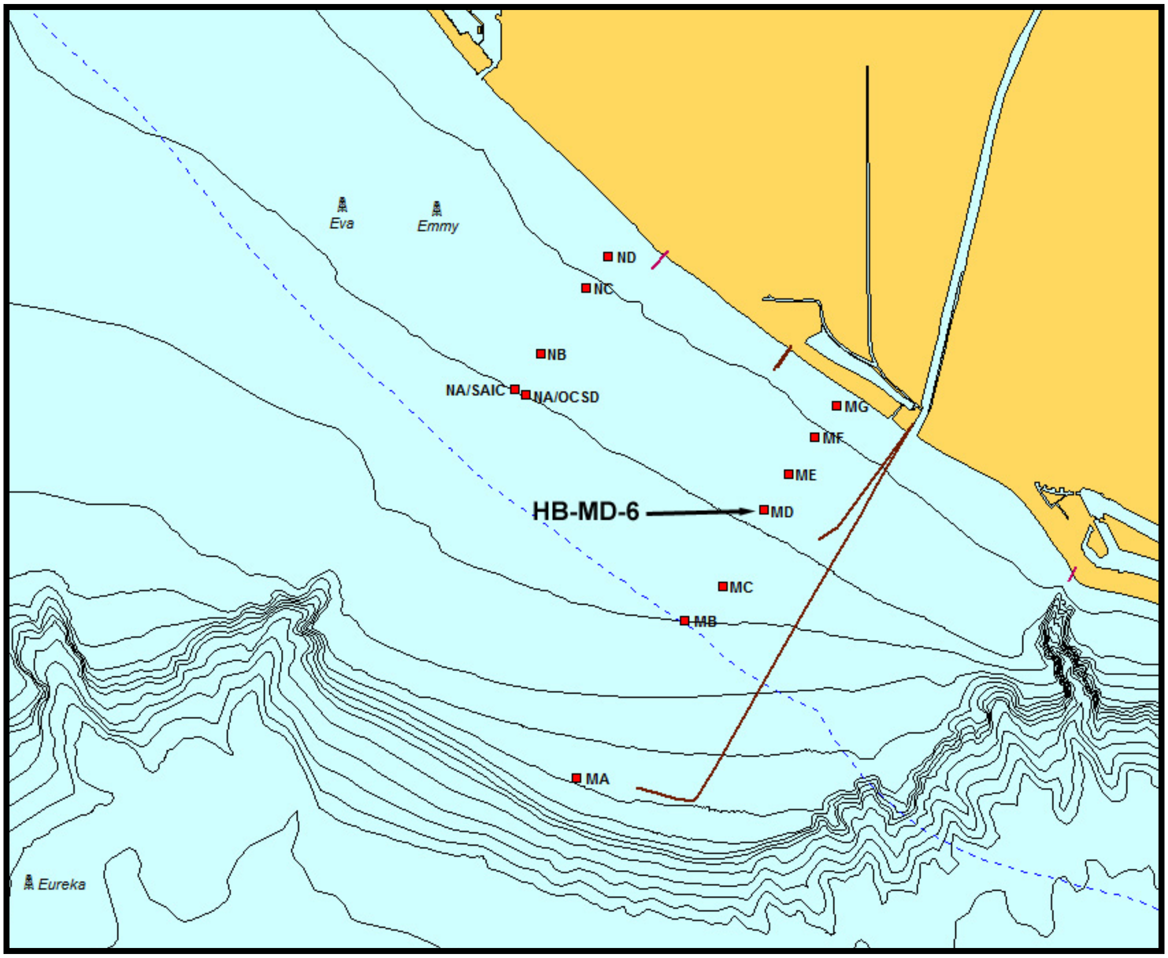

Figure 2-2: Location of HB06 Moorings. Downloaded from SAIC Website
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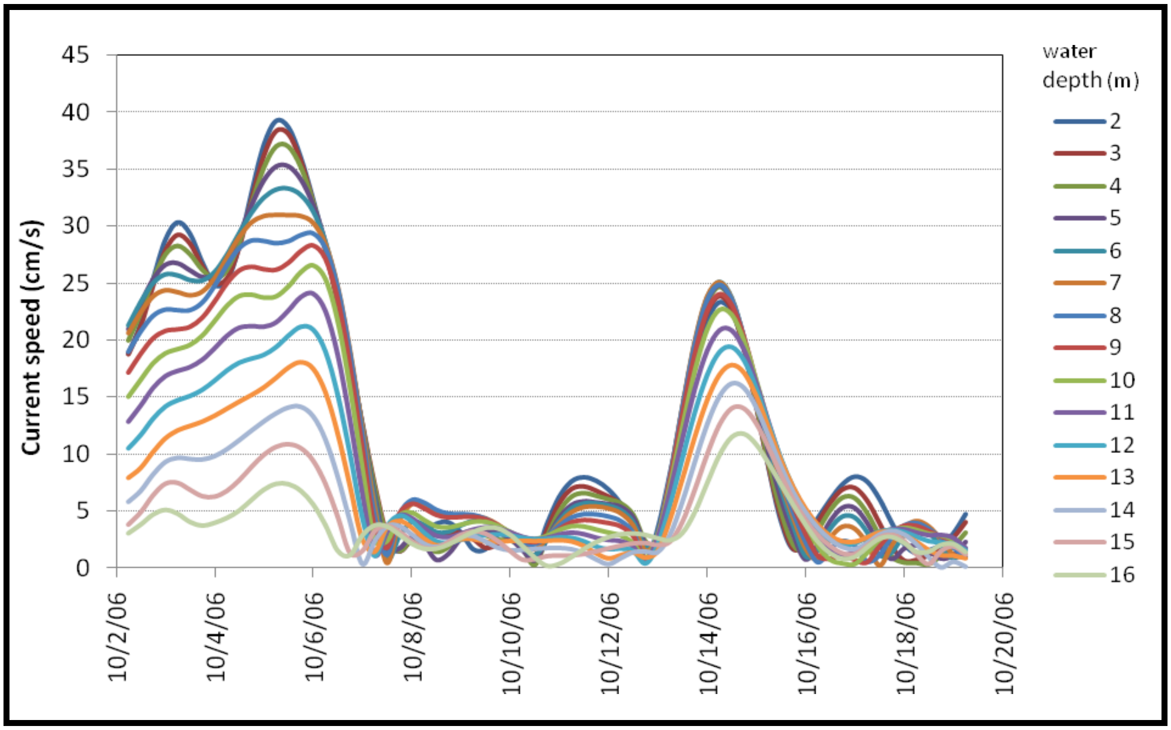


Figure 2-3: Ambient Current Speed Profile by Water Depths at Station HB-MD-6

The vertical density distribution in the receiving water body is important for determining the mixing behavior of the outfall plume (Doneker and Jirka, 2007). In CORMIX, fresh water or non-fresh water with uniform or stratified density distribution are available. For a stratified distribution, one of three types of profiles can be further selected.

Receiving water density can be calculated through one of the two internal algorithms in CORMIX if temperature and salinity are known. For this study, temperature profiles (shown in Figure 2-4) and salinity measurements from late June to October, 2006 were analyzed for station MD in project HB06 (shown as red MD in Figure 2-2). Although the temperature and salinity were measured in the year 2006 while the effluent flow rate and bacteria concentrations were sampled in the year 2010, it is considered reasonable to determine representative conditions for each month without addressing the temporal discrepancy.

Figure 2-5 illustrates the selected representative temperature profile for each month: July presents stratified distribution with the maximum temperature difference between the water surface and bottom; August shows a smooth distribution with a linear temperature drop; September transitions from stratified to well-mixed condition; and October indicates uniform temperature throughout the water column. Because there are no November measurements at station MD, the temperature profile was assumed to be identical to the October profile. This assumption is further verified with station C2 data (location shown on Figure 2-2) in the following paragraph. For the plume model, a linear stratified temperature profile is used for months July to September while a uniform distribution is used for October and November.

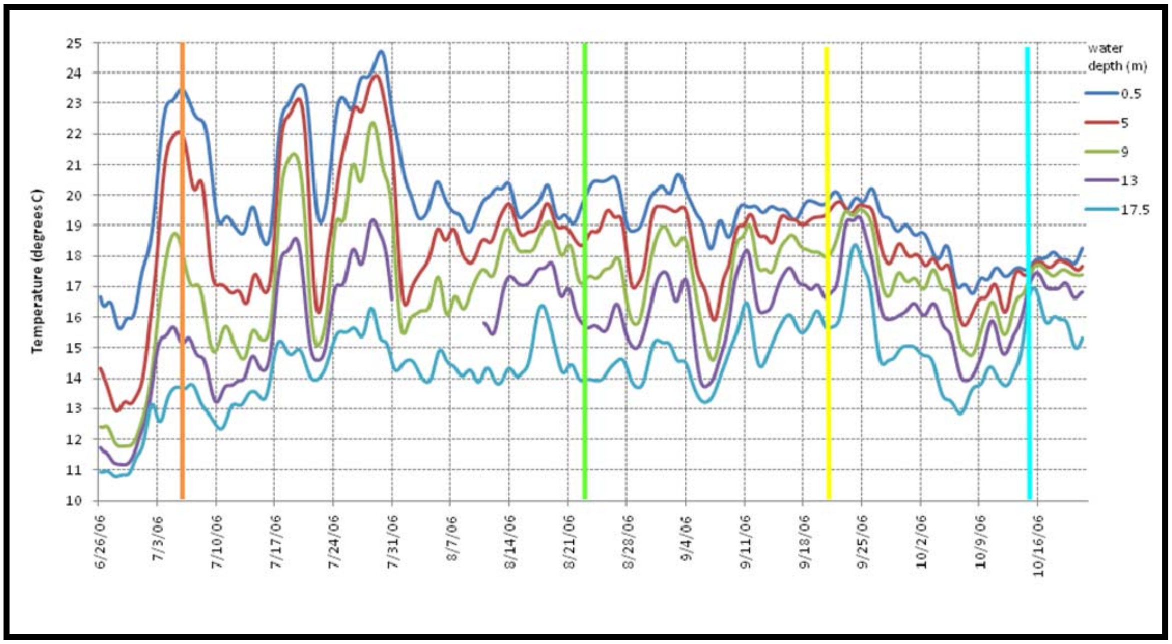


Figure 2-4: Ambient Temperature Profiles from Quarterly Survey at Station MD

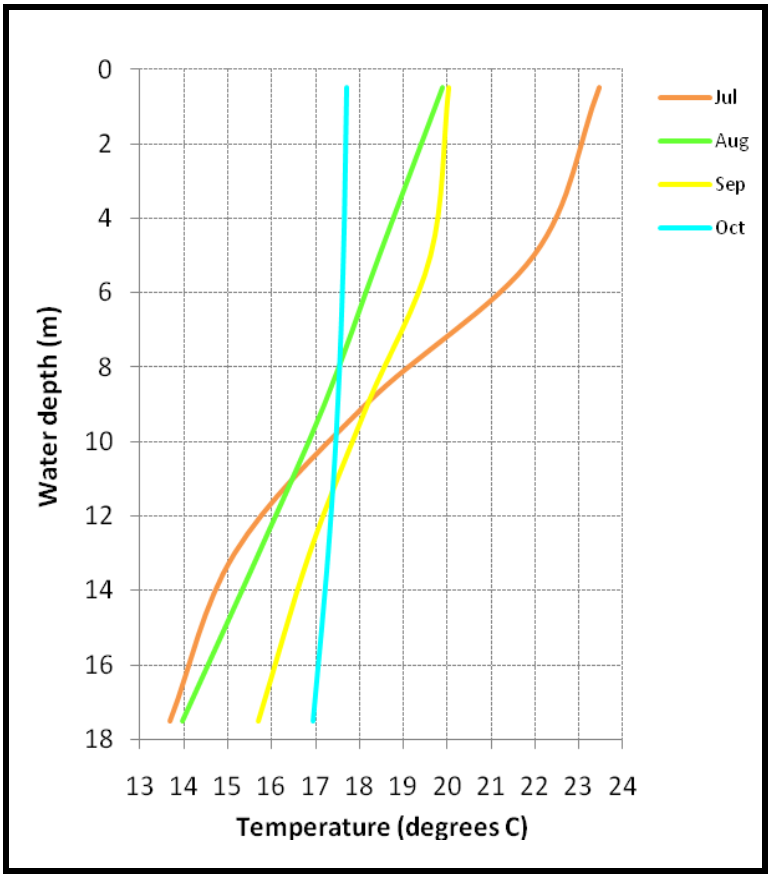


Figure 2-5: Selected Representative Temperature Profiles for Each Month

Further evaluation of the selected temperature profiles is illustrated in Figure 2-6 where the distribution of the difference between near-surface and bottom temperature is plotted for the complete MD data set for the period of July through October 2006. This temperature difference is assumed to be a simple indicator of the stratification. The data indicate that the stratification in the temperature profile selected for July is almost never exceeded in this period of record. This suggests the July temperature profile represents a relatively extreme case for this season. Conversely, the October temperature profile represents a scenario where very few profiles have less stratification. The August stratification is exceeded approximately 25% of the time and the September stratification is exceeded approximately 65% of the time. These results suggest that the selected temperature profiles represent the wide range of conditions expected during the months of interest.

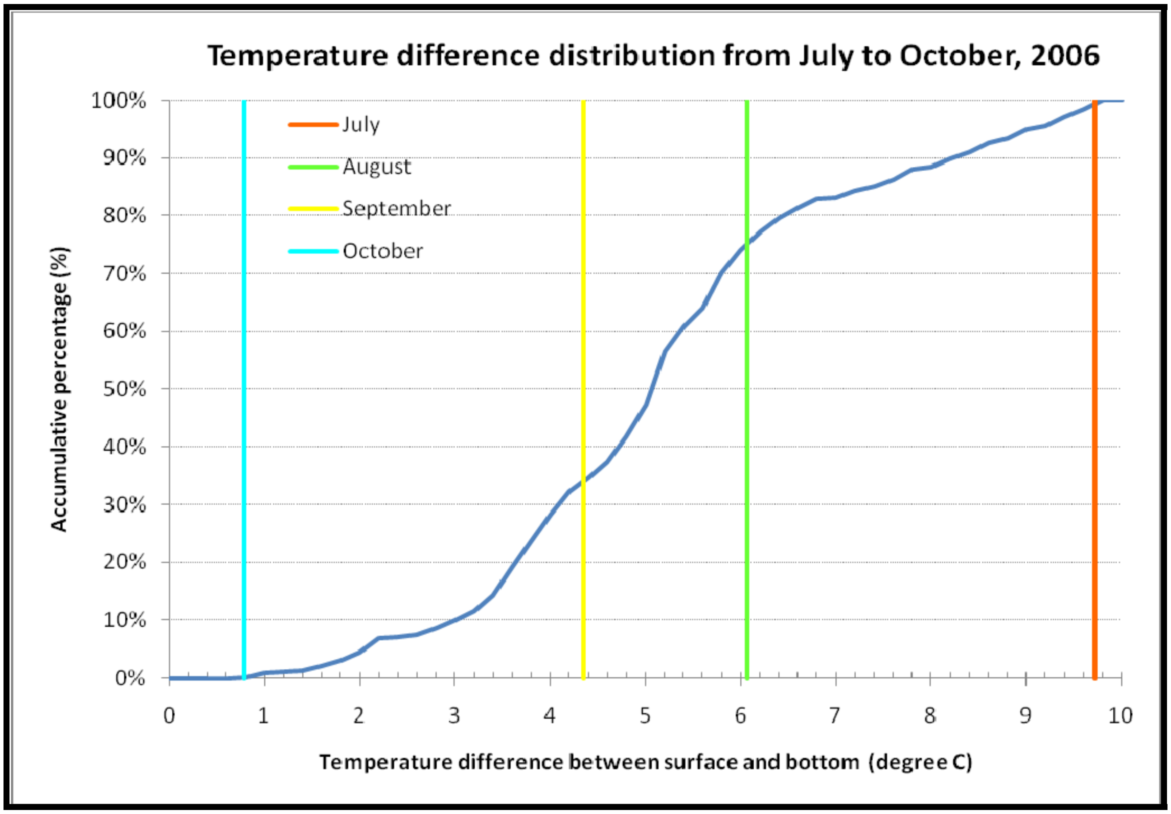


Figure 2-6: Distribution of Near-Surface to Bottom Temperature Differences Compared with Selected Monthly Temperature Profiles

Figure 2-7 illustrates the temperature measurements at station C2. The temperature profile shows a relatively uniform pattern, except the bottom measurement at 14.5 m depth. Overlapping with the MD profiles, the temperature is consistent with C2 on September 21 and October 15 (Figure 2-8, left panel). The minor discrepancy might be that C2 has more vertical resolution (9 bins) while MD has only 5 bins. Three November profiles at C2 were selected and compared with the analyzed October profile at MD. As shown in Figure 2-8, right panel, the MD profile is not only within the temperature range but also shows a similar pattern as November 17 and 30 profiles. Therefore, it is considered reasonable to use October profile for November as well.

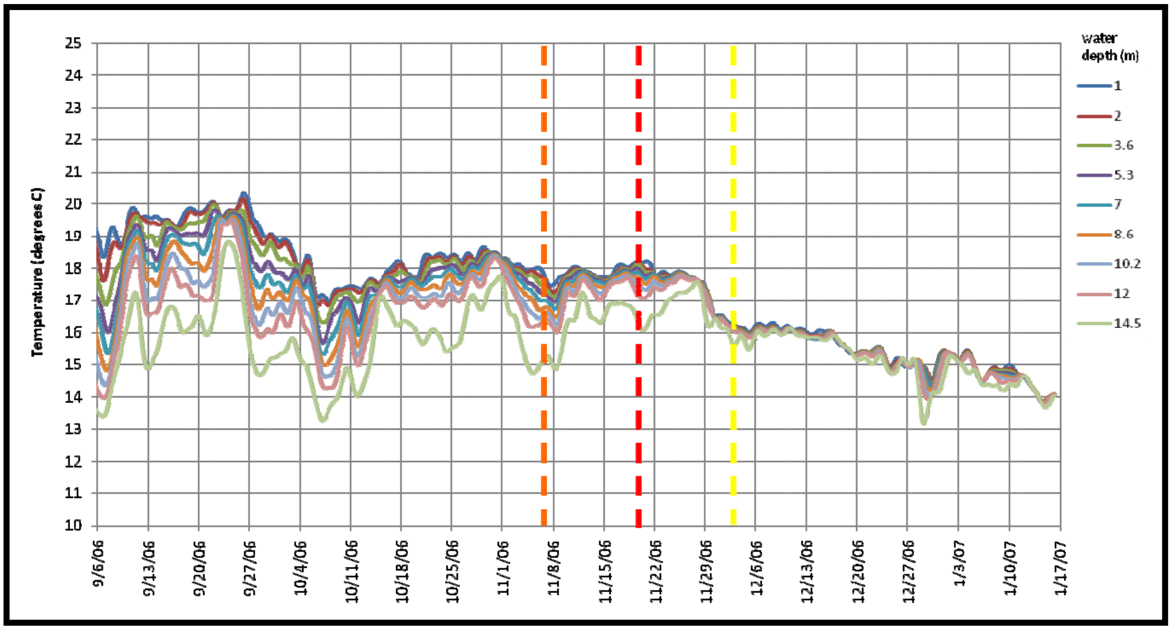


Figure 2-7: Ambient Temperature Profiles from Quarterly Survey at Station C2

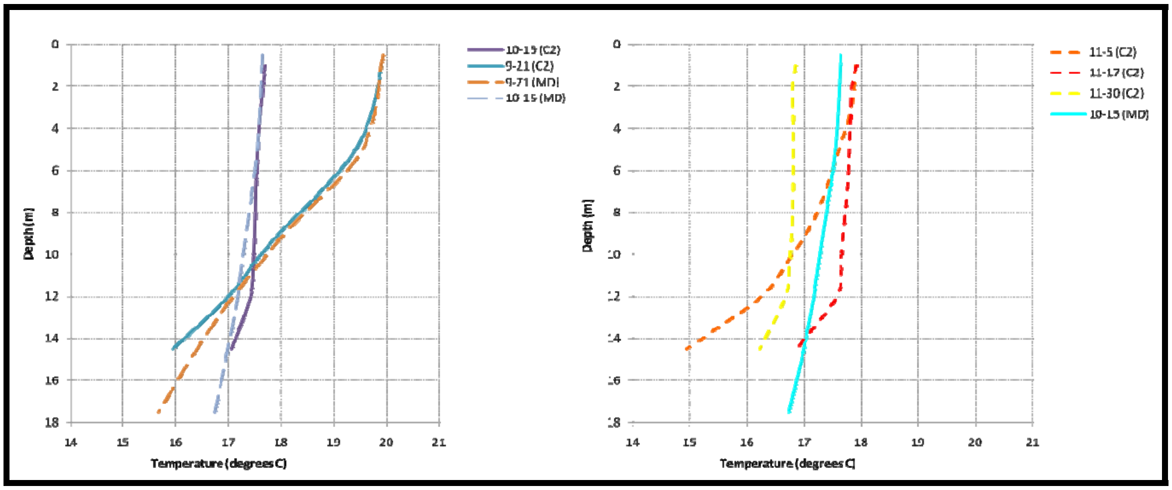


Figure 2-8: Left Panel: Comparison of MD and C2 Profiles Overlapped in September and October. Right Panel: Comparison of C2 November Profiles with Analyzed MD October Profile

2.1.3 Discharge Geometry

The discharge configuration of submerged multiport diffusers was used. Module inputs are the distance to the nearest shore, diffuser length, number of ports, port height and port diameter, alignment angle between ambient current direction and diffuser axis, and general configuration and orientation of each port.

The distance to the nearest shore was calculated based on the outfall structure coordinates provided by Mr. Tom Pesich (personal communication) which is approximately 2,000.83 m to the first port. According to the as-built drawings of the outfall diffuser, the total length is 292.7 m (960 ft), the port diameter is 0.159 m (6.25 in.) and 0.91 m (3 ft) above sea floor, 123 total ports (62 on one side and 61 on the other side of the pipe), and 30 degree alignment angle.

In CORMIX, three types of port or opening configurations can be specified: unidirectional, staged, and alternating. Given the District's outfall ports align orderly and separately on both sides of the pipe, the alternating configuration was selected. It was further noted that in CORMIX 2, one alternating type is used to represent all alternating configurations with the same effect as no net horizontal momentum flux.

Flow diagrams utilized with CORMIX to determine the plume geometry with stagnant ambient current are illustrated in Figure 2-9 and Figure 2-10 for the cases of linearly stratified receiving water column and vertically well mixed receiving water column, respectively. These flow diagrams illustrate how the plumes are classified related to various properties of the receiving water and the discharge.

2.2 Results

Three ambient current cases were investigated in this study: stagnant condition, 0.2 m/s with upcoast flow direction, and 0.2 m/s with downcoast flow direction. However, it was noted that the jet/plume characteristics are identical for both flow directions because all the modeling inputs are the same except the nearest shore location being reversed. Therefore, no further distinction is given for the flow directions.

In addition, three effluent bacteria (total coliforms, fecal coliforms, and enterococci) were calculated separately. However, the predicted plume dimensions and profiles depend on the relative percentage of initial pollutant concentration, not its absolute value. As a result, all plume characteristics of concern are identical for the three bacteria. In the following section, only the general behavior of the plume is provided, unless otherwise described.

2.2.1 Initial Dilution

The California Ocean Plan requires zero current speed to be used in computing minimum initial dilution as the worst case scenario (State Water Resources Control Board, 2005). Initial dilution is defined as the initial concentration C_0 of pollutant over concentration C where the submerged plume ceases to rise in the water column at an equilibrium depth below the water surface or where the momentum induced mixing becomes insignificant if the plume rises to the surface, which would typically occur in non-stratified receiving water. With a stagnant ambient current condition, mixing between the effluent and surrounding water body is minimal. In July, the ambient density stratification is somewhat influential; therefore, the discharge is trapped at a layer indicated as case “MS4” shown in Figure 2-9. During August through November, the ambient density stratification is relatively weak and a jet-like discharge dominated by its momentum flux penetrates to the surface as case “MU1V” shown in Figure 2-10. Although both figures show a possibility of upstream intrusion, it is not feasible to determine the corresponding characteristics due to non-stable conditions. Table 2-1 lists the calculated initial dilution increasing from 28 to 37 with the ambient water body being less stratified during the fall months. As stated above, the initial dilution is taken to be the dilution after the plume rises to it maximum height of rise when the plume does not reach the surface, of after the momentum induced mixing is no longer significant if the plume does reach the surface due to shallow water depth, relatively high momentum, or no stratification. Since this initial dilution case is for no ambient current, the location of the initial dilution calculation is directly above the diffuser.

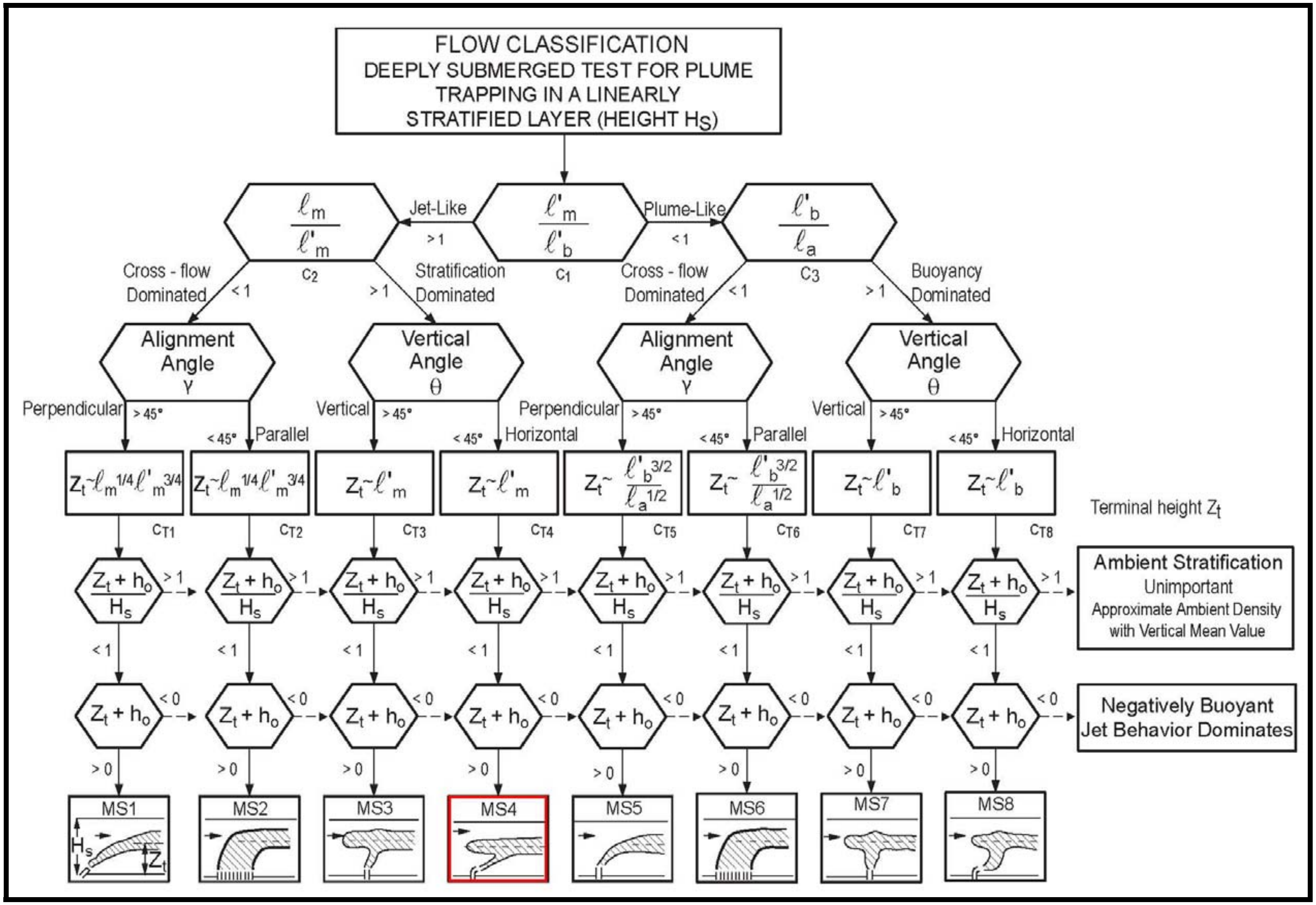


Figure 2-9: Flow Classification: Stagnant Condition, for July.

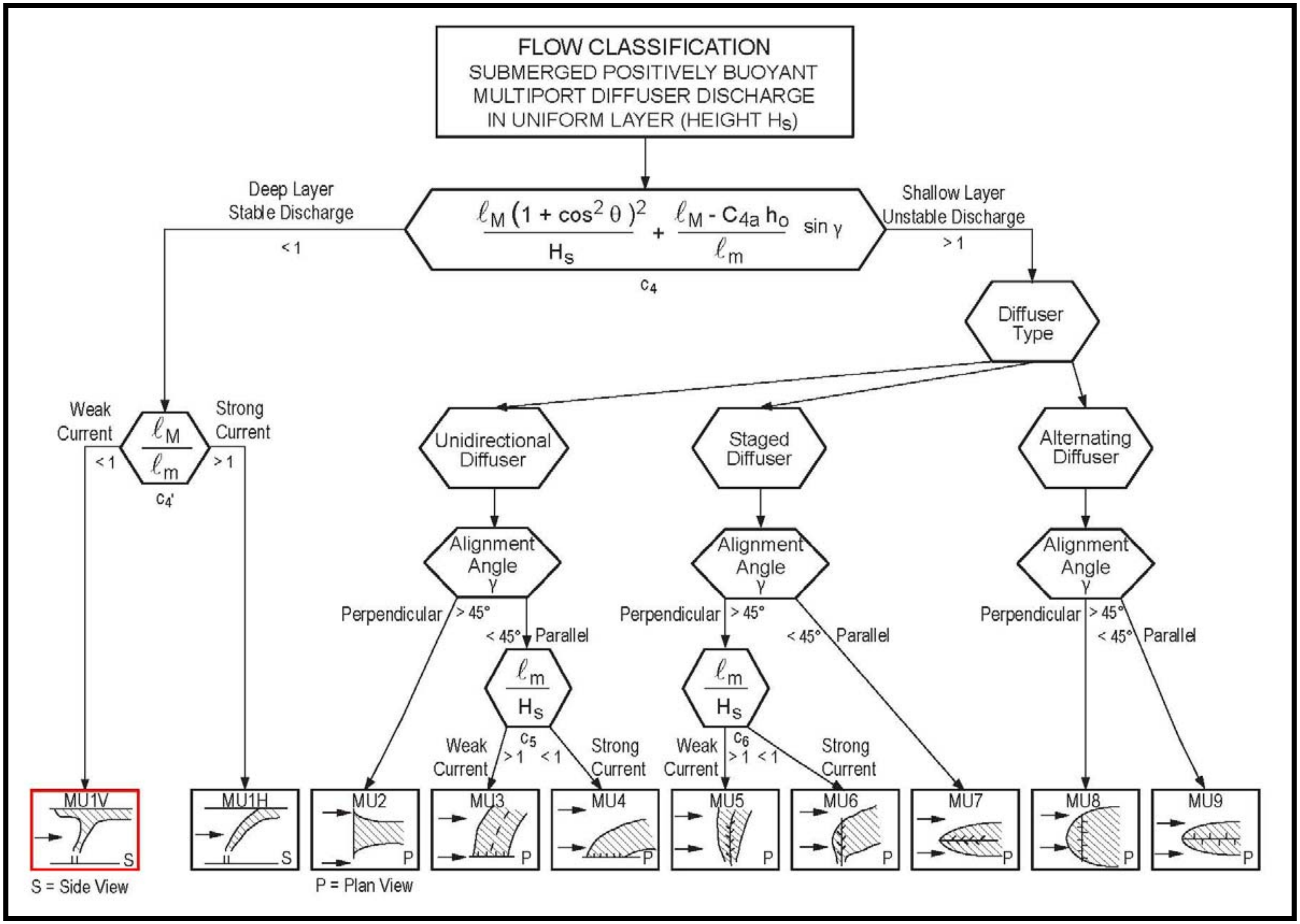


Figure 2-10: Flow Classification: Stagnant Condition, for August through November.

Table 2-1: Initial Dilution by Month

Month	Initial Dilution
Jul	28
Aug	32
Sep	34
Oct	37
Nov	37

* Note that these initial dilutions occur in the water column directly above the diffuser.

2.2.2 Effluent Discharge Profiles with Ambient Flow

More complex interactions occur between the effluent discharge and surrounding waters by adding in the ambient flow. Table 2-2 summarizes the predicted profiles and dimensions for different interactions, or modes. Generally, two modes form during July to September when density stratification is relatively influential. An example in August of this two-mode pattern is shown in Figure 2-11, top panel. The plume size increases with time and distance because more mixing is induced by the ambient flow. Minor differences occur if the effluent discharge is jet-like (relatively momentum-dominated) or plume-like (relatively buoyancy-dominated). Results show that the mixing region length, pollutant dilution, plume thickness, and well-mixed water depth all increase during July to September with less stratified surrounding waters. In September, up to 91 percent of the water column is fully mixed at the edge of jet/plume mixing region.

The second mode during July to September is a developing internal density current. It forms when the cross-flow component and stratified condition dominate the plume behavior and the plume is trapped within a stratified ambient density layer, called the terminal layer. Not only does the plume spread downstream, it is carried back to the previous region (jet/plume mixing) with the same distance as its downstream counterpart. Overall, the spreading is slightly increased in the vertical direction and greatly increased in the lateral direction. Similarly, the region length, pollutant dilution, and plume thickness increase with less stratified conditions. Figure 2-12 shows the dilution profile with respect to the centerline trajectory distance in August. The remaining bacteria concentrations drop to 0.6 percent of initial concentrations at the edge of the NFR (325 m from the diffuser ports).

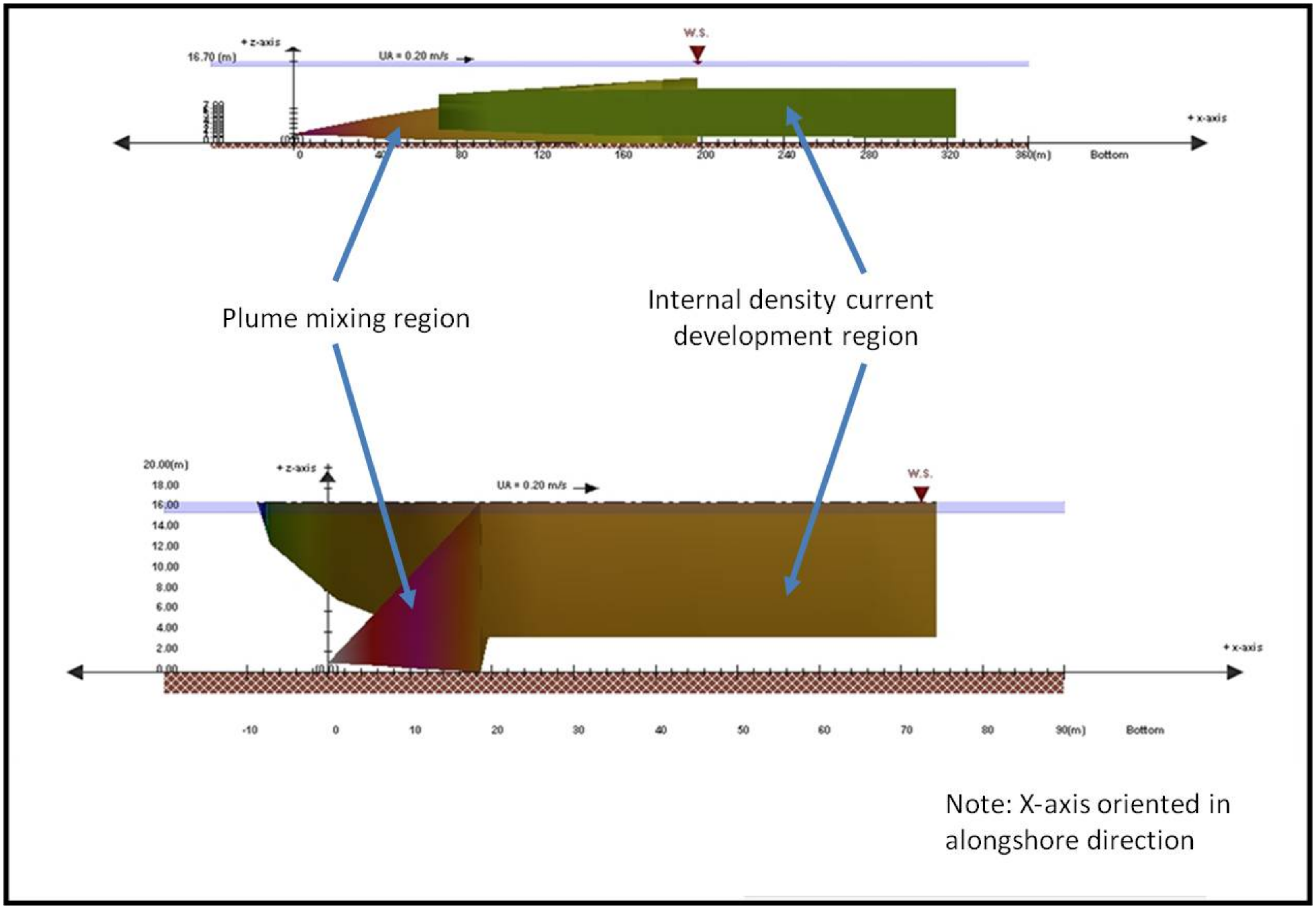
Unstable near-field mixing occurs in October and November when the water column is well-mixed. As illustrated in Figure 2-11, bottom panel, the effluent discharge immediately rises to the surface from the outfall ports. Strong effluent current remains on the surface shortly after release, similar to a discharge from shallow water. As a result, a uniformly mixed layer (79 percent of the water column) shows between 17 and 75 m is, in effect, spreading in a top-down direction. In addition, upstream intrusion is present due to an unstable recirculation of initial discharge flow. This intrusion extends upstream of the diffuser line until it reaches the stagnation point (-8.8 m). Table 2-2 shows the plume characteristics for October and November. Similarly, Figure 2-13 shows the dilution profile with respect to the centerline trajectory distance in October. The remaining bacteria drop to 1.5 percent of initial concentrations at the edge of the NFR (approximately 75 m from the diffuser ports).

Flow classifications in the model are defined as MS2 for July, MS6 for August and September, and MU9 for October and November (see Figure 2-14 and Figure 2-15).

Table 2-2: Discharge Profiles and Dimensions by Modes

Mode		Jet/Plume Mixing Region				Internal Density Current Development			
Month	End Dist. (m)	Pollutant Dilution (=C0/C)	Plume Thickness (m)	Plume Half-Width (m)	Water Column Mixing (%)	End Distance (m)	Pollutant Dilution (=C0/C)	Plume Thickness (m)	Plume Half-Width (m)
Jul	149.2	92.9	10.6	151.8	64%	276.0	131.4	7.9	421.8
Aug	198.0	117.6	13.3	153.4	80%	324.8	166.3	10.1	419.0
Sep	233.3	134.5	15.1	154.4	91%	360.1	190.3	11.6	416.7

Mode			Upstream Intrusion after Near-field Instability				
Month	Upstream Intrusion Length (m)	X-coordinate of Stagnation Point (m)	Thickness in Intrusion Region (m)	End Distance at Downstream End (m)	Thickness at Downstream End (m)	Half-width at Downstream End (m)	Dilution at Downstream End
Oct Nov	27.4	-8.8	13.2	74.5	13.2	111.8	67.5



Plume mixing region

Internal density current development region

Note: X-axis oriented in alongshore direction

Figure 2-11: Top Panel: Example of Two-mode Profiles in August. Bottom Panel: Example Profile in October

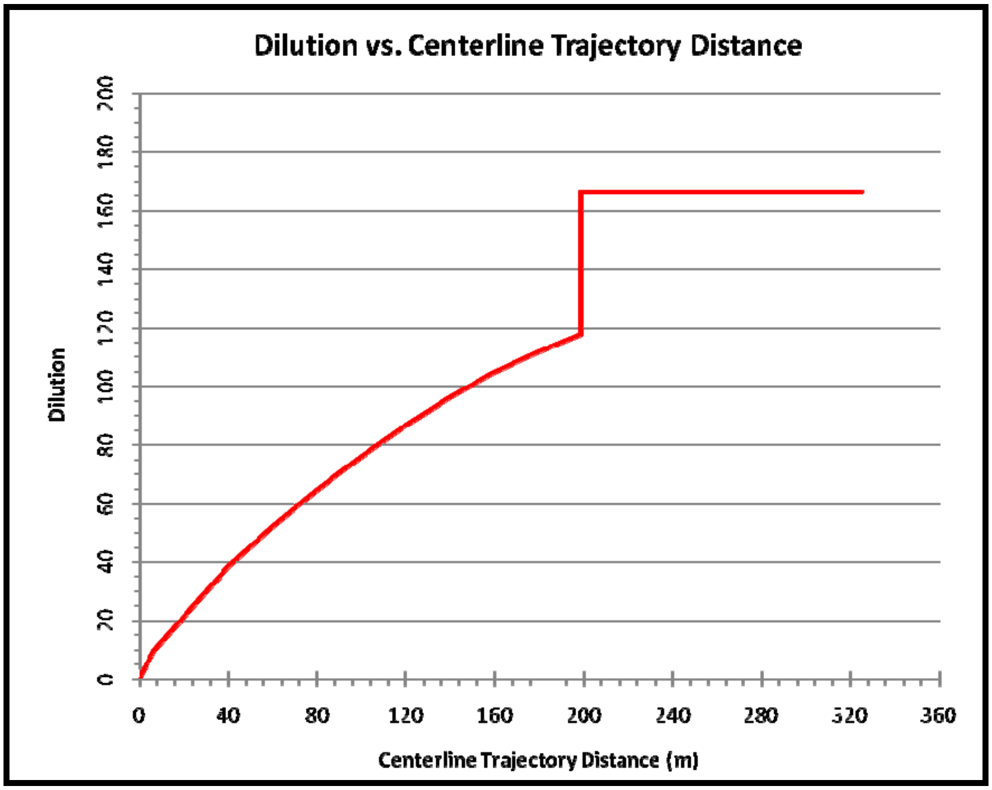


Figure 2-12: Dilution Profile in August

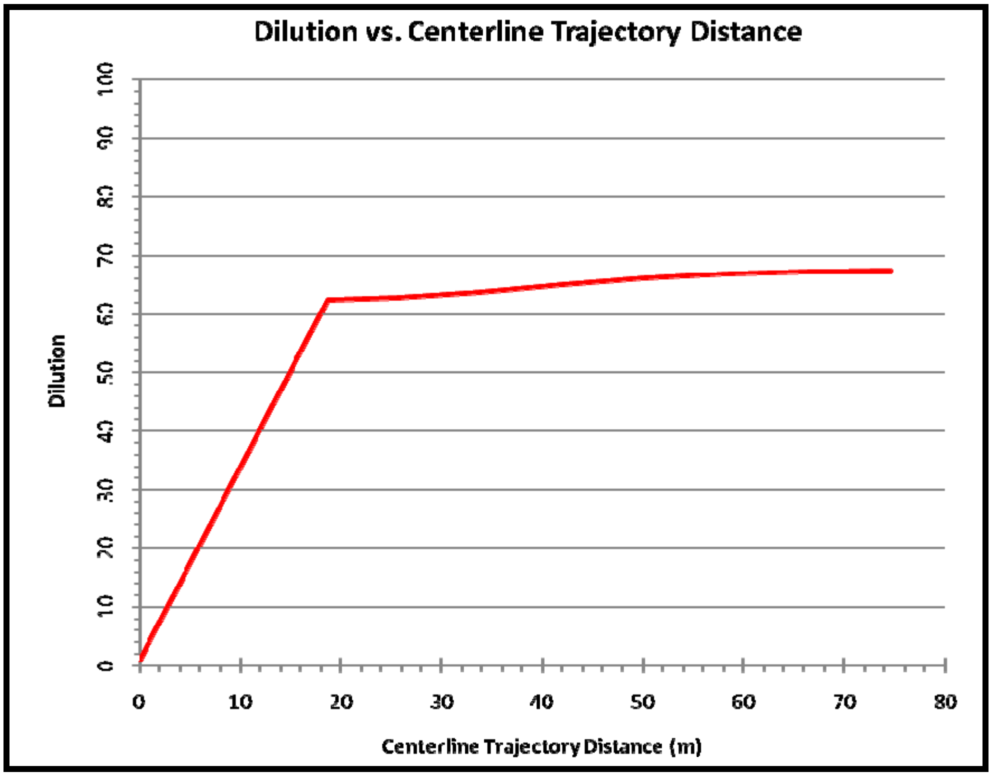


Figure 2-13: Dilution Profile in October

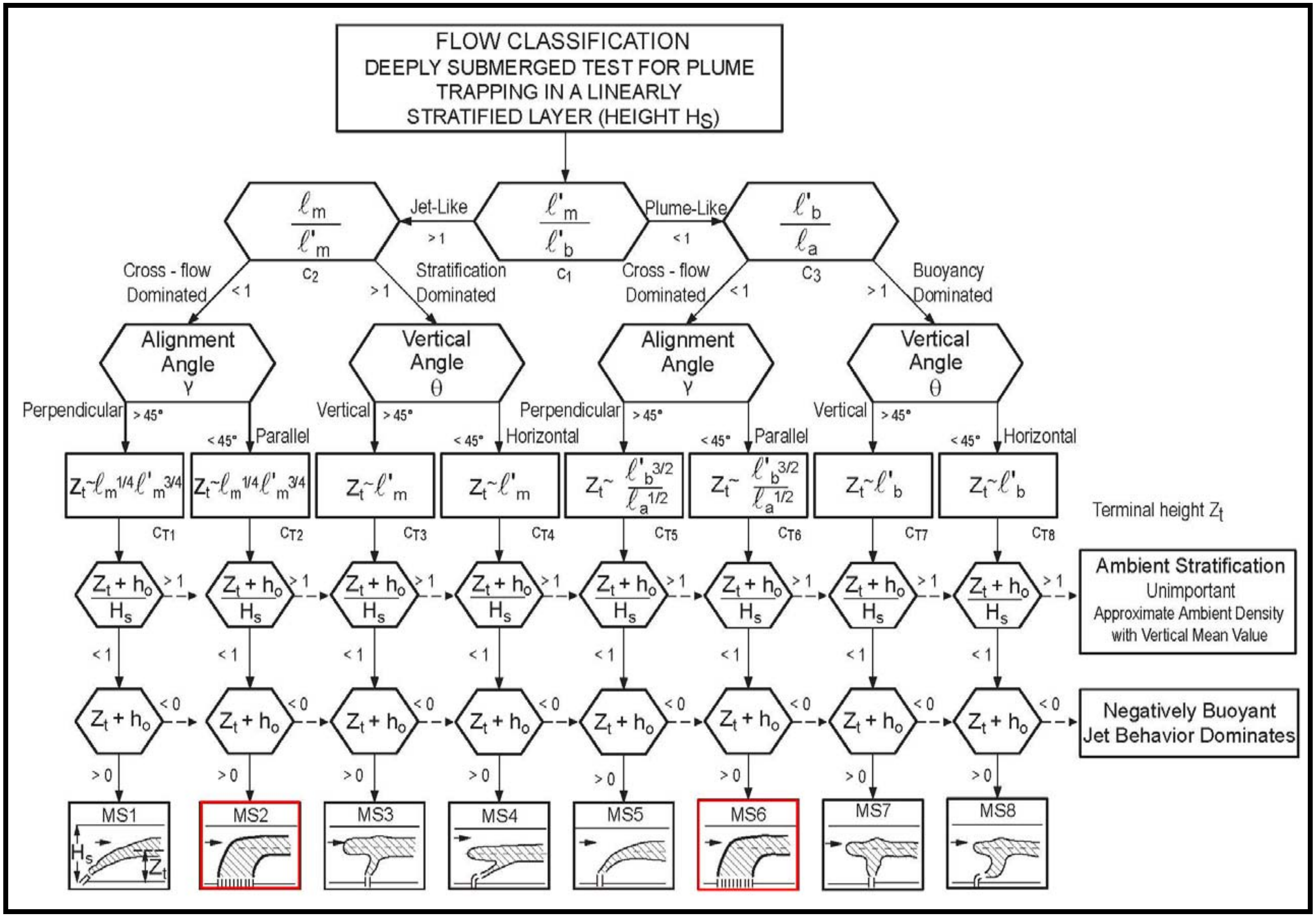


Figure 2-14: Flow Classification: with Ambient Flow, MS2 for July and MS6 for August and September

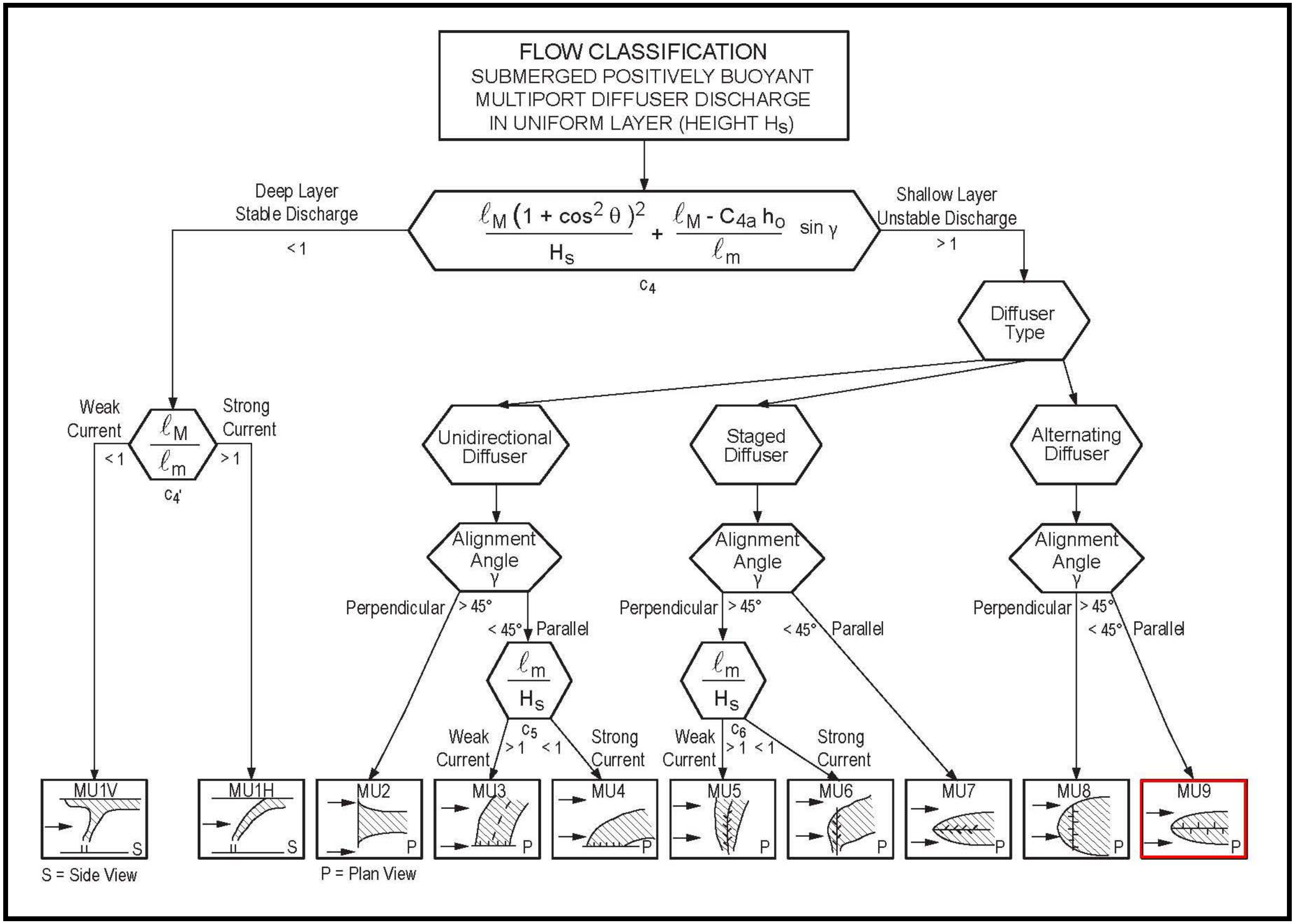


Figure 2-15: Flow Classification: with Ambient Flow, for October and November

2.3 Conclusions from Initial Dilution Modeling

The plume model CORMIX, submerged multiport diffusers module, was used to investigate the dilution and the plume profiles during July through November at the OCSD's shallow outfall diffuser. Focusing on the near-field region, a stagnant and ambient flow condition with three individual bacteria concentrations was studied. For the stagnant condition, the minimum dilution varies from 28 to 37 and the plume penetrates to the surface during August through November.

With ambient flow, results show that the near-field region length, pollutant dilution, plume thickness, and well-mixed water depth all increase during July to September. The plume does not penetrate to the surface during this period, but tends to spread more in the vertical direction with time. In October and November, the unstable interactions lead to upstream intrusion and confine the near-field region closer to the diffuser. The plume rises immediately to the surface and spreads downwardly.

Based on this near-field plume modeling study, a uniformly distributed effluent over a 200 m radius circular area around the outfall diffuser is considered reasonable and can be used in the two-dimensional modeling work in this project. This is based on the centerline dilution profiles illustrated for the two extreme cases of stratification in August and October as illustrated in Figure 2-12 and Figure 2-13, although the centerline dilution profile for October suggests this radius could be even less..

3.0 FAR-FIELD MODEL DEVELOPMENT

The MIKE by Danish Hydraulics Institute (DHI) modeling system was selected as a modeling platform for the project. MIKE is commercial software developed by DHI. It has the capability to model complex processes, such as the interaction between currents and waves, model transport and diffusion of various constituents and tracers, sediment transport and morphology, and water quality. MIKE FM (Flexible Mesh) was selected for the project due to the flexibility and numerical efficiency available with its unstructured mesh configuration. The unstructured mesh makes it possible to resolve both large and small scale flows and waves in a single model setup. A finer mesh may be used in the immediate vicinity of the areas of interest and a coarser mesh may be used offshore and away from the site.

MIKE FM consists of a finite volume/flexible mesh hydrodynamic model to which other modules can be added to address different phenomena. The system solves the two-dimensional incompressible Reynolds averaged Navier-Stokes equations under the assumptions of Boussinesq and of hydrostatic pressure. Thus, the model consists of continuity, momentum, temperature, salinity, density equations, and turbulent closure scheme. MIKE FM has the capability to resolve three-dimensional flows; however, for this study a two-dimensional model was used to assess the tidal and wave induced currents. Also, density variations due to salinity and temperature were not included in the present model.

Three modules of the MIKE suite were used. MIKE 21 FM HD (Hydrodynamic Model) was used to assess hydrodynamic conditions which included tidal, wind, and wave induced currents and superimposed along-shore current which mimics a large scale circulation of Southern California bight. MIKE 21 SW (Spectral Waves Model) was used to model the wave transformation from the offshore edge of the model domain to the beach. The SW model provides forcing into the HD model to generate water levels and currents resulting from the wave shoaling and breaking. MIKE21 SW includes the following physical phenomena: wave growth by action of wind; non-linear wave-wave interaction; dissipation due to bottom friction; dissipation due to depth-induced wave breaking; refraction and shoaling due to depth variations; and wave-current interaction. MIKE 21 AD (Advection-Diffusion Model) utilizes the currents calculated by the HD model and predicts transport and distribution of the effluent in the far-field region of the discharge location.

3.1 Model Domain

The model domain extends from Crystal Cove in the south to the Huntington Harbor South jetty in the north. The domain covers a rectangular area of 28 km along-shore and 8.5 km offshore. It includes part of the Santa Ana River and Newport Harbor. The diffuser is located about 2 km offshore from the Santa Ana River mouth, at least 11.5 km away from the southeast boundary, and 16.5 km away from the northwest boundary. A few preliminary tests were done during the selection of the model domain to verify if the plume is allowed sufficient space to develop and propagate away from the release area without interfering with the model boundaries. The tests showed that the extent is adequate for the far-field modeling of plume dispersion. The final selected model domain in shown in Figure 3-1.

For model development, all geographic data was converted to reference UTM-11, WGS84.

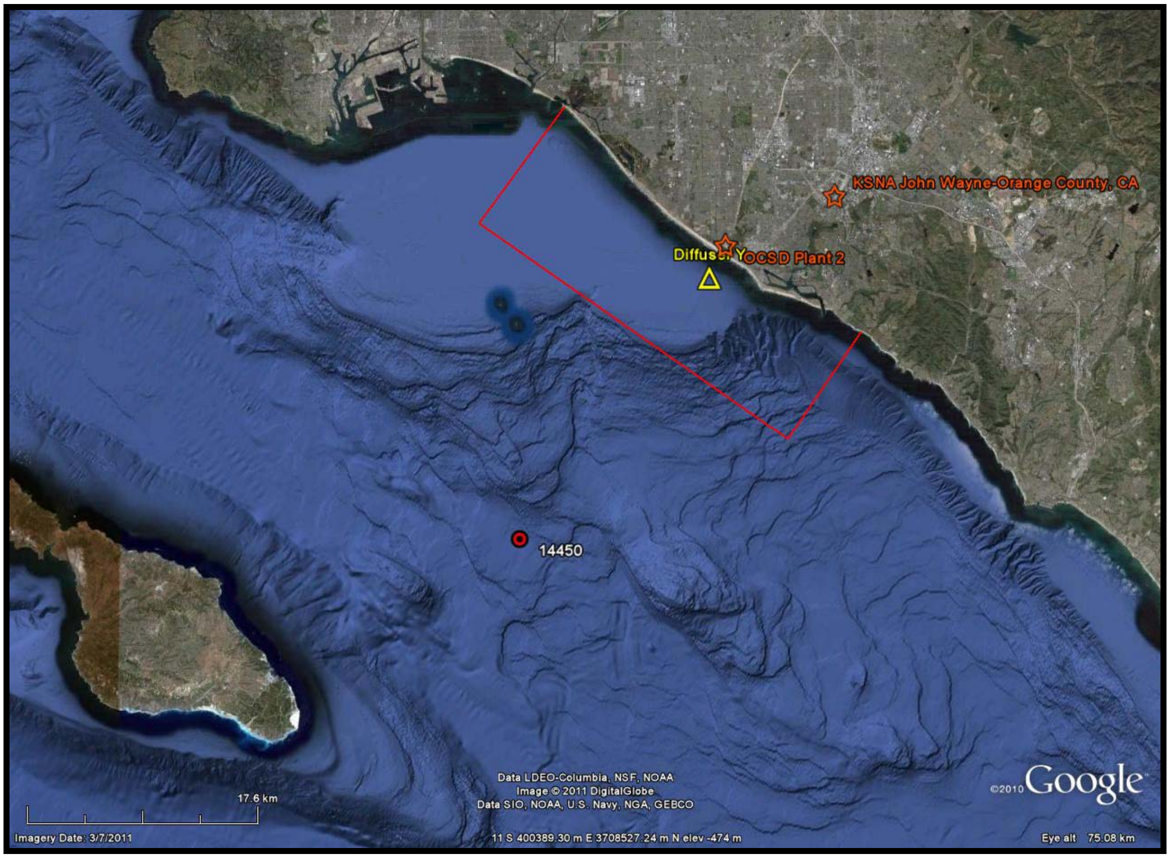


Figure 3-1: Extent of Model Domain with Locations of GROW station 14450, OCSD Plant No. 2 (P2), and John Wayne Airport (METAR Station KSNA)
(Source: Google Earth)

3.2 Model Bathymetry and Mesh

Digital Elevation Model of Santa Monica, California, Integrating Bathymetric and Topographic Datasets developed by NOAA NESDIC were used as a source of bathymetric data. The DEM is available from the NOAA NGDC website at http://www.ngdc.noaa.gov/mgg/inundation/tsunami/inundation.html. The data was referenced to North American Vertical Datum of 1988 (NAVD88). The interpolated bathymetry for the model domain is shown in Figure 3-2.

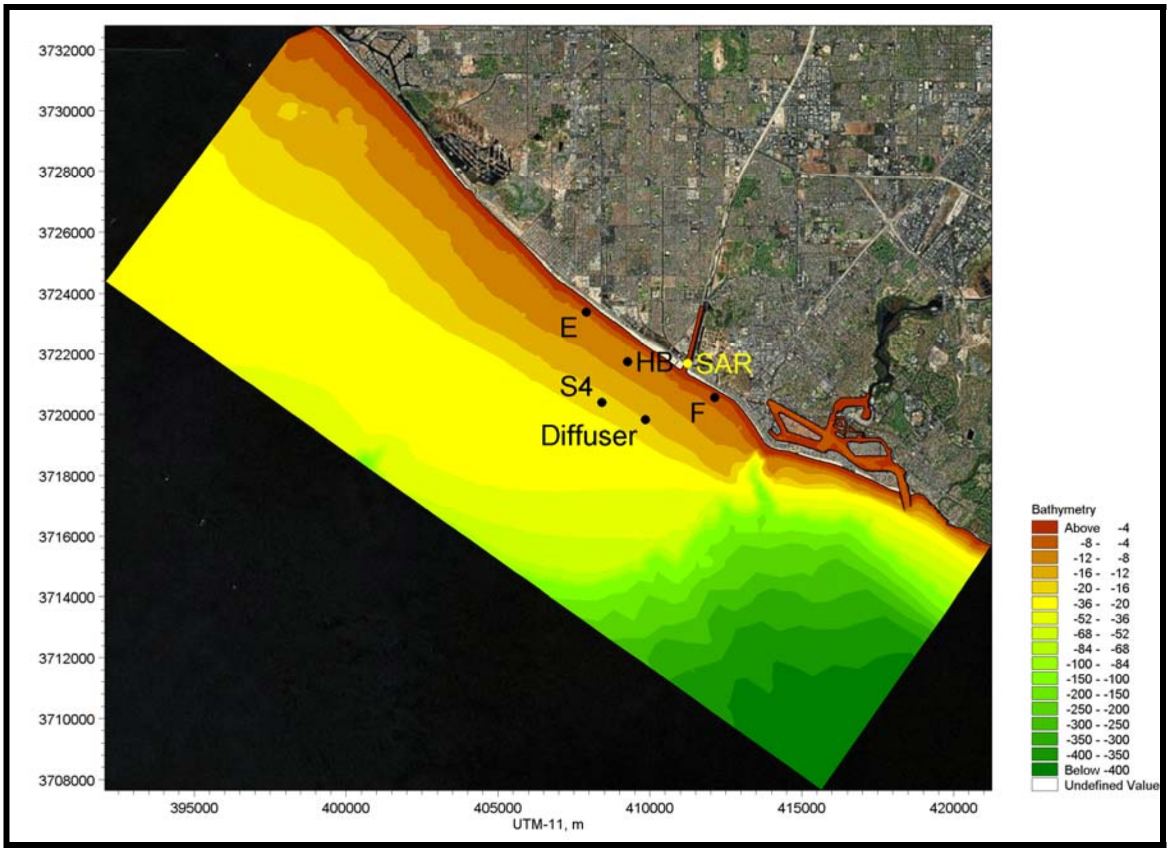


Figure 3-2: Interpolated Model Bathymetry from DEM of Santa Monica, CA (NAVD88)

The model mesh with interpolated bathymetry is presented in Figure 3-3. A close-up view of the area around the diffuser is shown in Figure 3-4. The mesh has a variable resolution. The largest elements (about 1,000 m) cover the deepest part of the domain in the submarine canyon. The shallow offshore area has a resolution about 300 m. The highest resolution is used in the area around the diffuser and along the coastline in the nearshore zone. The resolution in these areas is about 50 m. The total number of computational elements was about 18,500. The number of the elements and resolution of the model were optimized for reasonable computation times with accurate representation of the flow patterns including wave generated currents.

A mixed sigma- and z-layer mesh was used for 3D simulations. Thickness of sigma-layers was adjusted to local depth. Thickness of each z-layer was fixed. Six uniformly distributed sigma-layers were used. The sigma layers extended down to 30 m depth after which z-layers started. The thickness of z-layers varied from 10 to 100 meters. Up to nine z-layers were used in different locations depending on local depth.

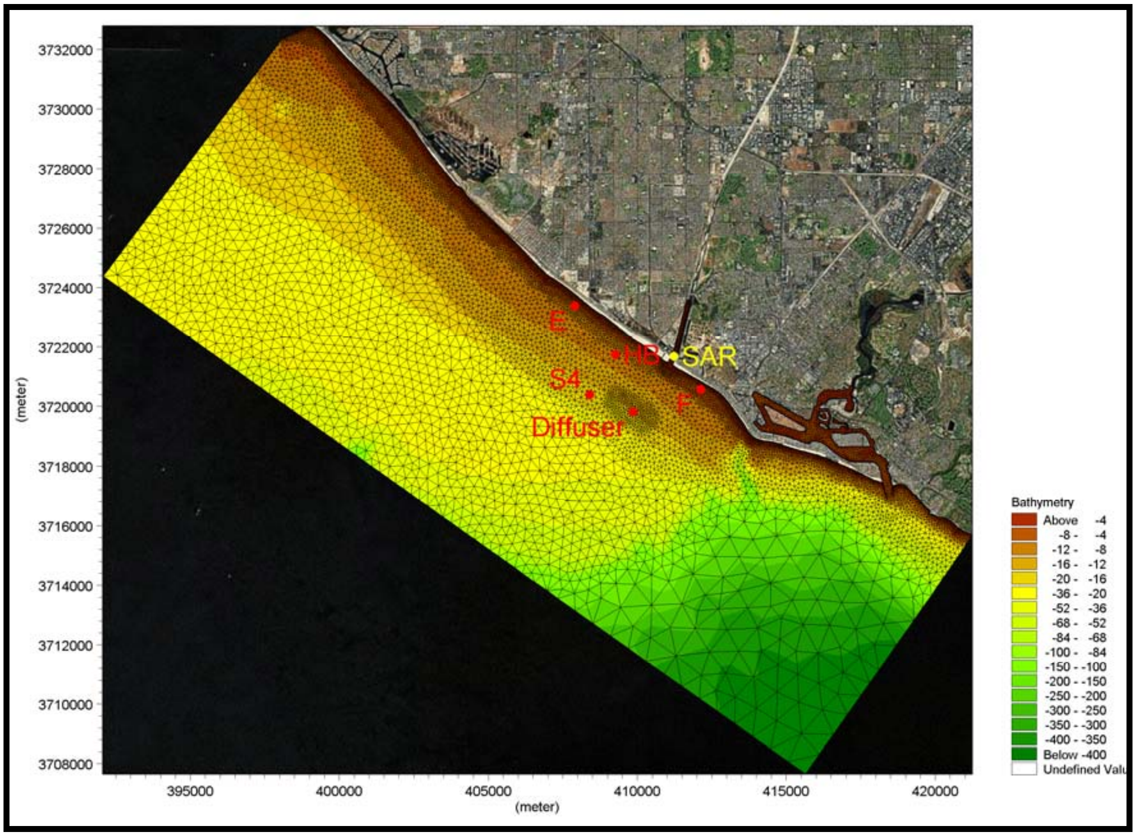


Figure 3-3: Model Mesh

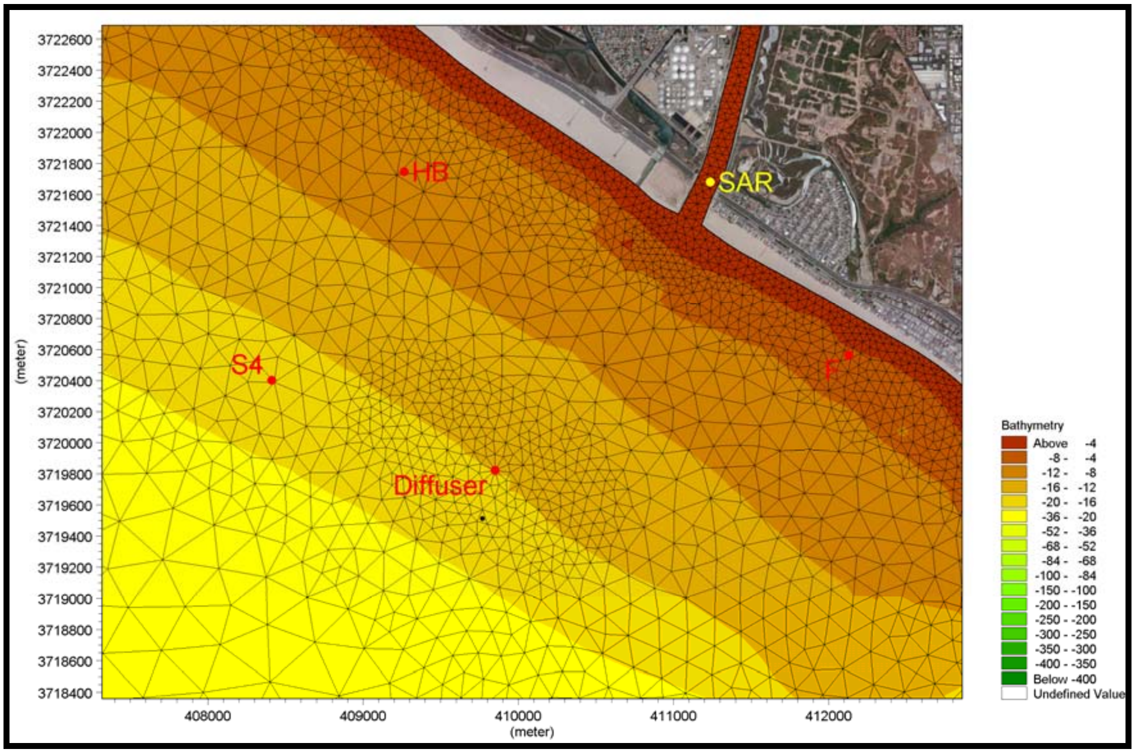


Figure 3-4: Model Mesh in vicinity of Diffuser

3.3 Offshore Boundary Conditions for Water Levels and Velocities

The flow model was forced at the offshore boundaries using astronomical tidal water levels and velocities obtained from tidal constituents from the West Coast of America Tidal Database (Egbert and Erofeeva, 2010). This tidal database was developed by Oregon State University by assimilating satellite altimetry data collected over numerous years into a tidal database using Ocean Tidal Inversion Software (OTIS). Tidal constituents were extracted from the tidal database at several locations along each offshore boundary of the model. Then time series of water levels and velocity components were derived for a selected time period.

To mimic a large scale circulation within the Southern California bight, which could force a steady along-shore current in the proximity to the coast at Huntington Beach, the tidal boundary conditions were modified to include a superimposed current in addition to the tidal current. In each simulation, a steady current was directed either up or down the coast. The current speed was equal to a specified value (for example, 0.2 m/s) at a depth of 30 meters and varied with depth following mass conservation equation along offshore boundary and Manning's equation with a constant friction coefficient across lateral boundaries.

Flather's type boundary conditions were used in the hydrodynamic model when both water level and velocities should be specified. Temporary and spatially variable water levels and velocity components were specified along each offshore boundary. As noted above, the data were extracted from the same database, which resulted in high quality boundary conditions.

3.4 Winds

The winds adjacent to the California coast are rather complex with large scale offshore systems forcing circulation cells at large distances offshore, while areas close to the coast and inland are more affected by the diurnal sea breeze system. An example of the offshore wind field is shown in Figure 3-5. The wind measurements at the John Wayne airport and at a station at OCSD Plant No. 2 during May 2000 show the diurnal sea breeze, while hindcast data from the Global Reanalysis of Ocean Waves (GROW) station (global wind, wave and hydrodynamic model from Oceanweather, Inc.) demonstrate the presence of a steady NW wind (Figure 3-6).

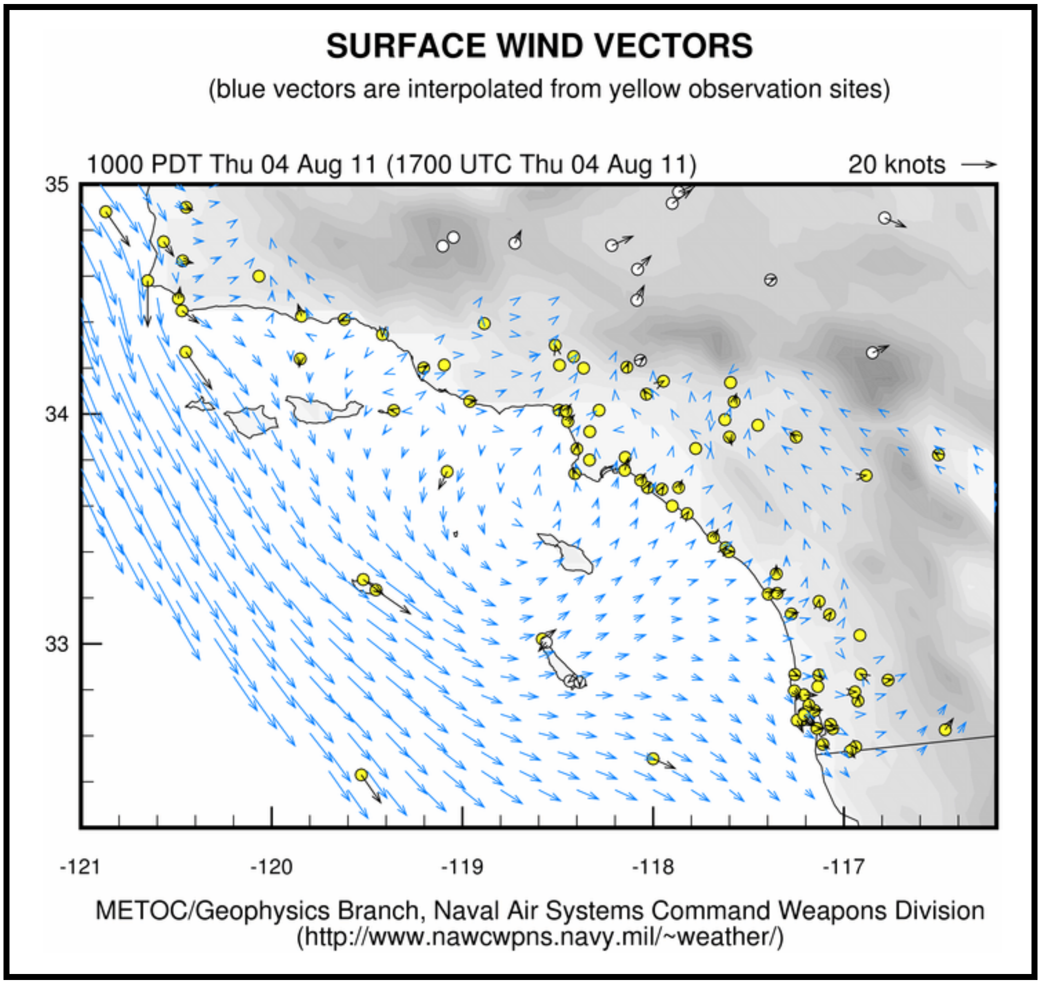


Figure 3-5: Surface Winds Offshore the California Coast

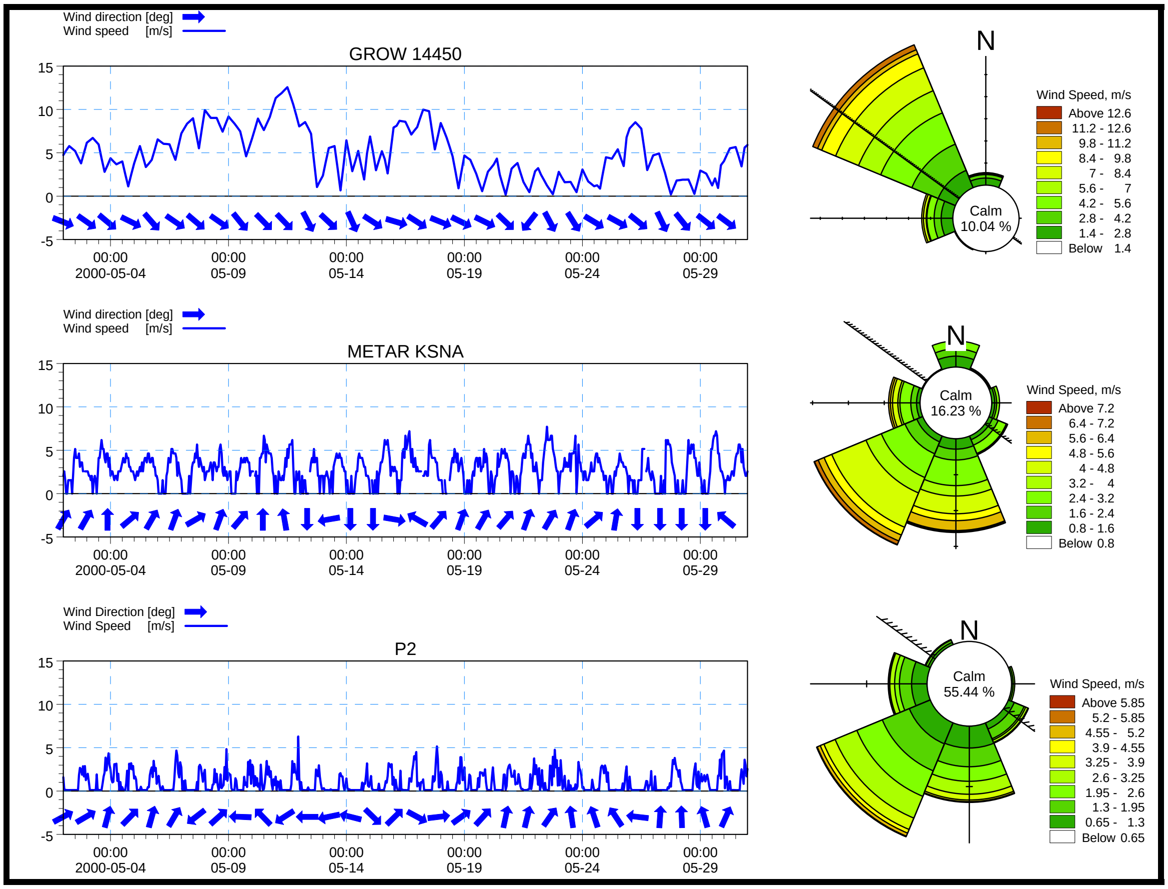


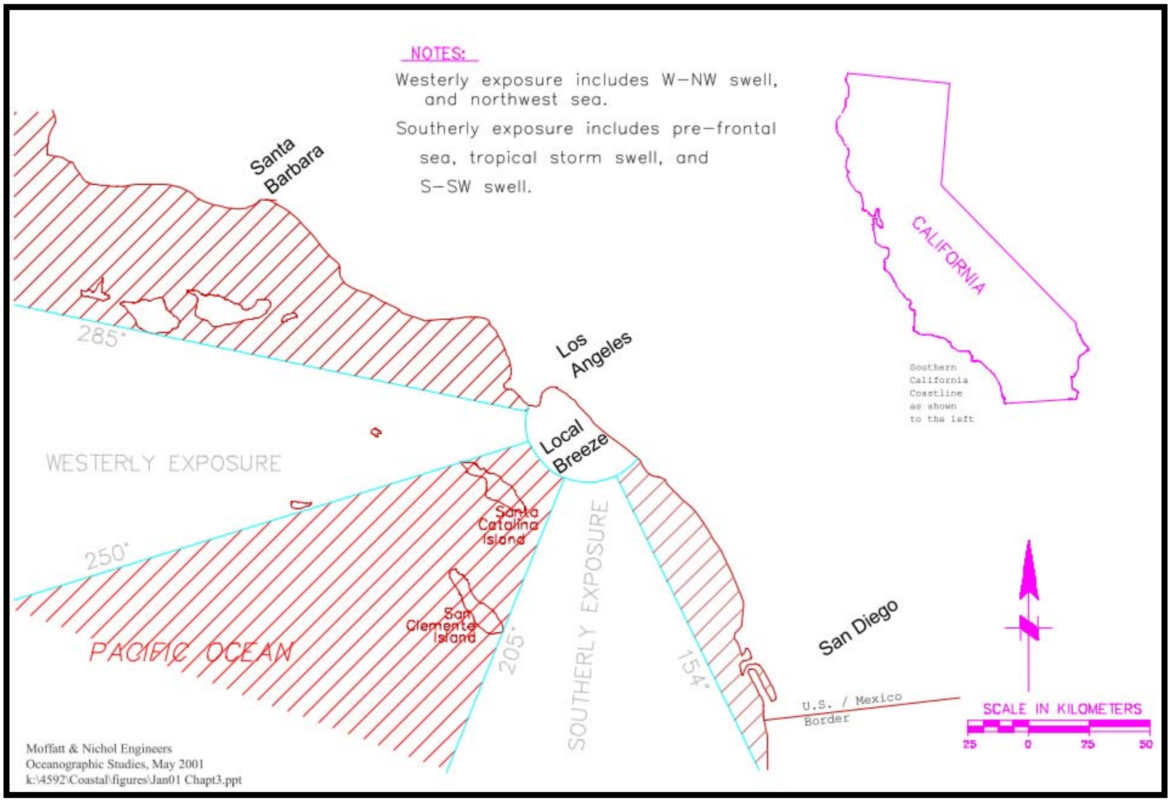
Figure 3-6: Wind Speed and Direction Measured at GROW Station 14450, OCSD Plant 2 (P2), and John Wayne Airport (METAR KSNA) during May 2000

3.5 Waves

The following paragraph with a general description of the wave climate was taken from a previous study done by M&N for the site (Moffatt & Nichol, May 2001).

The waves at Huntington Beach can be divided into three primary categories according to origin: northern hemisphere swell, southern hemisphere swell, and seas generated by local winds. Wave exposure at the site is shown in Figure 3-7. Huntington Beach is directly exposed to ocean swell entering from two main windows. The more severe waves from extratropical storms (Japanese-Aleutian and Hawaiian storms) enter between azimuths 250° and 285°. The Channel Islands and Santa Catalina Island provide some sheltering of these larger waves depending on the approach direction. The other major exposure window opens to the south, allowing swell from southern hemisphere storms, tropical storms (Chubascos), and southerly waves from extratropical storms to enter between azimuths 154° and 205°. Northern Hemisphere swells are predominantly from the west; they occur primarily during the months of November through April. Most of the wave energy reaching Southern California is attributed to swells generated by Japanese-Aleutian originated extratropical storms. Deepwater significant wave heights have ranged up to 20 ft, but are typically less than 12 ft. Wave periods typically range from 12 to

18 sec. Hawaiian storms occur infrequently, but can produce swells as large as those produced by Japanese-Aleutian storms. Swells from typhoons in the western North Pacific are usually insignificant by the time they reach the Southern California coast. Chubascos, tropical storms that develop off the west coast of Mexico, rarely travel as far north as Southern California, but can generate high waves. Southern hemisphere swells characteristically have low heights and long periods. Most of these swells arrive during the months of May through October. Typical southern hemisphere swells rarely exceed 4 ft in height in deep water; however, with periods ranging up to 21 secs, they can break at over twice the deepwater wave height. Locally-generated seas are predominantly from the west and southwest. However, these locally- generated seas, including waves generated by diurnal sea breezes, can occur from all offshore directions throughout the year. Waves are usually less than 6 ft in height with wave periods less than 10 secs.



Moffatt & Nichol Engineers
Oceanographic Studies, May 2001
k:\4592\Coastal\figures\Jan01 Chapt3.ppt

Figure 3-7: Wave Exposure Map
(Moffatt & Nichol, Oceanographic Studies, May 2001)

The wave data from GROW station 14450 (shown in Figure 3-1) was analyzed to obtain the distribution of direction of swell. The two sectors were considered. The southern sector covered the angles between 36° and 216° T and western sector covered the angles between 216° and 36°. The angle 216° is an approximate shore normal direction of the coastline at Huntington Beach. Table 3-1 presents the distribution of direction of swell based on 30 years of hindcast data. It shows that most long period waves arrive to the beach from the western window. The largest contribution of southern waves occurs during the months of August to September, when it may reach 13–15%. Annually, the distribution of swell waves between the southern and western sectors is 6.4% versus 93.7%.

Table 3-1: Distribution of Swell Direction at GROW station 14450

Month	South Sector 36° to 216°	West Sector 216° to 36°	Month	South Sector 36° to 216°	West Sector 216° to 36°
1	0.80%	99.20%	7	13.50%	86.60%
2	1.00%	99.00%	8	12.40%	87.80%
3	1.10%	99.00%	9	15.30%	84.80%
4	5.60%	94.50%	10	5.90%	94.30%
5	8.50%	91.50%	11	2.00%	98.00%
6	9.40%	90.70%	12	0.50%	99.50%
			Annual	6.40%	93.70%

3.6 Outfall Discharge

The diffuser is located on the open coast about 2 km offshore of the Santa Ana River entrance in a depth of 16.7 m. The near-field region modeling results previously discussed, show the initial dispersion of the plume under normal conditions results in a relatively uniform concentration profile over the water column at the distance of approximately 200 m from the diffuser. For the far-field modeling, the total discharge was distributed uniformly over a circle of 200 m radius in the HD and AD model setups.

The measured flow rates were provided by OCSD for the study for the period July 1–December 31, 2010. The data show that the discharge rates vary during a day ranging on average between 76 and 185 MGD. The minimum discharge occurs at approximately 7AM and the maximum discharge occurs near 3PM. The overall range of discharges is between 50 and 330 MGD. Based on the data, average discharges were calculated for each hour. A 24-hour time series of average hourly discharges was then derived. This 24-hour time series was repeated several times to construct a longer time series to be used as an input to the HD and AD models. The hourly averaged discharges are presented in Table 3-2.

Table 3-2: Average Hourly Discharge during 24 Hours

Hour	MGD	m^3/s	Hour	MGD	m^3/s	Hour	MGD	m^3/s
0	173	7.595	8	80	3.524	16	184	8.080
1	164	7.186	9	91	4.004	17	182	7.982
2	145	6.371	10	112	4.913	18	178	7.799
3	126	5.505	11	136	5.942	19	176	7.718
4	106	4.635	12	157	6.882	20	176	7.691
5	91	3.969	13	172	7.535	21	175	7.679
6	80	3.510	14	182	7.956	22	176	7.709
7	77	3.359	15	185	8.086	23	175	7.685

3.7 Effluent Parameters

Coliform bacteria were modeled with a first order decay law, or

$$\frac{dC}{dt} = -K_B C \tag{1}$$

where K_B is the first order loss rate, C is bacterial concentration, and t is time. The loss rate was treated as a constant over space in the model, but was varied over a diurnal cycle described below. The loss rate can be estimated using methods described by Chapra (1997) and Thomann and Mueller (1987), which include loss due to natural mortality and photo-oxidation. Settling can also be included, but is ignored in this case since suspended solids concentrations are expected to be low. For a depth-integrated modeling domain, the bacterial total loss rate K_B(1/day) can be estimated from

$$K_B = \left(0.8 + 0.02S\right)1.07^{(T-20)} + \frac{\alpha I_0}{k_e H}\left(1 - e^{-k_e H}\right) \tag{2}$$

where S is salinity (ppt), T is water temperature (deg C), α is a proportionality constant of approximately unity, I_0 is the solar radiation at the water surface (Langley/hour, ly/hr), k_e is the light extinction coefficient (1/m), and H is the water depth (m). One ly/hr equals 11.6 Watts/m^2. The first term in the above loss rate equation represents natural mortality, and the second term represents depth-integrated photo-oxidation loss. The light extinction coefficient can be estimated from site-specific measurements of underwater light versus depth or from Secchi depth (Chapra 1997). Light attenuation can also be estimated from concentrations of inorganic suspended solids, particulate organic matter, and algae (Chapra 1997).

The above loss rate equation is most appropriate for total coliform bacteria (TC). Loss rates for bacteria (including enterococci) are usually less than for TC, with enterococci loss rates roughly 1/3 to 1/10 TC rates (WHO 1999, Easton et al. 1999, and EPA 2001). However, enterococci are generally more sensitive to sunlight (Sinton et al. 2002).

An example estimate of loss for TC rate is made using the above loss rate equation. Assuming a water temperature of 13° C and salinity of 33 ppt, the first term in the above equation has a value of 0.91 day^{-1}. Assuming light attenuation is 1.0 m^{-1} (which is a Secchi depth of about 1.8 m), an average water depth of 15 m, and a daily average solar radiation of 275 W/m^2 (which is 23.7 ly/h average over the day), the second term in the above equation is 1.6 day^{-1}. Thus, the total loss rate would be about 2.5 day^{-1} for these conditions.

As a conservative estimate for modeling purposes, the average total loss rate of total/fecal coliform and enterococci were assumed to be 1.5 and 0.5 day^{-1}, respectively. Inactivation rates compiled from the literature by Boehm et al. (2005) for enterococci in sunlight and in seawater are on the order of $1.0{\times}10^{-4}$ sec^{-1}, or 8.6 day^{-1}, while enterococci loss rates in the dark and seawater are on the order of $1.0{\times}10^{-6}$ to $1.0{\times}10^{-5}$ sec^{-1}, or about 0.1 to 1.0 day^{-1}. Therefore, the assumed daily average loss rate for enterococci of 0.5 day^{-1} appears to be conservative compared to observed loss rates. Enterococci loss rates of 0.5 day^{-1} and higher were used to model enterococci concentrations in Lake Michigan (Liu et al. 2006).

As noted, the bacteria decay rate was modeled at a time varying over a diurnal cycle. The decay rates depend on the time of day. The following assumptions were made for all modeled bacteria:

- the maximum decay rates occur during daylight hours between 10AM and 4PM;
- the minimum decay rates occur during night hours between 10PM and 4AM;
- there is a linear increase in rates from minimum to maximum between 4AM and 10AM and linear decrease in rates from maximum to minimum between 4PM and 10PM.

The minimum rates were assumed to be zero. The maximum rates were assumed to be 1.5 day^{-1} for total and fecal coliform bacteria and 0.5 day^{-1} for enterococci. This diurnal cycle results in a somewhat reduced rate compared to the daily average die-off rates discussed above, which results in slightly more conservative model estimates of bacteria concentration.

With the given rates, the concentration of bacteria after one day should be 22% of initial for total and fecal coliform bacteria and 60% of initial for enterococci due to decay alone. After seven days it should be less than 0.003% and 3% of the initial concentrations for total and fecal coliforms and enterococci, respectively.

3.8 Dispersion Formulation

The horizontal dispersion in the advection-diffusion model was defined by the scaled eddy viscosity from the hydrodynamic model with a constant scale coefficient equal to one. The Smagorinsky formulation was utilized to approximate the horizontal eddy viscosity in the hydrodynamic model, which is calculated as

$$A = c_s^2 l^2 \sqrt{2 S_{ij} S_{ij}} \qquad (3)$$

where c_s is a constant and l is the characteristic length and the deformation rate is given by

$$S_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right) \quad (i,\ j = 1,\ 2) \qquad (4)$$

The constant c_s was equal to 0.28.

From prior experience, the Mike FM model may generate significant numerical diffusion, which could be a result of the numerical solution scheme. The high order scheme was utilized to minimize the effect of numerical diffusion in the advection-diffusion module.

The vertical eddy viscosity in the 3D hydrodynamic simulations was approximated with the use of k-ε formulation. The vertical dispersion in the advection-diffusion model was also calculated by scaling the vertical eddy viscosity with a constant scale coefficient equal to one.

All relevant dispersion coefficients were initialized with the default recommended values. There was no specific calibration performed for the site.

3.9 Temperature in 3D Simulation

Because of a strong vertical gradient in temperature, which may affect vertical dispersion of effluent, temperature was included as a parameter in the 3D simulations. In the model setup for the 3D simulation the water density was assumed to be a function of temperature. The following somewhat arbitrary vertical profile was assumed for the initial state and enforced at the open boundaries:

- 19°C from 0 to 30 m depth
- 15°C from 30 to 50 m depth
- Linear change in temperature from 15 to 10°C for depths between 50 to 500 m.

4.0 MODEL CALIBRATION

The hydrodynamic and wave models were calibrated to a set of data obtained from field measurements near Huntington Beach in May 2000. The same set was used for the calibration and validation of the model in M&N's previous study (Moffatt & Nichol, 2001). The water level, wave, and current measurements were available at several locations as summarized in Table 4-1.

Table 4-1: Measurements Locations during May 2000

Station	Name	Latitude/ Longitude	Easting/ Northing*	Measurements**
S4	Nearshore	33°37'10.1"N 117°59'14.5"W	408411E 3720401N	Waves, Water Level
HB	Huntington Beach Array	33°37'54.0"N 117°58'42.0"W	409263E 3721746N	Waves
E	Beach Boulevard ADCP	33°38'46.6"N 117°59'35.4"W	407900E 3723381N	Velocity
F	Newport Beach ADCP	33°37'16.5"N 117°56'50.3"W	412129E 3720565N	Velocity
SAR	Santa Ana River	33°37'52.1"N 117°57'26.0"W	(approximate)	Water Level

* *Easting and northing are given in meters in UTM-11.*

4.1 Model Calibration Setup

4.1.1 Wind

Wind measurements from OCSD Plant No. 2 were used to force the hydrodynamic model (Figure 3-6). Winds were not included in the wave model.

4.1.2 Waves

Wave data from two locations were available for the calibration period. Station 14450 from GROW hindcast dataset (Oceanweather, Inc.) provided swell and sea conditions as well as total wave energy conditions at a deepwater location relatively far offshore. Station S4 located in shallow water closer to the shore only provided averaged parameters, such as significant wave height, mean and peak period, and mean wave direction. The comparison of the two datasets is presented in Figure 4-1. It can be seen from the plot, that the difference between the datasets is significant enough that the wave model, if forced with GROW data, will not be able to reproduce the data at S4 station.

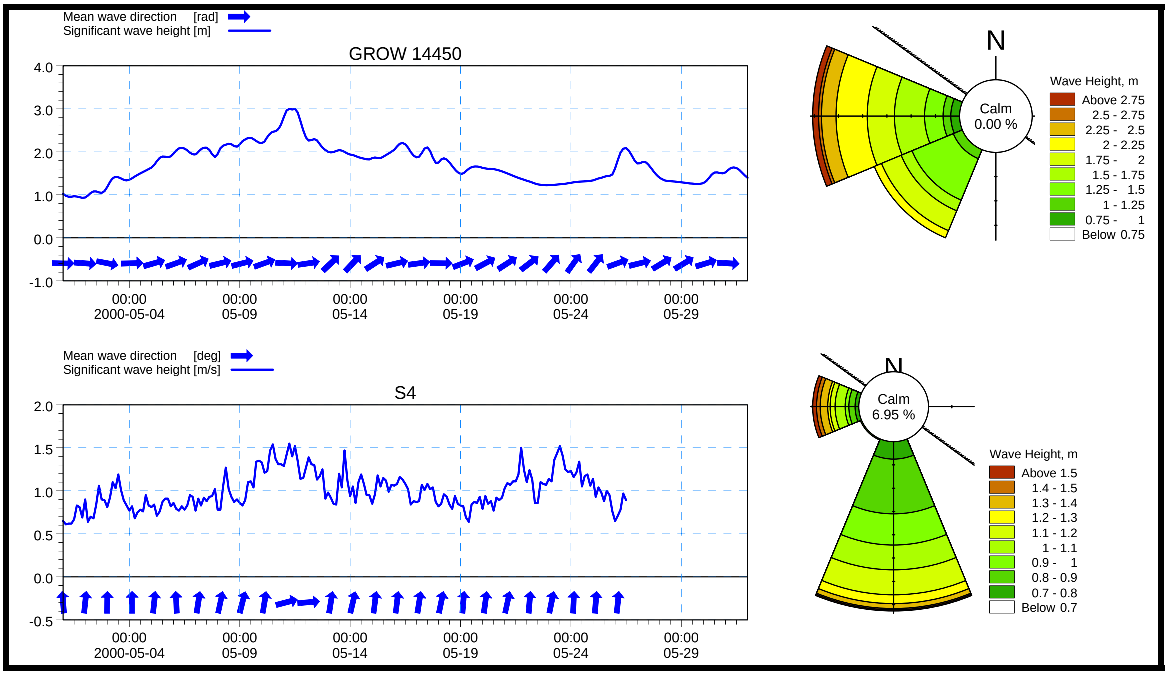


Figure 4-1: Waves Measured at Nearshore Station S4 and GROW Station 14450

As a solution, the S4 station data was used to construct the offshore boundary conditions for the wave model for calibration runs. The wave heights and directions were adjusted for the model to match data at S4 location. The following corrections were made to the S4 data: the wave heights were increased by 5%; the wave directions were corrected relative to the shore-normal direction; and the difference between the shore-normal direction and wave direction was increased by 10% to the north and 80% to the south to account for wave refraction.

4.2 Model Calibration Statistics

Several statistical parameters were used to assess the model calibration and validation results. These include the mean error (*ME*), root mean square (*RMS*) error, normalized *RMS* error, correlation coefficient (*R*), time delay or lag (ΔT), mean absolute error (*MAE*), and index of agreement (*d*). These parameters are briefly described here.

Let x and y be the measured and calculated data respectively. Then the following statistics can be calculated:

Mean error (*ME*):

$$ME = \bar{x} - \bar{y} \tag{5}$$

where “bar” denotes the sample mean.

Root-mean-squared (*RMS*) error:

$$\varepsilon_{RMS} = \sqrt{\overline{(x-y)^2}} \tag{6}$$

To reduce an effect of measurement error and possible outliers, a one hour low-pass filter was applied to the measured data and a trend x_f is determined. Then a normalized error is calculated as:

$$\varepsilon_{norm} = \frac{\varepsilon_{RMS}}{x_{f,\max} - x_{f,\min}} \cdot 100\% \tag{7}$$

where the denominator represents the range of values with $x_{f,\max}$ and $x_{f,\min}$ being the maximum and minimum values of the trend x_f.

Correlation coefficient, *R,* was calculated using standard method and represents a non-squared value.

Time delay, ΔT, shows possible time difference between corresponding events in measured and calculated data. To estimate the delay, the cross-correlation function between measured and calculated data is computed and the smallest time lag at which a maximum of function occurs is determined. Because the cross-correlation function is calculated from discrete data, the resulting time resolution may not be sufficient to accurately define a maximum. Therefore, computed values of the cross-correlation function were interpolated with a piecewise polynomial of 5th order, which was then used to determine the extremum.

Mean absolute error (*MAE*):

$$MAE = \overline{|x-y|} \tag{8}$$

Model prediction capability was estimated with an index of agreement between measured and calculated data (after Willmott, 1982 and Willmott et al., 1985):

$$d = 1 - \frac{\overline{(x-y)^2}}{\overline{\left(|x-\bar{x}| + |y-\bar{x}|\right)^2}}, \quad 0 \le d \le 1 \tag{9}$$

4.3 Calibration Results

The time series of measured and calculated quantities for the calibration runs are presented in Appendix A. The quantitative assessment of the goodness of match for various parameters is given in the tables below.

The main purpose of the model is to accurately reproduce flow circulation in the nearshore region. This circulation is affected by tidal currents, large scale circulation, winds, and waves. There is a limitation to resolve wind-induced circulation imposed by the use of a two-dimensional depth averaged model because the vertical structure of the flow is not fully resolved. However, other components (tides and waves) have much stronger effects on the flow compared to local winds.

According to the results, the tide propagation through the model is very good. The water levels match the measurements at all stations with a very high level of agreement. The wave model results showed that the waves were affected by the selection of boundary conditions. With an overall good agreement, there are some events when the model did not match the measurements accurately. This is attributed to the presence of complex offshore wave conditions with both locally generated seas and ocean generated swell. The data used to force the model at the offshore boundary (data from Station S4 measured in the nearshore) did not provide sufficient information about the two wave systems. Thus it was impossible to correctly define the offshore boundary conditions. However, with the given limitations, the significant wave heights, mean wave direction, and peak period match very good with the measurements at S4 and HB stations (see Figure 3-2 for locations).

The accurate prediction of the currents is the primary focus of the model calibration. The two stations with the current measurements (station E at Beach Boulevard and station F at Newport Beach) were located in the nearshore region, which are significantly affected by the waves. There were no current data from a location sufficiently far from the nearshore zone which would not be affected by the wave conditions. From the calibration simulations it was found that the model predicts currents very accurately during periods with mild waves. This means that the tidal currents were represented very accurately regardless of the station locations. However, during periods when the wave model had difficulty matching the wave measurements, the currents were also in a lesser agreement. This suggests the importance of accurate offshore boundary conditions for waves, which was not available for this calibration as previously noted.

Additionally, it can be seen that there is a significant variability in the cross-shore velocity component which the model will be unable to reproduce accurately due to the limitations of the 2-dimensional formulation and insufficient grid resolution. In general velocities are typically much more difficult to replicate as these are spot measurements influenced by localized features and also due to potential for measurement error in shallow water under the influence of both currents and waves. However, even under these limitations, the wave induced currents had similar magnitudes as measured currents while the direction depended on the direction of approaching waves. The critical aspect for the transport modeling is that the overall transport patterns be adequately reproduced and this will generally follow if the tidal amplitudes and phasing are reasonably reproduced which is the case for these calibration results. The tidal amplitudes and phasing are the result of integrating currents over the entire domain rather than at specific spot locations.

Due to the fact that the tidal currents are more significant at the diffuser location compared to the wave-induced currents and they were modeled correctly (with the wave induced currents being on a similar trend with measurements), it was concluded that the developed hydrodynamic and wave models produced adequate flows for the plume dilution modeling.

Table 4-2: Calibration Results for Water Levels Nearshore Station (S4), Mouth of the Santa Ana River (SAR), Beach Boulevard (E), and Newport Beach (F) (in Meters)

Station	*RMS*	*RMS* norm.	*R*	Δ*T*, min	*ME*	*RMS* meas.	*MAE*	*d*	Norm. range
S4	0.059	3.1%	0.99	-2	0.000	0.094	0.049	0.997	1.905
SAR	0.132	10.2%	0.93	47	0.001	0.086	0.103	0.961	1.289
E	0.204	10.2%	0.93	-9	0.000	0.121	0.154	0.960	2.001
F	0.203	10.2%	0.93	-9	0.000	0.121	0.153	0.960	2.001

Table 4-3: Calibration Results for Significant Wave Heights at Nearshore Station (S4) and Huntington Beach Array (HB) (in Meters)

Station	*RMS*	*RMS* norm.	*R*	Δ*T*, min	*ME*	*RMS* meas.	*MAE*	*d*	Norm. range
S4	0.201	37.4%	0.64	0	0.027	0.114	0.152	0.776	0.536
HB	0.273	48.4%	0.45	180	-0.001	0.080	0.204	0.642	0.565

Table 4-4: Calibration Results for Mean Wave Direction at Nearshore Station (S4) (in Degrees)

Station	*RMS*	*RMS* norm.	*R*	Δ*T*, min	*ME*	*RMS* meas.	*MAE*	*d*	Norm. range
S4	2.044	3.5%	1.00	0	-0.612	21.248	1.645	0.999	58.208

Table 4-5: Calibration Results for Peak Period (in Seconds) at Nearshore Station (S4) and Huntington Beach Array (HB)

Station	*RMS*	*RMS* norm.	*R*	Δ*T*, min	*ME*	*RMS* meas.	*MAE*	*d*	Norm. range
S4	0.000	0.0%	1.00	0	0.000	3.089	0.000	1.000	7.959
HB	3.884	66.8%	0.51	18	-1.031	2.654	2.202	0.695	5.812

Table 4-6: Calibration Results for Currents at Beach Boulevard (E) (in m/s)

Parameter	*RMS*	*RMS* norm.	*R*	Δ*T*, min	*ME*	*RMS* meas.	*MAE*	*d*	Norm. range
u-velocity	0.109	28.5%	0.47	-32	-0.062	0.035	0.084	0.633	0.380
v-velocity	0.092	36.7%	0.39	-23	0.059	0.032	0.071	0.568	0.251
Speed	0.088	38.9%	0.22	-87	0.020	0.034	0.068	0.521	0.227
Along-shore	0.137	30.4%	0.47	-29	-0.084	0.036	0.106	0.619	0.449
Cross-shore	0.036	35.4%	0.00	135	0.008	0.031	0.025	0.229	0.102

Table 4-7: Calibration Results for Currents at Newport Beach (F) (in m/s)

Parameter	*RMS*	*RMS* norm.	*R*	ΔT, min	*ME*	*RMS* meas.	*MAE*	*d*	Norm. range
u-velocity	0.120	31.8%	0.36	90	-0.075	0.035	0.094	0.560	0.377
v-velocity	0.146	57.5%	0.33	-8	0.122	0.031	0.124	0.440	0.253
Speed	0.110	47.2%	0.22	-14	0.059	0.034	0.085	0.471	0.234
Along-shore	0.175	38.5%	0.43	33	-0.138	0.036	0.145	0.525	0.454
Cross-shore	0.057	59.9%	0.00	-219	0.005	0.030	0.041	0.324	0.094

5.0 FAR-FIELD PLUME DILUTION MODELING

5.1 Modeled Conditions

5.1.1 Waves

The wave hindcast data from GROW Station 14450 (Ocean Weather, Inc.) was analyzed to evaluate wave conditions during the months of August to November. The data covers the 30-year period from 1980 to 2009 at 3-hour intervals. The average wave conditions were found to be similar between the months (Table 5-1), with waves arriving from the western sector. GROW Station 14450 is located behind Santa Catalina Island and San Clemente Island, which could affect the wave direction predicted at the station.

Table 5-1: Average Wave Conditions Based on GROW Station 14450

Month	Significant wave height, m	Peak Period, sec	Mean Wave Direction, deg N
August	1.22	15.4	236
September	1.26	15.3	238
October	1.34	15.1	250
November	1.36	14.0	267

The previous analysis (M&N 2001) showed that the Huntington Beach coast is exposed to waves from two sectors—western waves from 250–285° and southern waves from 154–205°. In order to cover these two sectors, the simulations were performed for two directions—western waves from 270° and southern waves from 180°, which correspond to the middle of each sector. The average wave peak periods correspond to swell conditions. A single wave peak period of 15 sec was selected for all cases. Wave heights affect the intensity of the along-shore currents. The average significant wave heights during the months of August to November vary between 1.22 and 1.36 m. To reduce the total number of simulations and to evaluate the effect of the wave height on the plume distribution, a set of two wave heights was selected for the simulations. Significant wave heights of 1.2 and 1.4 m were used.

5.1.2 Wind

The model domain is located relatively close to the shore; therefore, sea breeze conditions will likely dominate. To force the model, synthetic winds were developed to closely replicate the sea breeze. The maximum offshore wind speed was set to 5 m/s. These winds were applied uniformly over the model domain. An example of sea breeze conditions is shown in Figure 5-1.

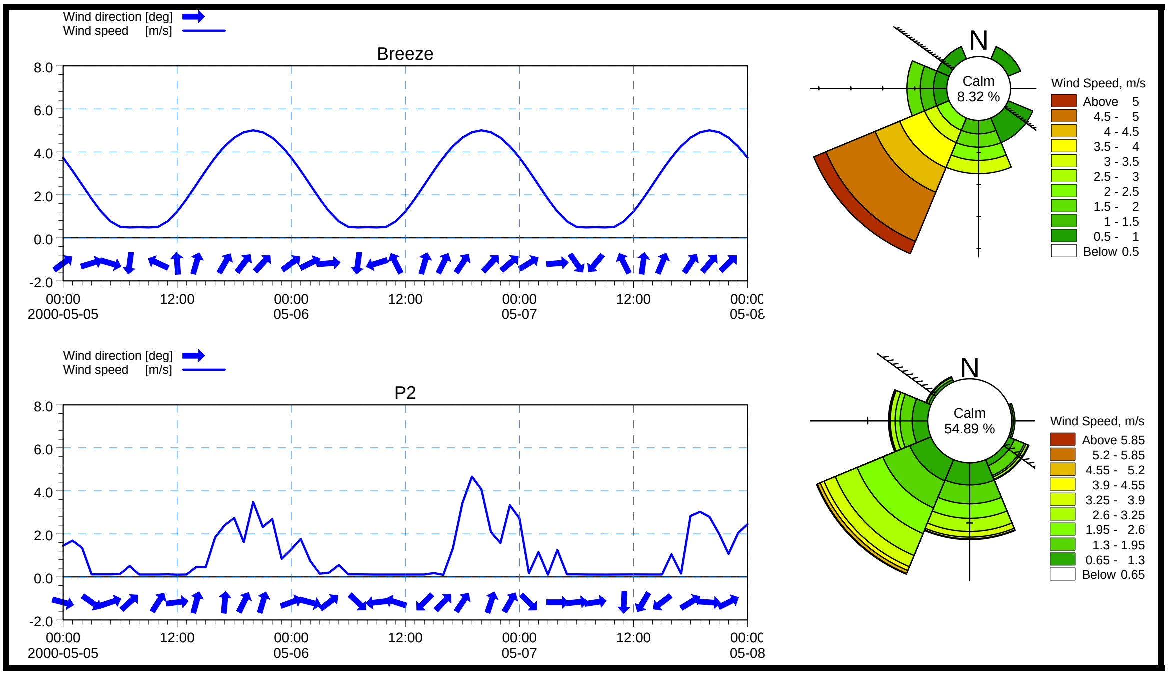


Figure 5-1: Synthetic Sea Breeze and Winds Measured at OCSD Plant No. 2

5.1.3 Superimposed Along-Shore Current

A large scale circulation existing in the Southern California bight cannot be generated within a local scale model. A larger scale regional model would be required to accurately represent the circulation. However, the effect of such circulation on the local currents can be added to a local scale model using a superimposed current. For the present simulations, a current speed of 0.2 m/s was used for the currents flowing in both directions along the coast. The value was an estimate of potential high current speeds in the area. Some indications of such currents were identified from numerical experiment with ROMS model (Dong et.al, 2011).

5.1.4 Modeled Scenarios

A total of 12 cases were simulated to produce different transport conditions for the plume dilution modeling. The inputs into the hydrodynamic and wave models are presented in Table 5-2 for each case. The astronomical tidal conditions imply that only astronomical tidal water levels were applied at the boundaries, which did not include any meteorological surges.

The two modeled wave directions correspond to the two sectors from which ocean waves can arrive at the site. The frequency of these conditions is different, as is shown in Table 3-1. The southern waves have a smaller probability of occurrence. However, because the effects produced by the waves from the two directions were expected to be significantly different, both directions were included in the simulations.

Table 5-2: Modeled Scenarios

Case	Tide	Superimposed current, m/s "towards"	Significant wave height, m	Peak Period, sec	Mean Wave Direction, deg North
1	Astronomical	none	1.2	15	180
2	Astronomical	0.2 m/s NW	1.2	15	180
3	Astronomical	0.2 m/s SE	1.2	15	180
4	Astronomical	none	1.4	15	180
5	Astronomical	0.2 m/s NW	1.4	15	180
6	Astronomical	0.2 m/s SE	1.4	15	180
7	Astronomical	none	1.2	15	270
8	Astronomical	0.2 m/s NW	1.2	15	270
9	Astronomical	0.2 m/s SE	1.2	15	270
10	Astronomical	none	1.4	15	270
11	Astronomical	0.2 m/s NW	1.4	15	270
12	Astronomical	0.2 m/s SE	1.4	15	270

5.2 Results

The simulations were run for a total of 21 days. The first seven days were considered as model "spin-up" time and were disregarded in the analysis. The initial seven day period was selected to allow the initially discharged effluents to decay. The remaining 14 days of each simulation were used as the base for construction of bacteria concentration distribution maps. The average and maximum values were found for each location from the 14-day hourly time series of model results.

The contour maps of geometric mean and maximum concentrations were produced and are shown in appendices. Estimated concentration of total coliform, fecal coliform and enterococci based on the 2D simulations are presented in Appendix B. The maps show the distribution of total and fecal coliform bacteria and enterococci in MPN/100mL. Results from 3D simulations for Case 12 are presented in Appendix C similarly to 2D results. The geometric mean and maximum values were calculated for the top 30 m layer of water. Maps of relative concentrations are presented in Appendix D. The results were produced by averaging the 14-day results with initial concentration of each bacteria set according to the results of the enhanced treatment study: 630 MPN/100mL for total coliform, 180 MPN/100mL for fecal coliform and 30 MPN/100mL for enterococci.

The time series of concentrations of reactive tracers were output from the results of the advection-diffusion model. The output locations were provided by the Client and are listed in Table 5-3 and shown in Figure 5-2. The stations are located at the shoreline where outputs from the model may not be possible or accurate. To ensure that the resulting time series contain representative concentrations in the nearshore at the specified locations, the outputs were obtained along 200 meter lines extending from the shoreline at the specified location into the ocean. Then average and maximum concentrations were calculated along each line to define the time series of concentrations at each station. As a result, time series were produced for each location for each scenario: average and maximum values for all types of effluent.

Similar calculations were performed for the 3D simulation for Case 12. The results were calculated from 2D vertical cross-sections based on the 3D results similarly to 2D results.

Table 5-3: Output Locations for Time Series

Station	Latitude	Longitude	Station	Latitude	Longitude
39N	33.7019	-118.055	ZERO	33.6294	-117.96
27N	33.67645	-118.029	3S	33.62698	-117.954
15N	33.6519	-117.997	27S	33.5941	-117.882
3N	33.63363	-117.967	39S	33.57833	-117.849

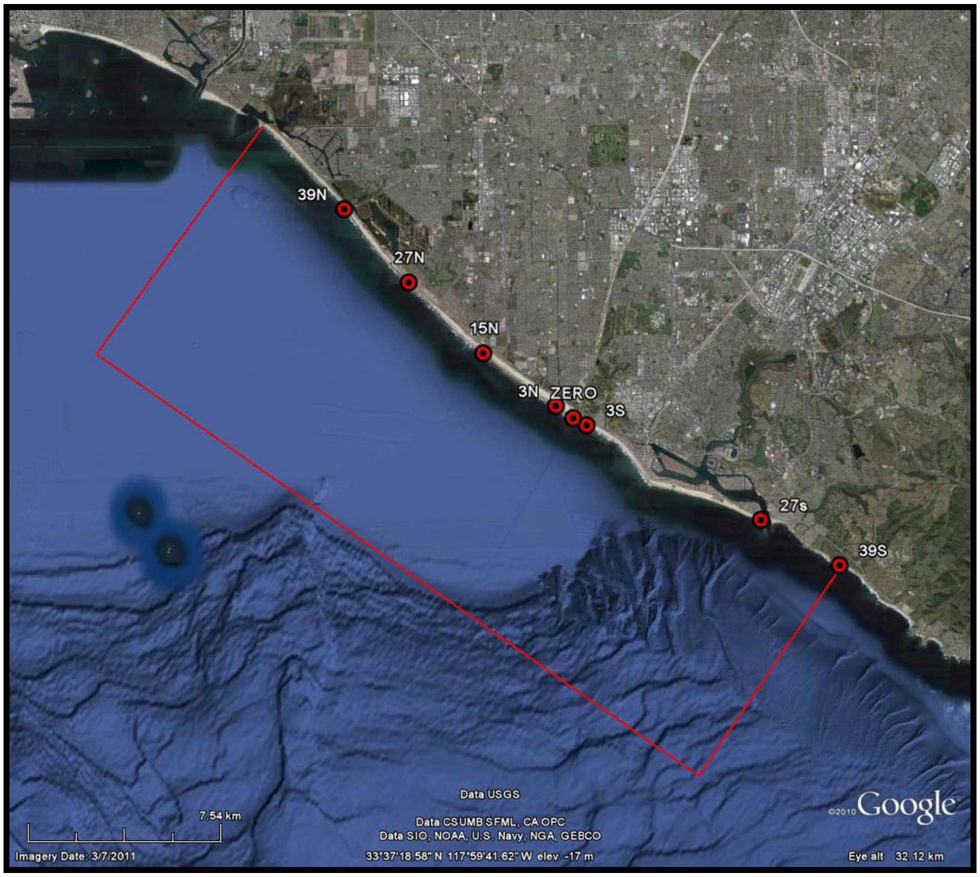


Figure 5-2: Time Series Output Locations

A closed-loop circulation at the NW boundary was noticed in the simulations with no superimposed current. This loop affected the results for bacteria concentrations by forcing the plume to follow the NW and then SW boundaries. This closed-loop circulation seems to be an artificial result, which may not exist in reality, although the existence of the Huntington Harbor Jetties along this NW boundary may contribute to this closed-loop circulation. Therefore, the location of the plume close to these boundaries in cases without a superimposed current may be inaccurate and should be considered as a modeling artifact; although, concentration of effluent in the tail of the plume is already very low. In reality, some circulation in Southern California bight almost always exists, and not imposing such circulation in the model is more conservative. The results with the superimposed currents show a more accurate representation of the plume in this regards.

The relatively limited area of the plume for cases where the general transport direction is towards the south is related to the presence of the Newport Canyon. Since the model approach uses a depth-averaged formulation for the bacteria concentrations, once the plume flows south over the deeper water in the canyon, the plume gets immediately diluted with the additional water depth. While some vertical mixing is to be expected as the plume moves over the canyon, the depth-averaged model results likely overestimate the dilution. For those cases where the plume approaches the shoreline inshore of Newport Canyon, the depth-averaged dilution becomes less of a factor. For example, the results for total coliform in Case 3 with waves from the south and a coastal current of 0.2 m/sec towards the southeast show the plume located immediately adjacent to the shoreline and penetrating into Newport Harbor, although at low bacteria levels. In the 3D simulation for Case 12 (SE current and western waves) the plume extends further south as mixing is limited to the surface water layer. This produced a more realistic results over the deep canyon compared to the depth averaged results from 2D simulation.

The results suggest that the far-field transport of the plume is relatively insensitive to the wave height, although it is very sensitive to the wave direction. In addition, the wave generated radiation stress appears to dominate transport mechanisms compared to the coastal current. The modeled wave conditions are representative of the typical wave conditions expected during the season of interest. While it is possible for storm events with higher wave heights to occur during this time of year, these storm events typically do not occur until the winter months. These storm events would increase transport and turbulent mixing which suggests that the wave conditions simulated represent a more conservative estimate of the expected transport and concentrations, i.e. higher concentrations are expected with the normal wave environment that was simulated. It should also be repeated that the wind field used in the model simulations is for normal sea breeze conditions where the winds are from the southwest during the daytime and decreasing in speed during the night. This sea breeze produces some net southerly forcing near the coastline for all simulations.

Based on the modeling results, the worst case scenario for the potential of high bacteria concentrations close to the beach and spread over a wide area appears to be for the case of waves from the south with the coastal circulation current towards the southeast. This scenario produces a plume along the entire coastline in the model domain. For total coliform with this scenario during September, the concentrations along the shoreline reach as high as 100 MPN/100 mL along an approximately 10 km stretch of coast from the diffuser northward and near 10 MPN/mL southward extending to Crystal Cove near the southeastern extent of the model domain.

6.0 CONCLUSIONS

The CORMIX near-field plume model was configured to represent receiving water properties representative of the months of July through November based on measured temperature profiles in the vicinity of the outfall for these months. The effluent flow rate was taken to be 200 MGD, which is near the 230 MGD capacity of the nearshore outfall.

The California Ocean Plan calls for calculation of the initial dilution without any ambient current which produces the least amount of dilution. For this condition, the initial dilution ranged from a minimum of 28 in July when thermal stratification limits the plume to height of rise, to a maximum of 37 in when the water column is vertically well mixed and the plume rises to the surface.

For the more typical case of a coastal current, the results show that the near-field region length, pollutant dilution, plume thickness, and well-mixed water depth all increase from July to September. The plume does not penetrate to the surface during this period, but tends to spread more in the vertical direction with time. In October and November, the unstable interactions lead to upstream intrusion and confine the near-field region closer to the diffuser. The plume rises immediately to the surface and spreads downwardly. In all cases, the initial dilution with an ambient current was significantly greater than for the case of no ambient current.

Based on this near-field plume modeling study, a uniformly distributed effluent over a 200 m circular area around the outfall diffuser is considered reasonable and can be used in the two-dimensional modeling work in this project.

The MIKE by Danish Hydraulics Institute (DHI) modeling system was selected as a modeling platform for the far-field modeling. Three modules of the MIKE suite were used. MIKE 21 FM HD (Hydrodynamic Model) was used to assess hydrodynamic conditions which included tidal, wind, and wave induced currents and superimposed along-shore current which mimics a large scale circulation of the southern California bight. MIKE 21 SW (Spectral Waves Model) was used to model the wave transformation from the offshore edge of the model domain to the beach. The SW model provides forcing into the HD model to generate water levels and currents resulting from the wave shoaling and breaking. MIKE 21 AD (Advection-Diffusion Model) utilizes the currents calculated by the HD model and predicts transport and distribution of the effluent in the far-field region of the discharge location.

The model domain extends from Crystal Cove in the south to the Huntington Harbor South jetty in the north. The domain covers a rectangular area of 28 km along-shore and 8.5 km offshore. It includes part of the Santa Ana River and Newport Harbor. The diffuser is located approximately 11.5 km away from the southeast boundary, and 16.5 km away from the northwest boundary. The HD and SW wave models were calibrated against data collected during a field monitoring program during 2000. The waves and currents agree reasonably with these available data.

A total of 12 cases were simulated to produce different transport conditions for the plume dilution modeling. The cases varied the background coastal ocean current from 0.2 m/s towards north and south as well as no current to simulate possible scenarios. These types of coastal currents could occur at any time during the year and cannot be tied to any specific month. The offshore wave height was varied to bracket the average wave heights computed from the wave hindcast for the months of August through November. The wave direction was varied between west and south since these are the prevalent wave windows along this section of the coast. All simulations included the tidal currents and sea breeze wind forcing. The astronomical tidal conditions imply that only astronomical tidal water levels were applied at the boundaries, which did not include any meteorological surges.

The simulations were run for a total of 21 days. The first seven days were considered as model “spin-up” time and were disregarded in the analysis. The initial seven day period was selected to allow the initially discharged effluent to decay. The remaining 14 days of each simulation were used as the base for construction of bacteria concentration distribution maps. The average and maximum values were found for each location from the 14-day hourly time series of model results.

Based on the modeling results, the worst case scenario for the potential of high bacteria concentrations close to the beach and spread over a wide area appears to be for the case of waves from the south with the coastal circulation current towards the southeast. This scenario produces a plume along the entire coastline in the model domain. For total coliform with this scenario during September, the concentrations along the shoreline reach as high as 100 MPN/100 mL along an approximately 10 km stretch of coast from the diffuser northward and near 10 MPN/mL southward extending to Crystal Cove near the southeastern extent of the model domain.

The modeling results suggest that the far-field transport of the plume is relatively insensitive to the wave height, although it is very sensitive to the wave direction. In addition, the wave generated radiation stress appears to dominate transport mechanisms compared to the coastal current. The southwest sea breeze produces some southerly forcing near the coastline for all simulations.

There are some limitations to the modeling based on the 2-dimensional nature of the hydrodynamic model. Because the model represents only the horizontal dimensions, the bacteria concentration is averaged over the water column. This is a valid approximation near the discharge based on the initial dilution model results showing the plume reaching close to the water surface during the months of interest. It is also valid for slowly varying depths along the coast or shallower water depths near the beach. However, the assumption tends to breakdown in areas such as the Newport Canyon where the water depths increase rapidly with distance. Because the 2-dimensional model averages the concentrations over the water column, the plume becomes rapidly diluted when passing over the canyon. While there is some vertical mixing that will dilute the plume somewhat, the results suggest excessive dilution when the plume passes over Newport Canyon. For those cases where the plume approaches the shoreline inshore of Newport Canyon, the depth averaged dilution is not a factor. For example, the results for total coliform in the month of September with waves from the south and a coastal current of 0.2 m/sec towards the southeast show the plume located immediately adjacent to the shoreline and penetrating into Newport Harbor, although at low bacteria levels.

In addition to the impacts associated with Newport Canyon, there is an apparent closed-loop circulation at the NW boundary of the model when no coastal current is superimposed. This is an artifact of the model boundary condition specification which is unavoidable, although the existence of the Huntington Harbor Jetties along this NW boundary may contribute to this closed-loop circulation. Therefore, the location of the plume close to these boundaries in cases without a superimposed current may be inaccurate. In reality, some circulation in Southern California bight almost always exists, and not imposing such circulation in the model is more conservative and unlikely. The results with the superimposed currents show a more accurate representation of the plume in this regards.

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APPENDIX A

MODEL CALIBRATION RESULTS

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Figure A-4: Calibration for Mean Wave Direction at Offshore Station (S4)

Figure A-5: Calibration Results for Peak Period at Offshore Station (S4) and Huntington Beach Array (HB)

Figure A-6: Calibration Results for Currents at Beach Boulevard (E)

Figure A-7: Calibration Results for Currents at Beach Boulevard (E) (continued)

Figure A-8: Calibration Results for Currents at Newport Beach (F)

Figure A-9: Calibration Results for Currents at Newport Beach (F) (continued)

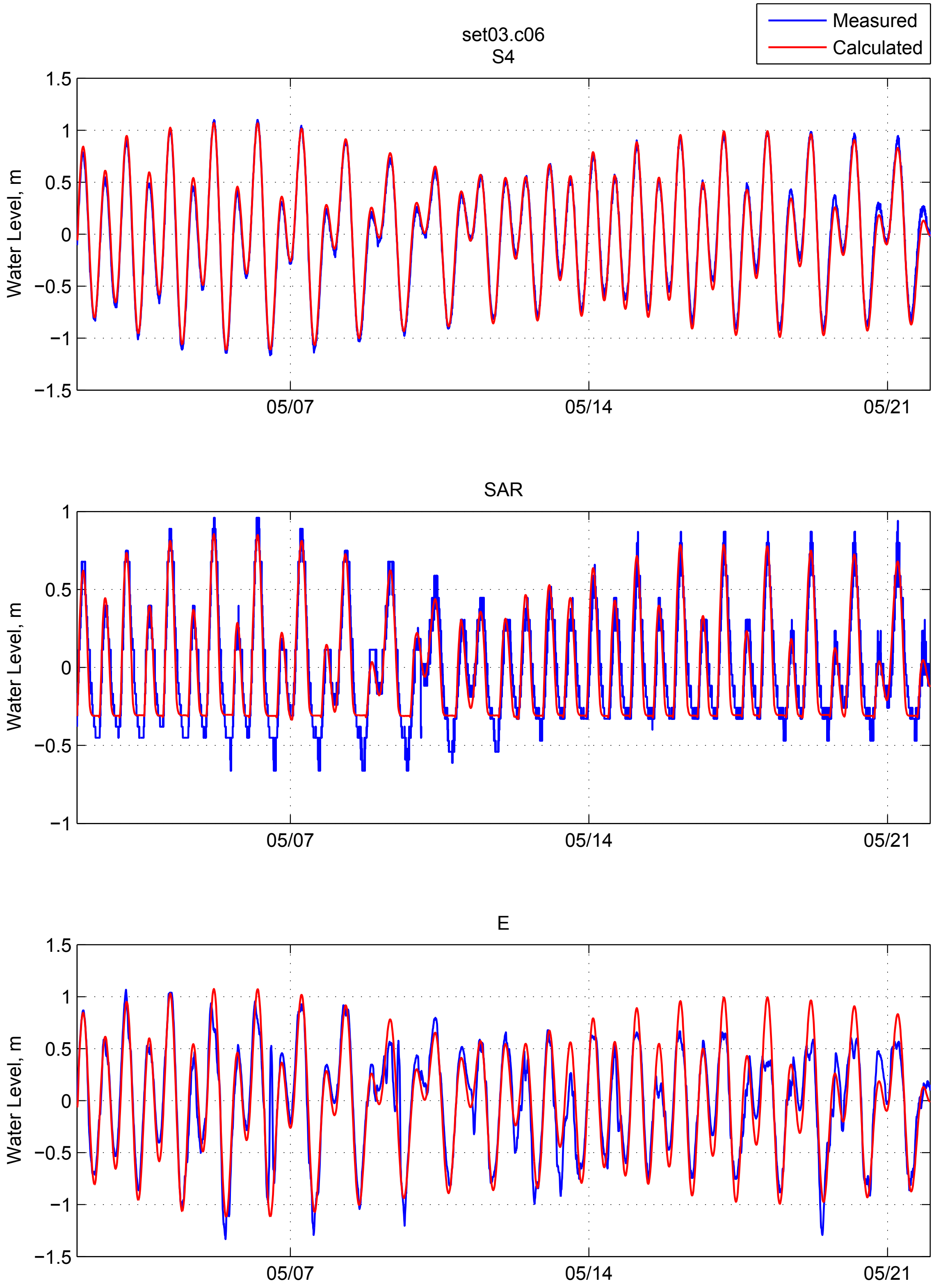


Figure A-1: **Calibration Results for Water Levels at Offshore Station (S4), Mouth of the Santa Ana River (SAR) and Beach Boulevard (E)**

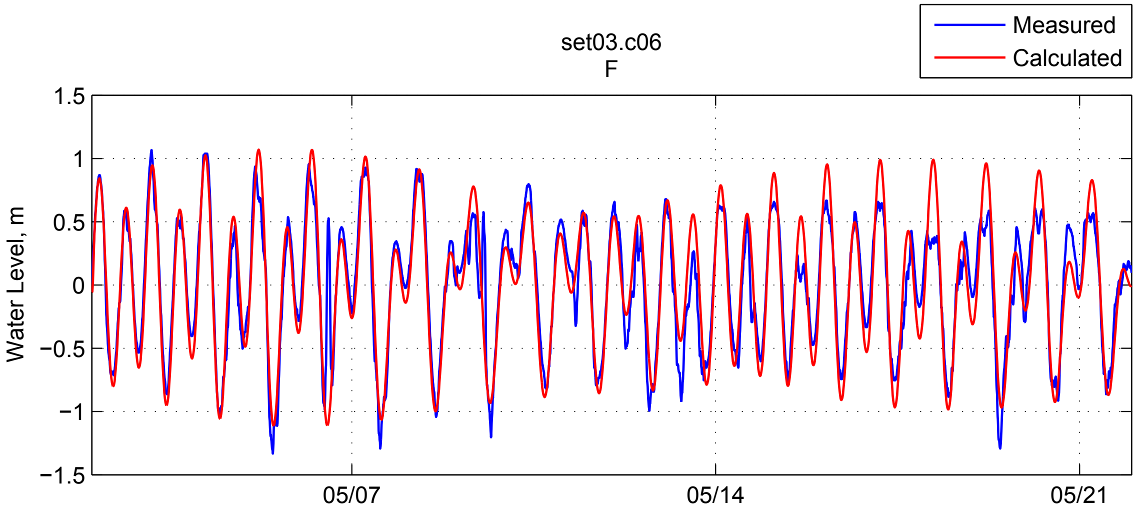


Figure A-2: **Calibration Results for Water Levels at Newport Beach (F)**

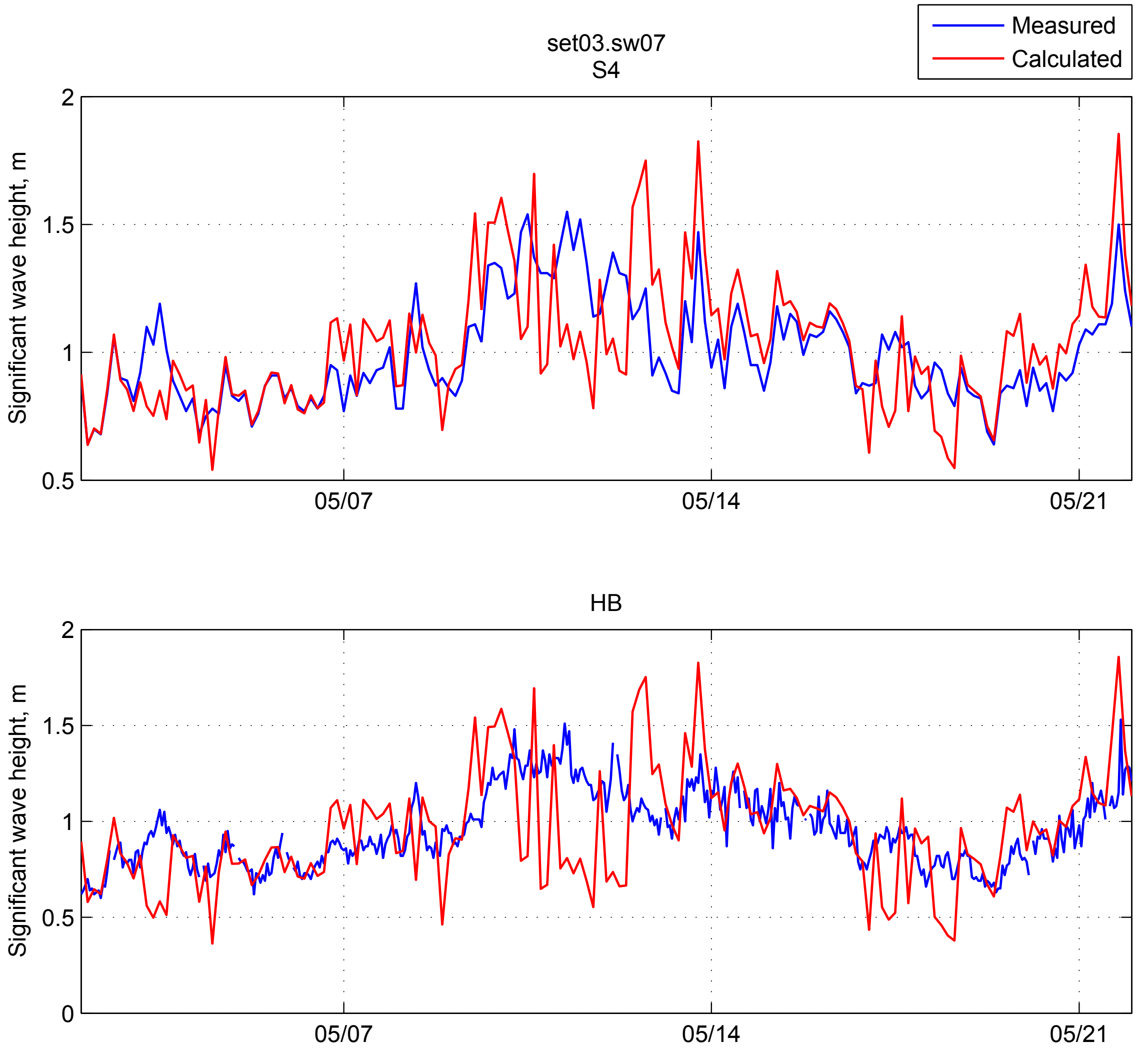


Figure A-3: **Calibration Results for Significant Wave Height at Offshore Station (S4) and Huntington Beach Array (HB)**

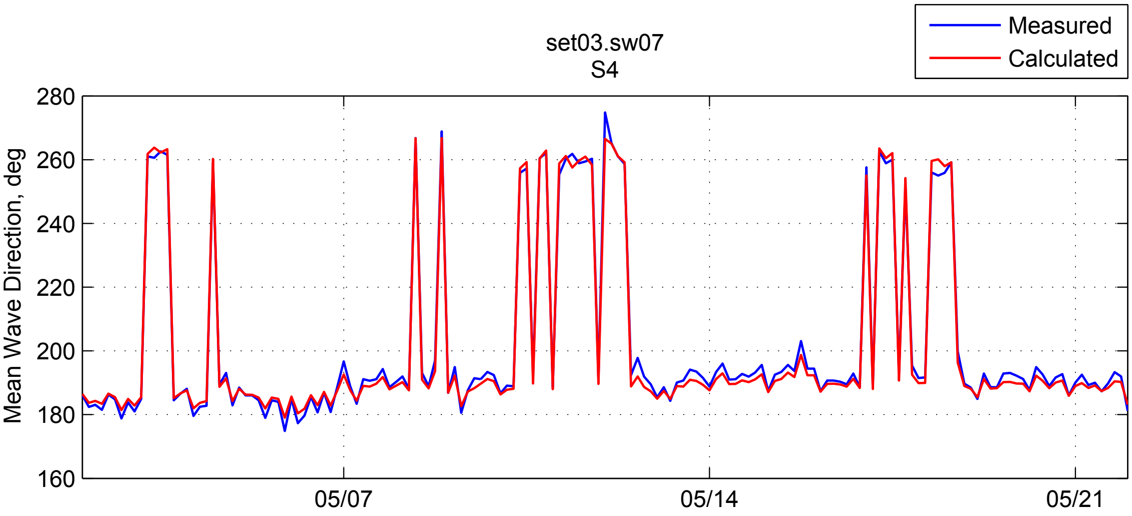


Figure A-4: Calibration for Mean Wave Direction at Offshore Station (S4)

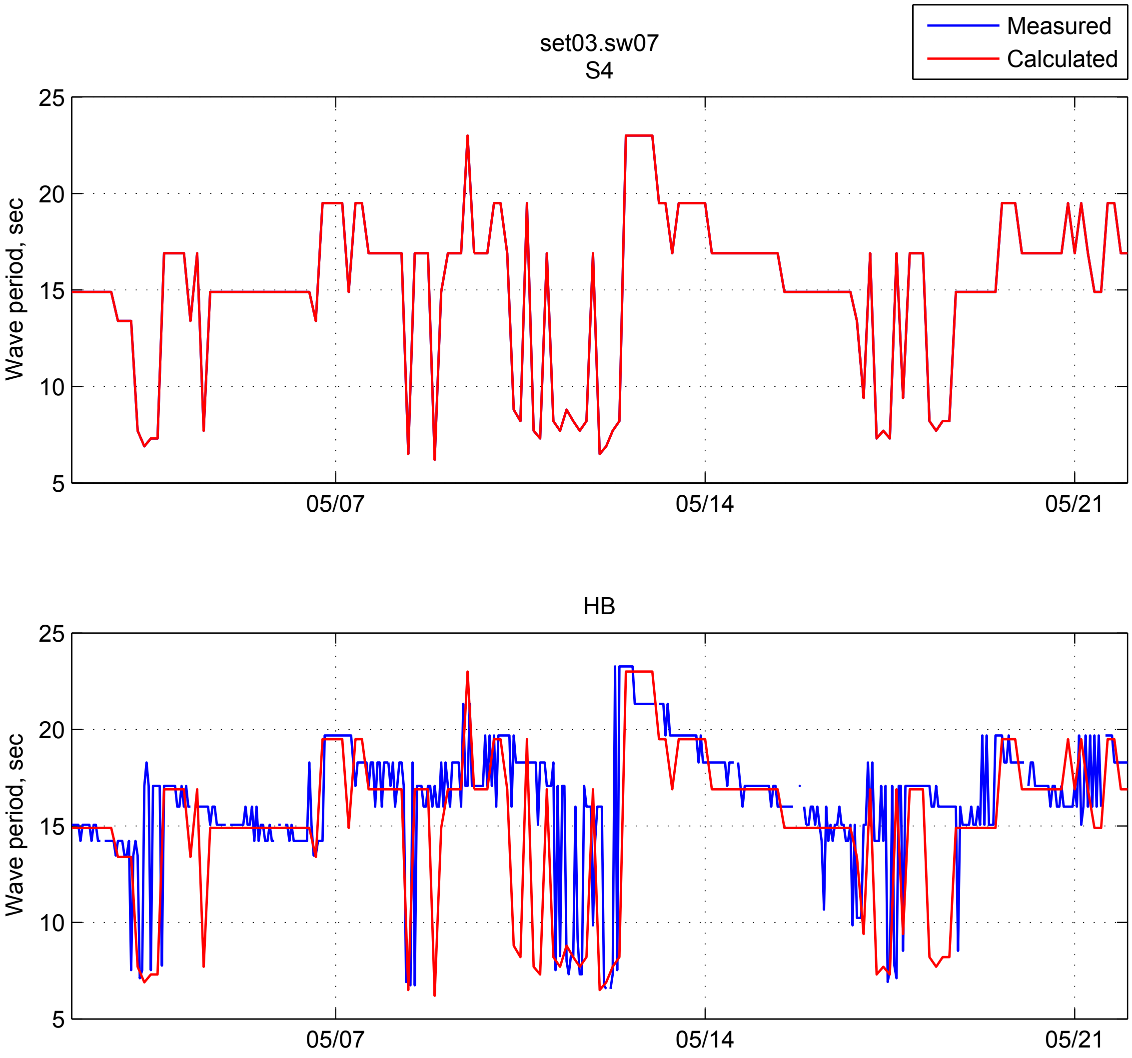


Figure A-5: Calibration Results for Peak Period at Offshore Station (S4) and Huntington Beach Array (HB)

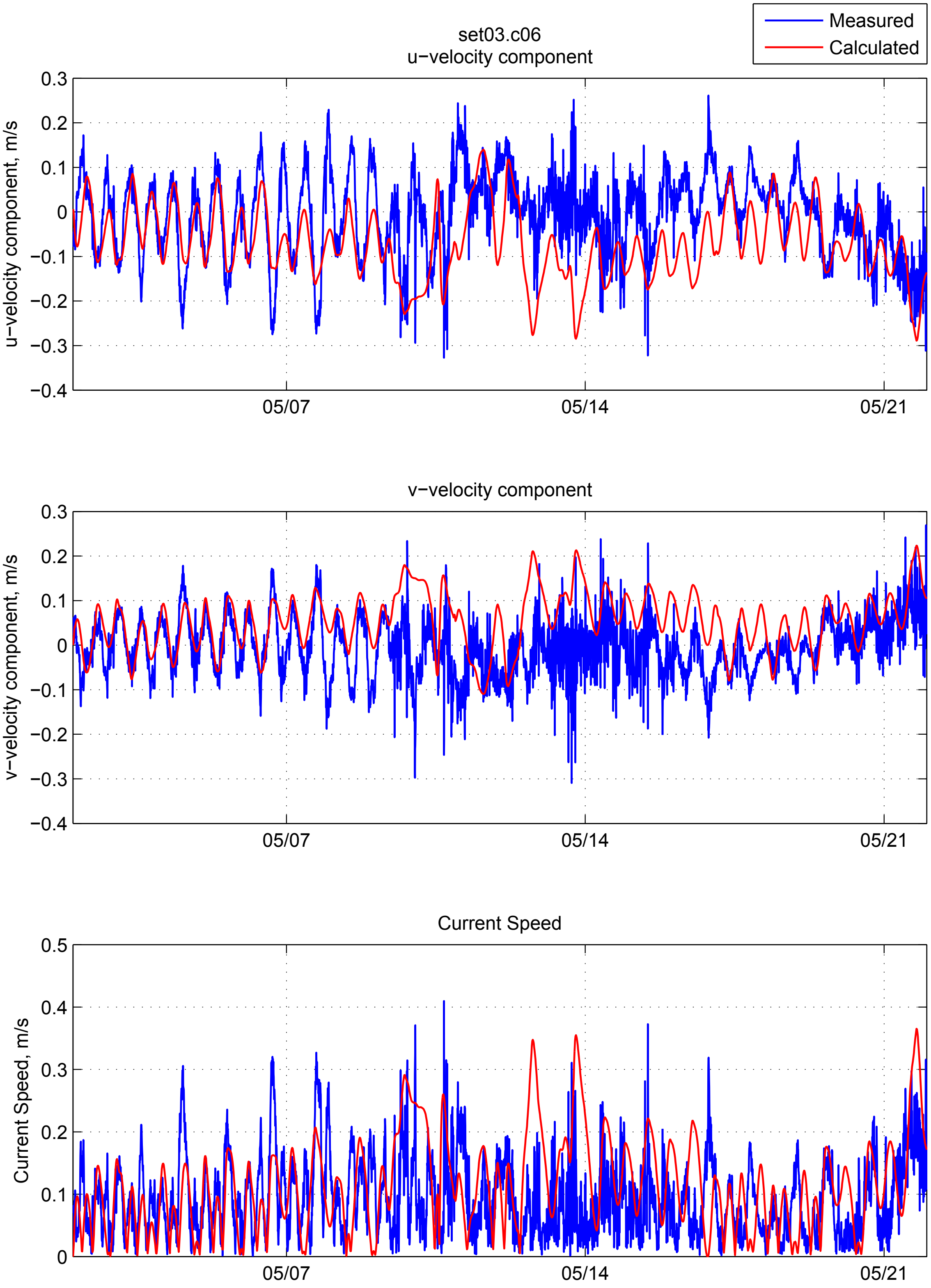


Figure A-6: Calibration Results for Currents at Beach Boulevard (E)

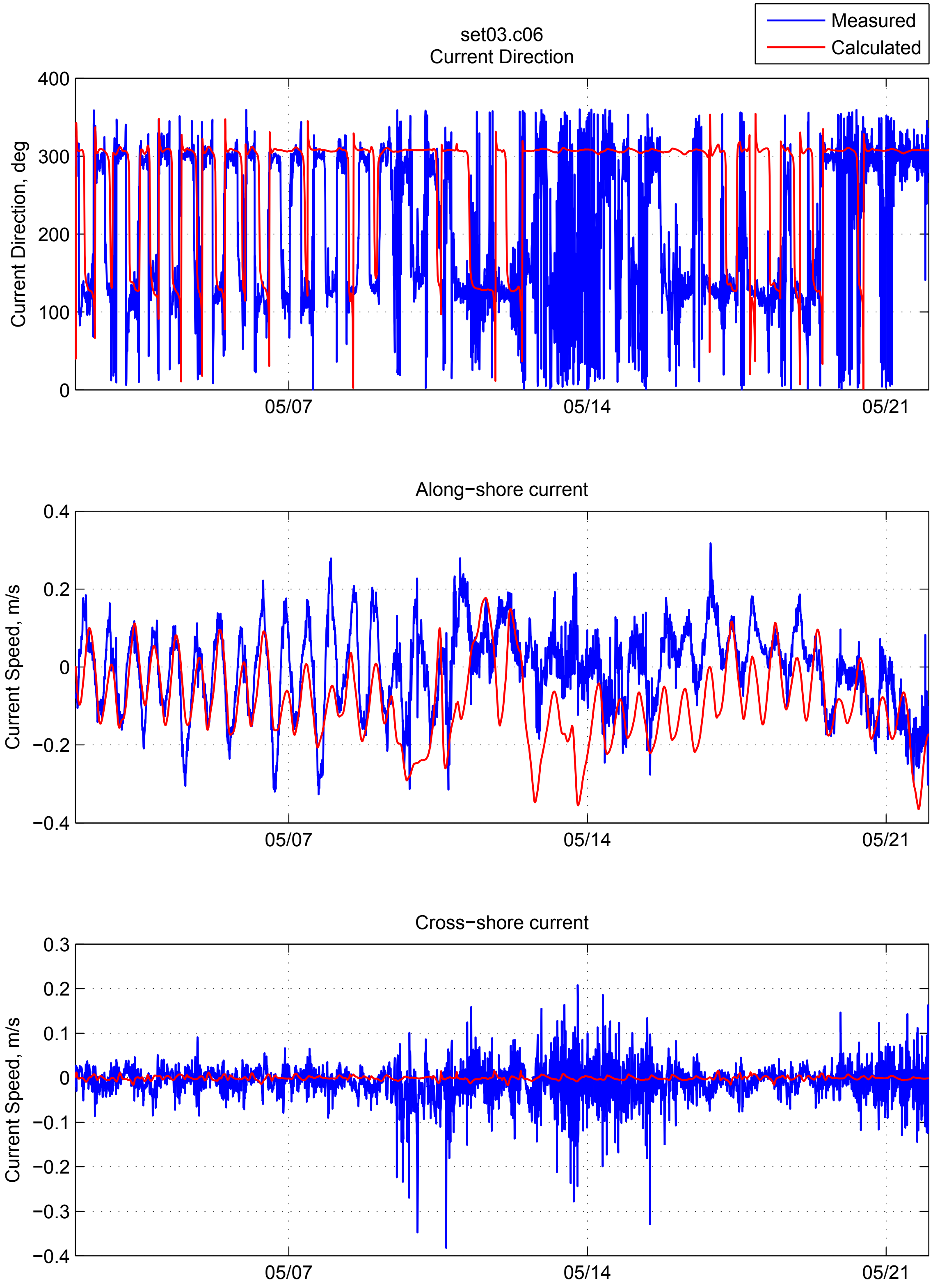


Figure A-7: Calibration Results for Currents at Beach Boulevard (E) (continued)

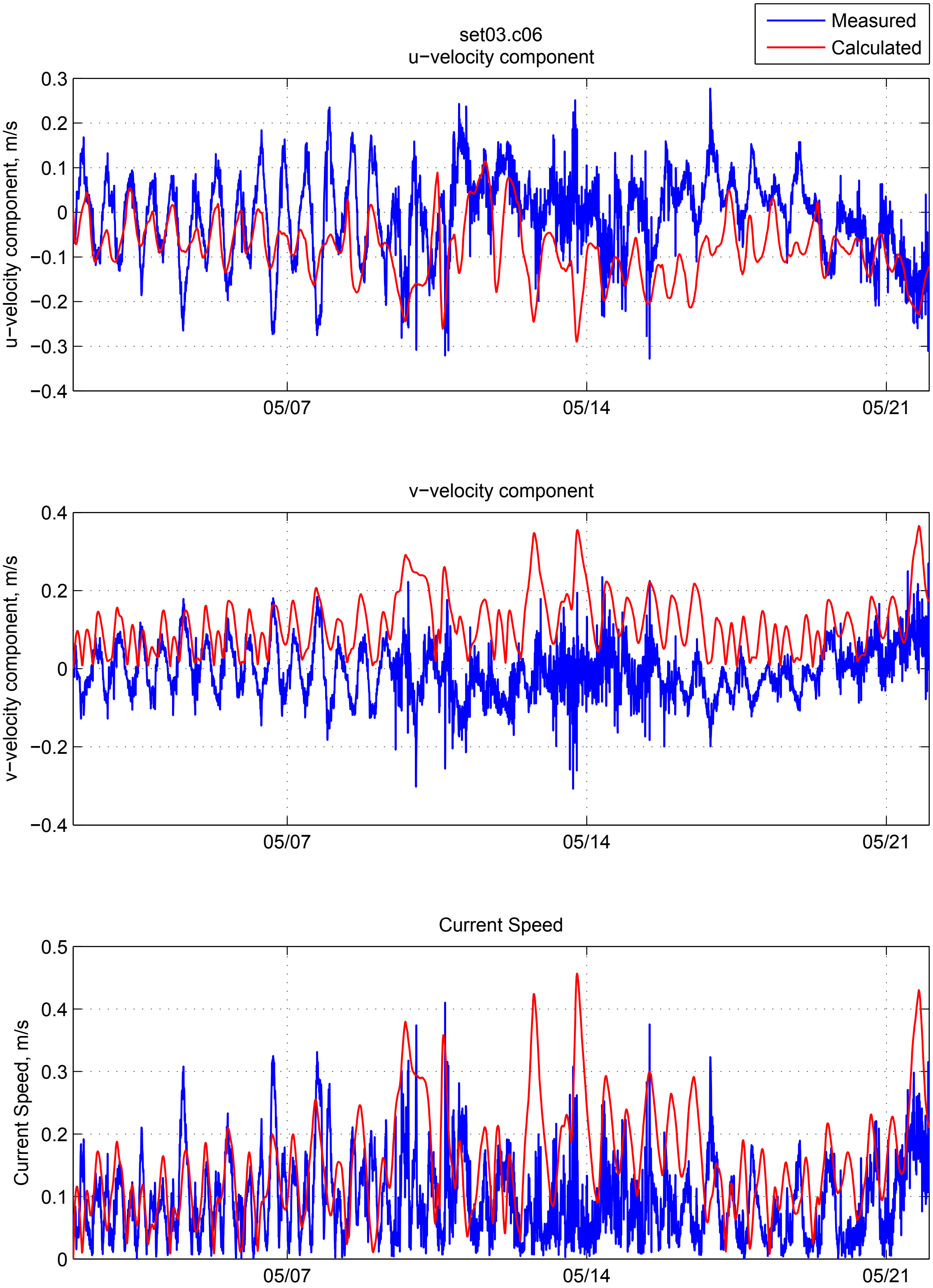
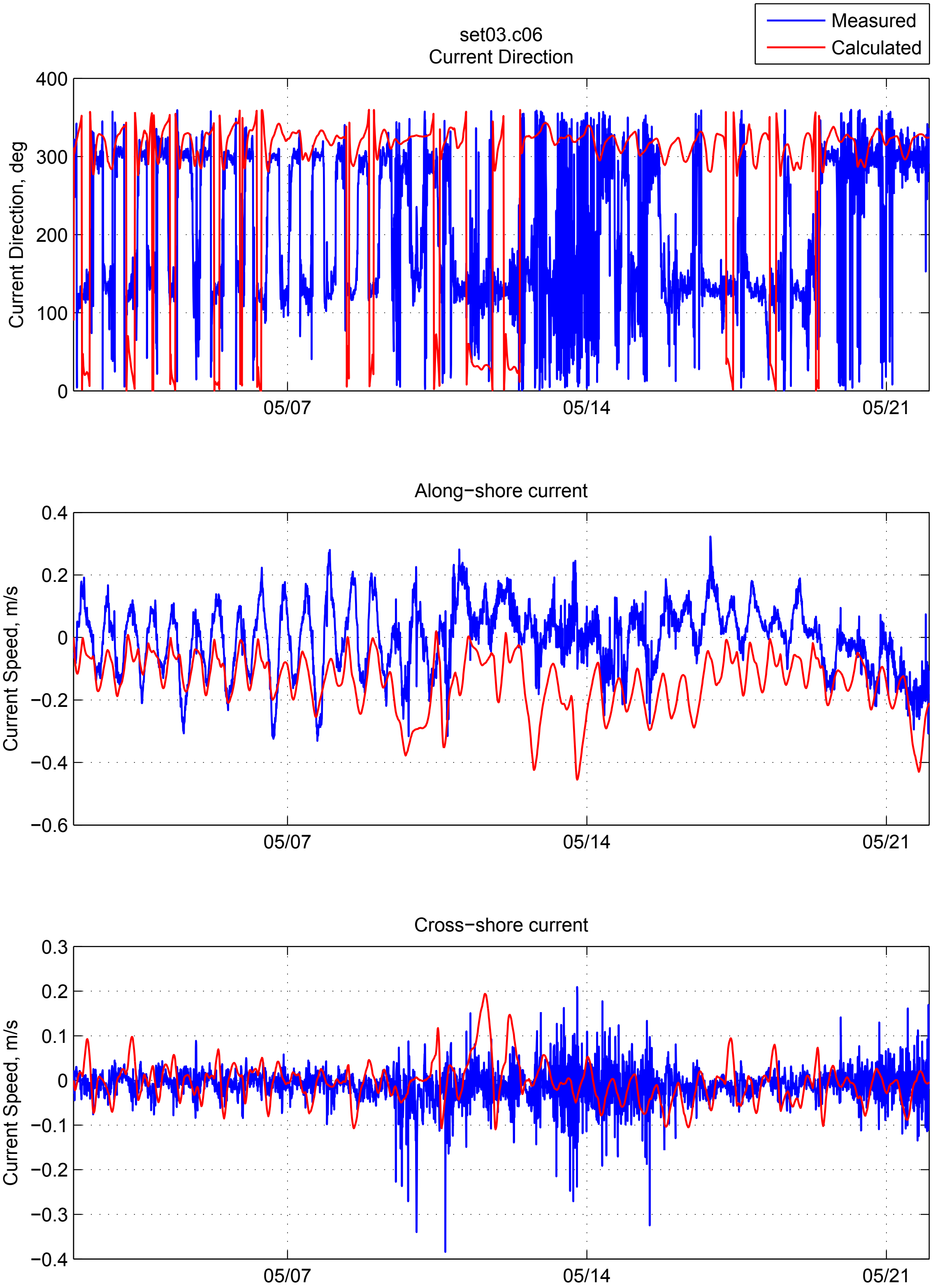


Figure A-8: Calibration Results for Currents at Newport Beach (F)



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APPENDIX B

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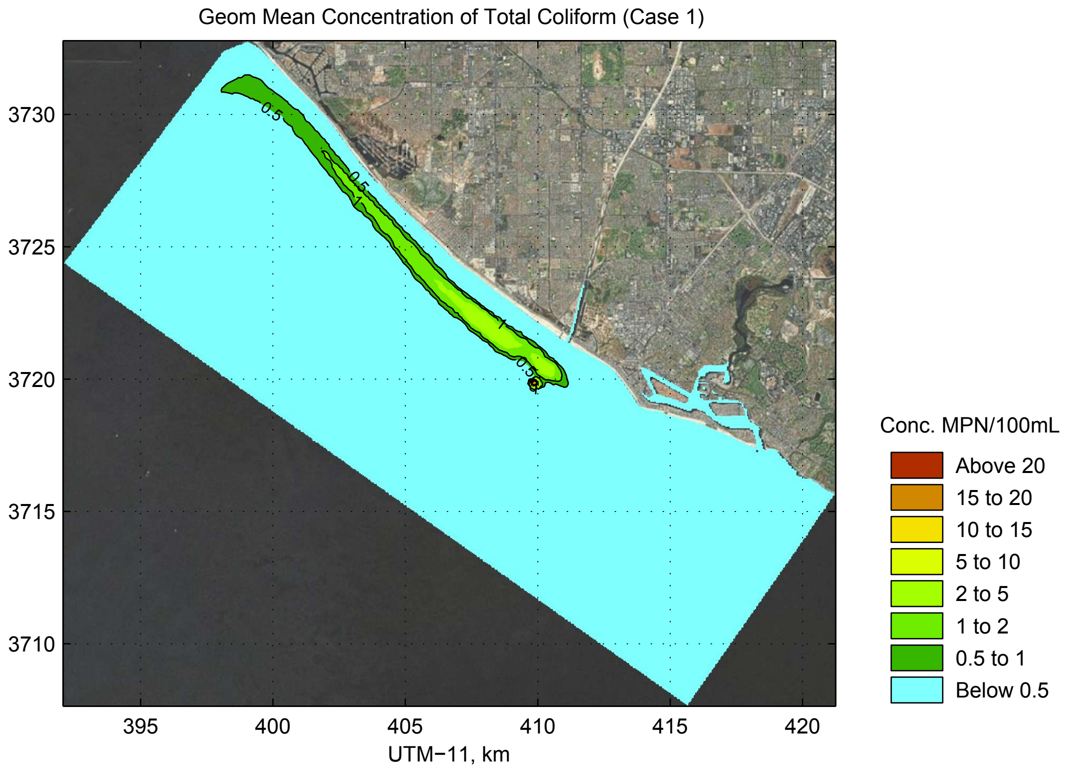

Figure B-1: Geom Mean Concentration of Total Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

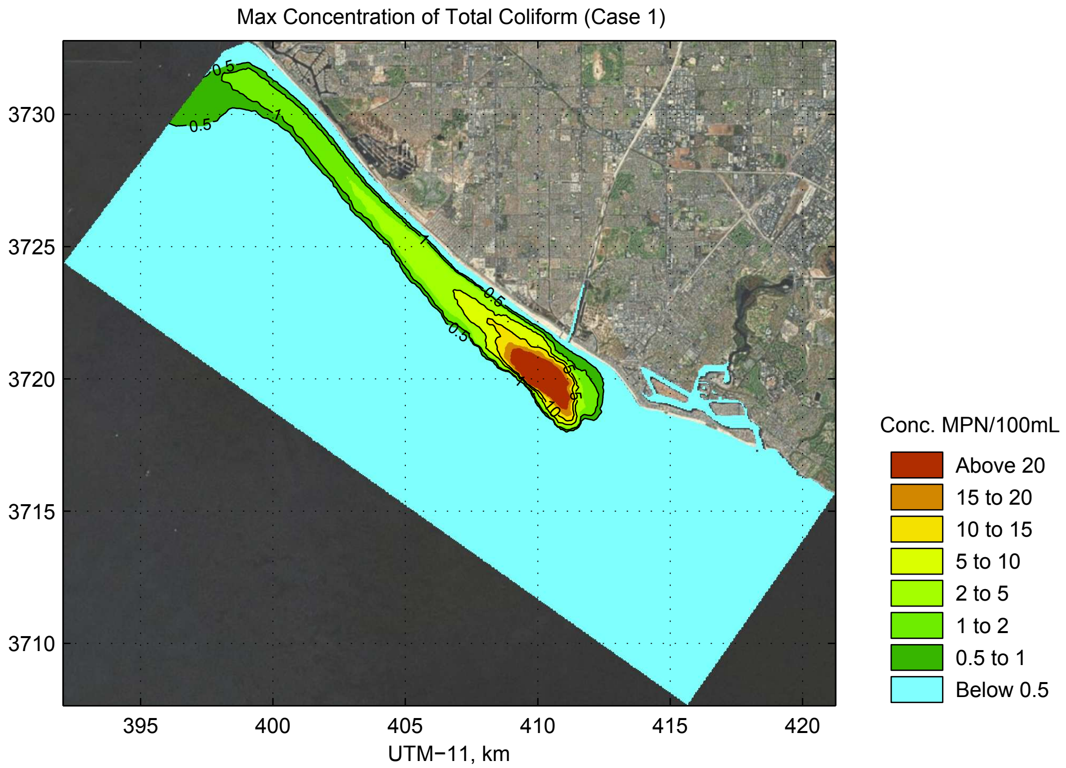

Figure B-2: Max Concentration of Total Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

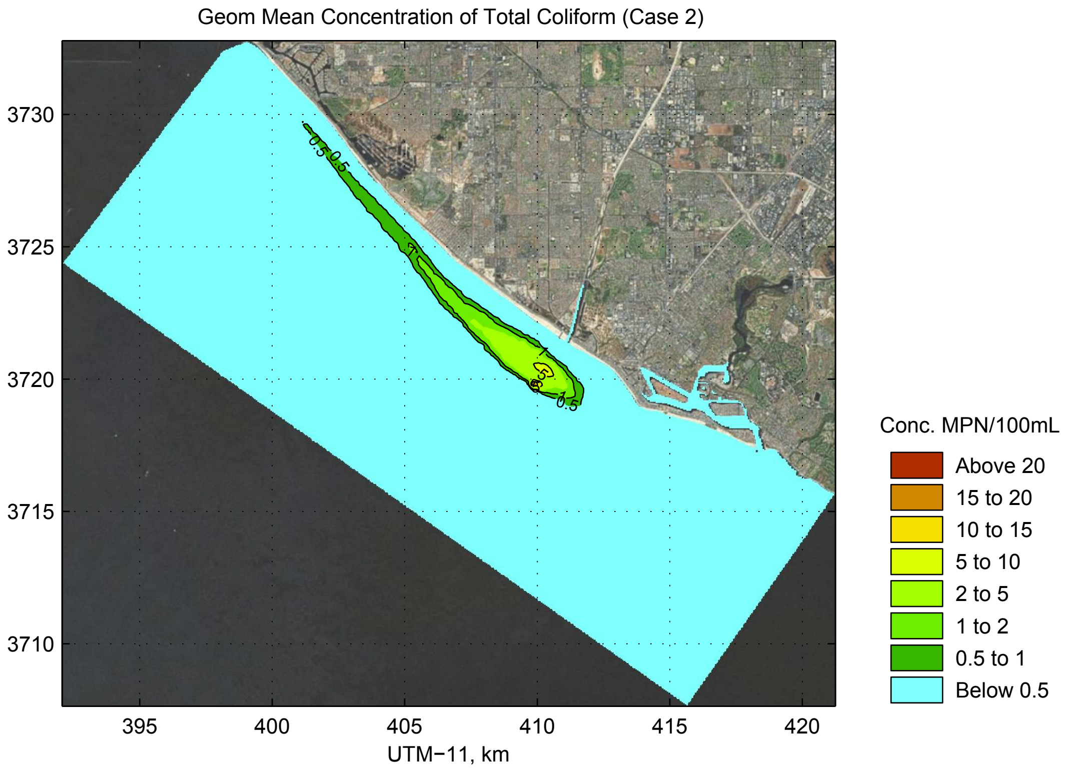

Figure B-3: Geom Mean Concentration of Total Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

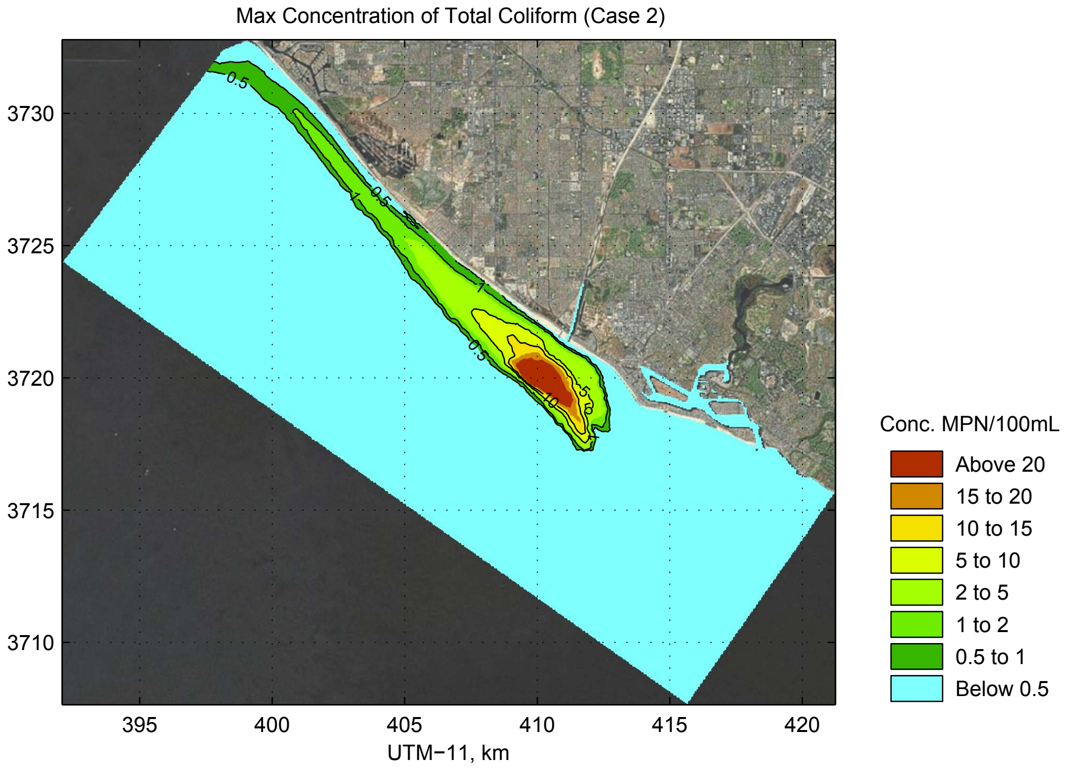

Figure B-4: Max Concentration of Total Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

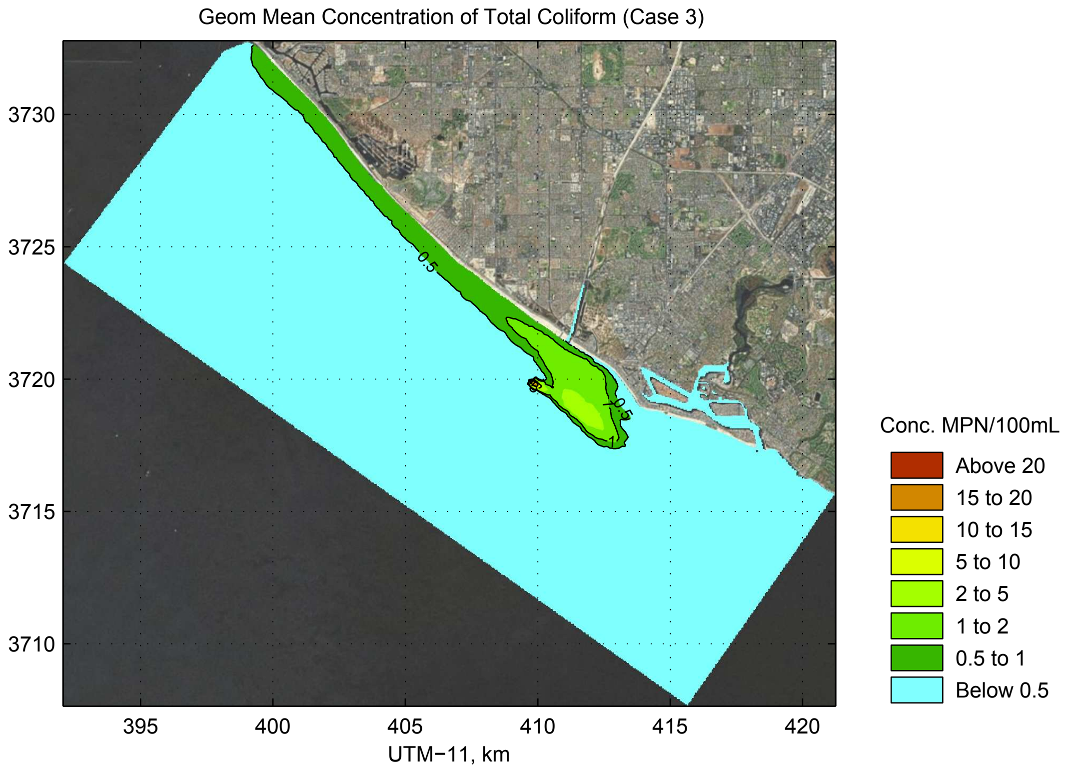

Figure B-5: Geom Mean Concentration of Total Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

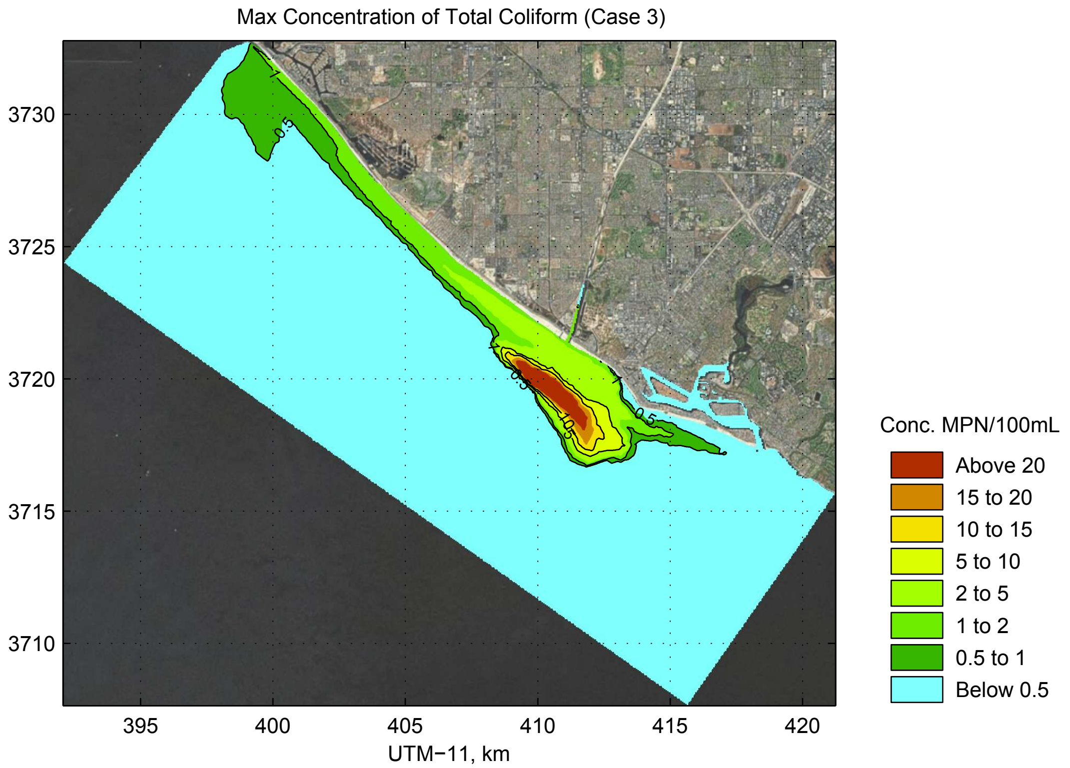

Figure B-6: Max Concentration of Total Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

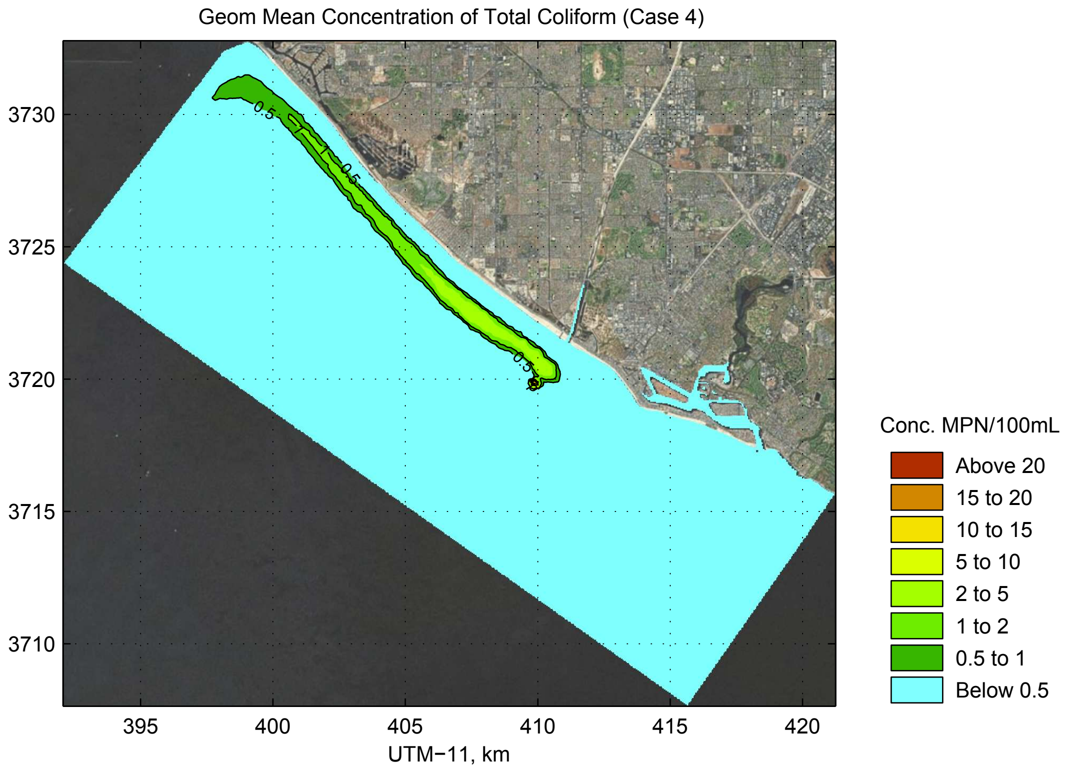

Figure B-7: Geom Mean Concentration of Total Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

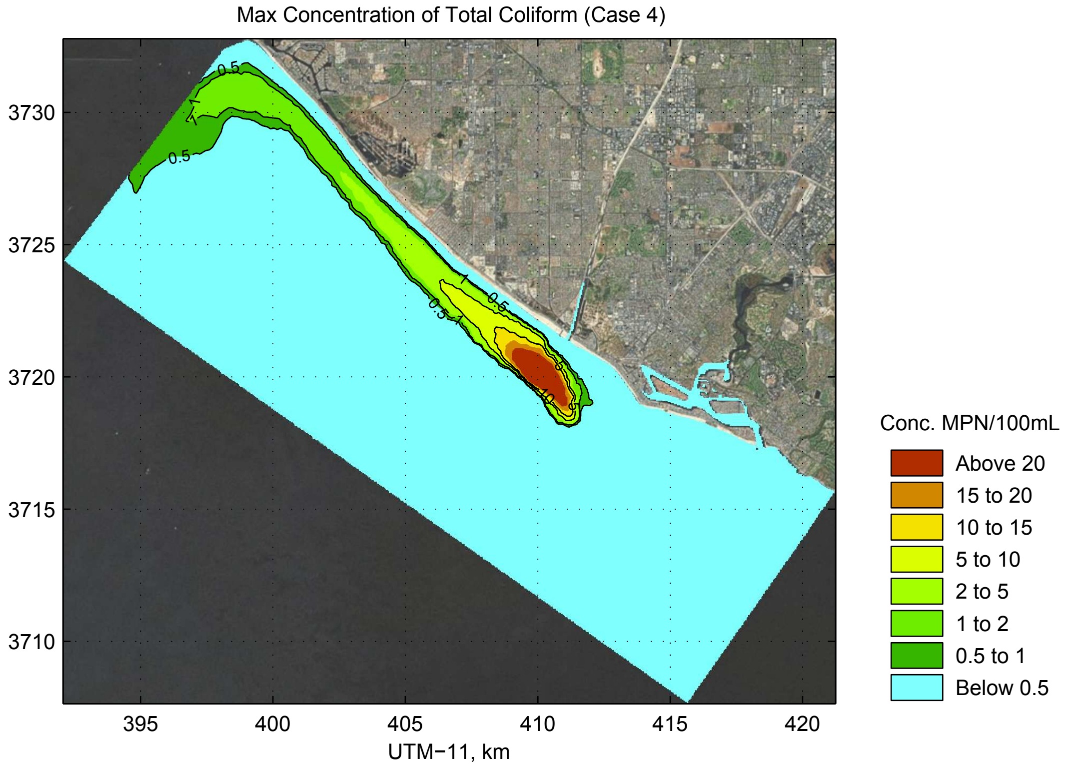

Figure B-8: Max Concentration of Total Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

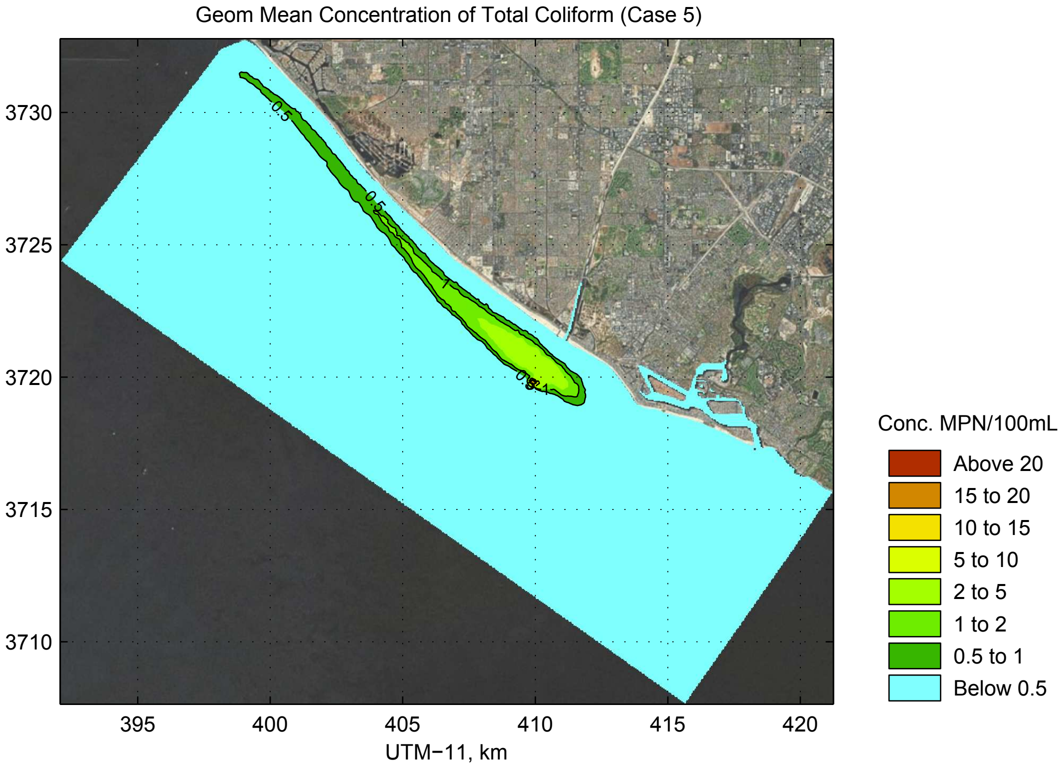

Figure B-9: Geom Mean Concentration of Total Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

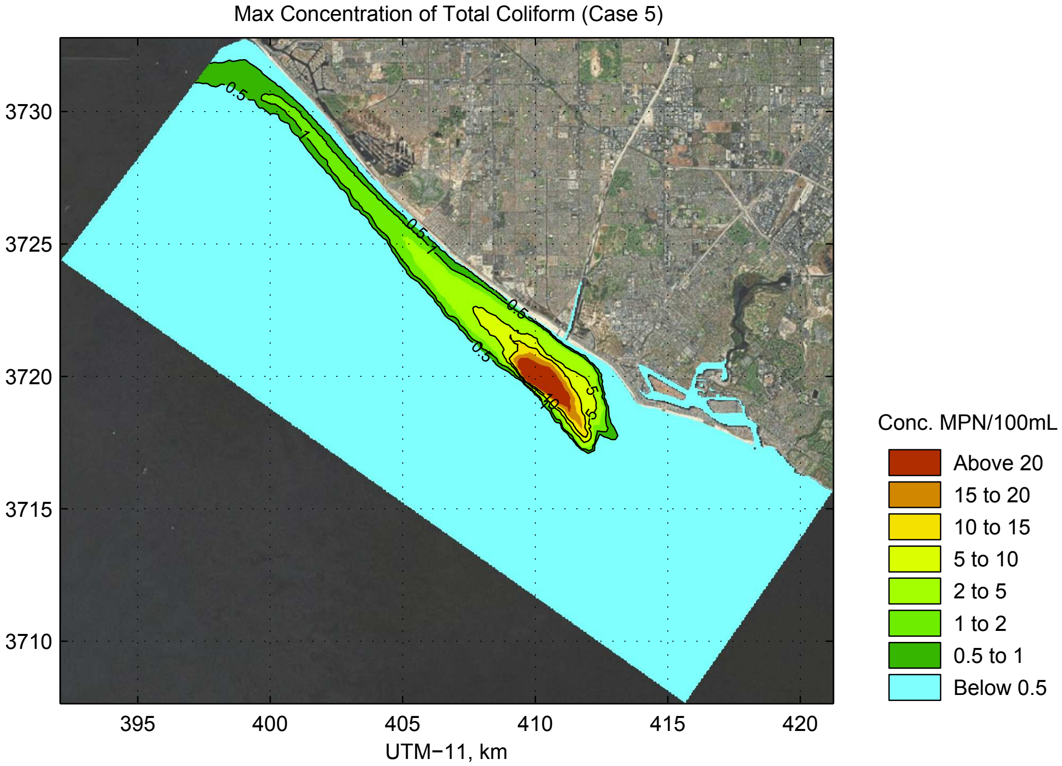

Figure B-10: Max Concentration of Total Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

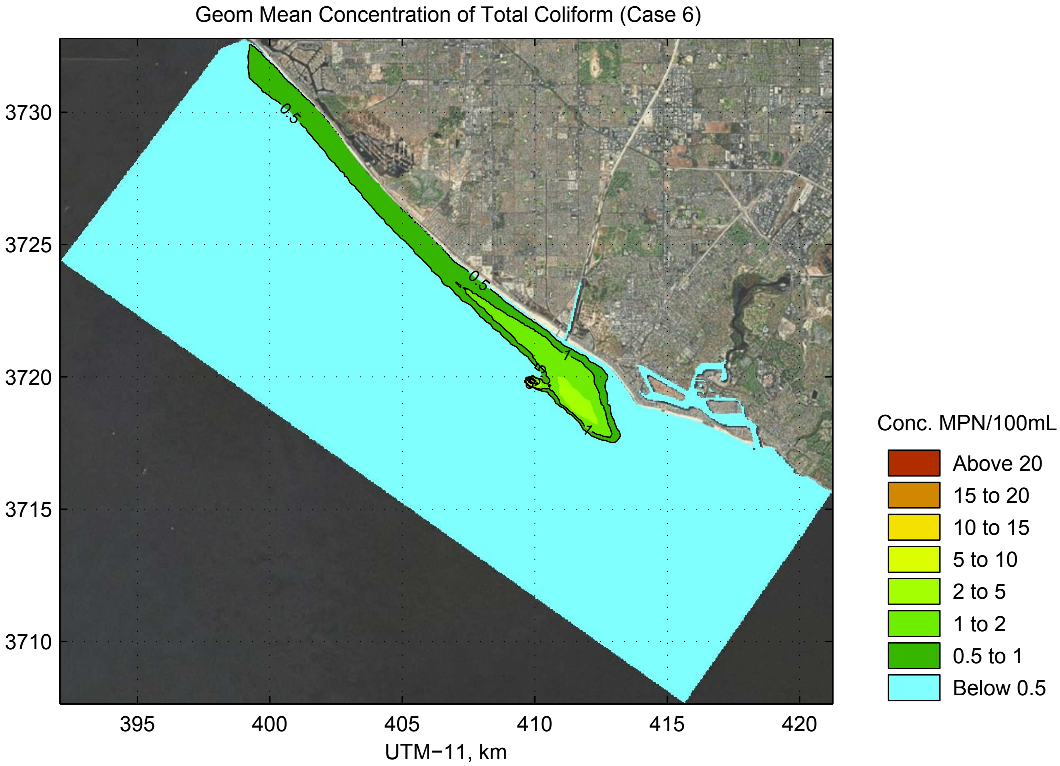

Figure B-11: Geom Mean Concentration of Total Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

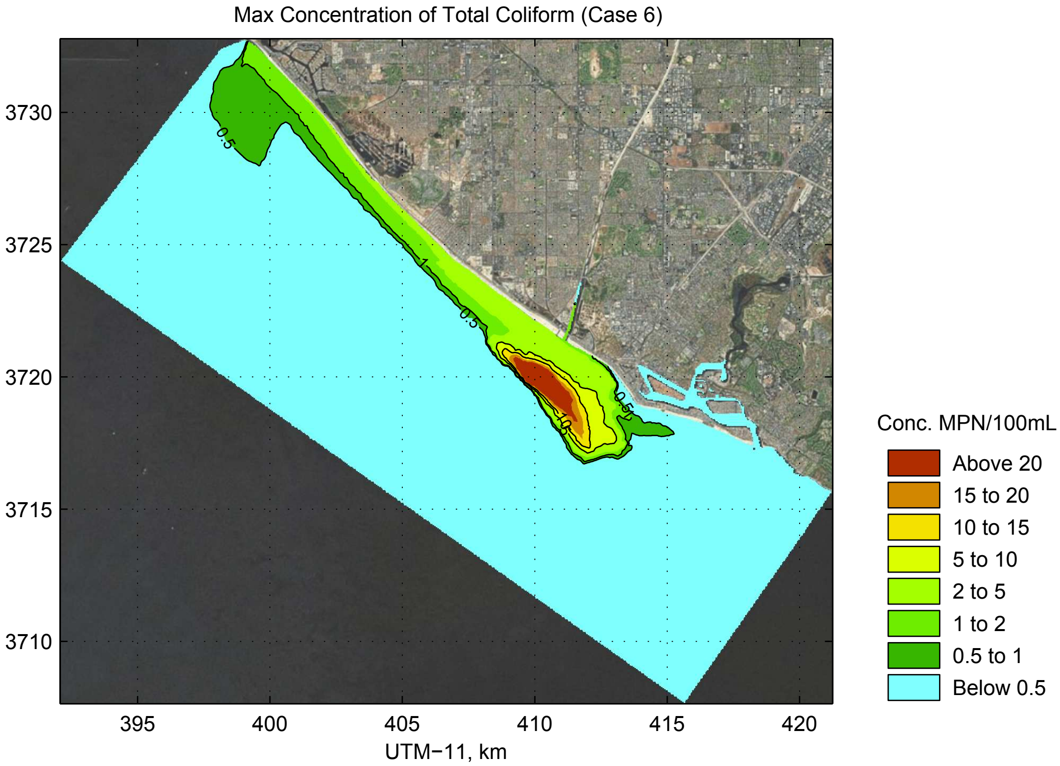

Figure B-12: Max Concentration of Total Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

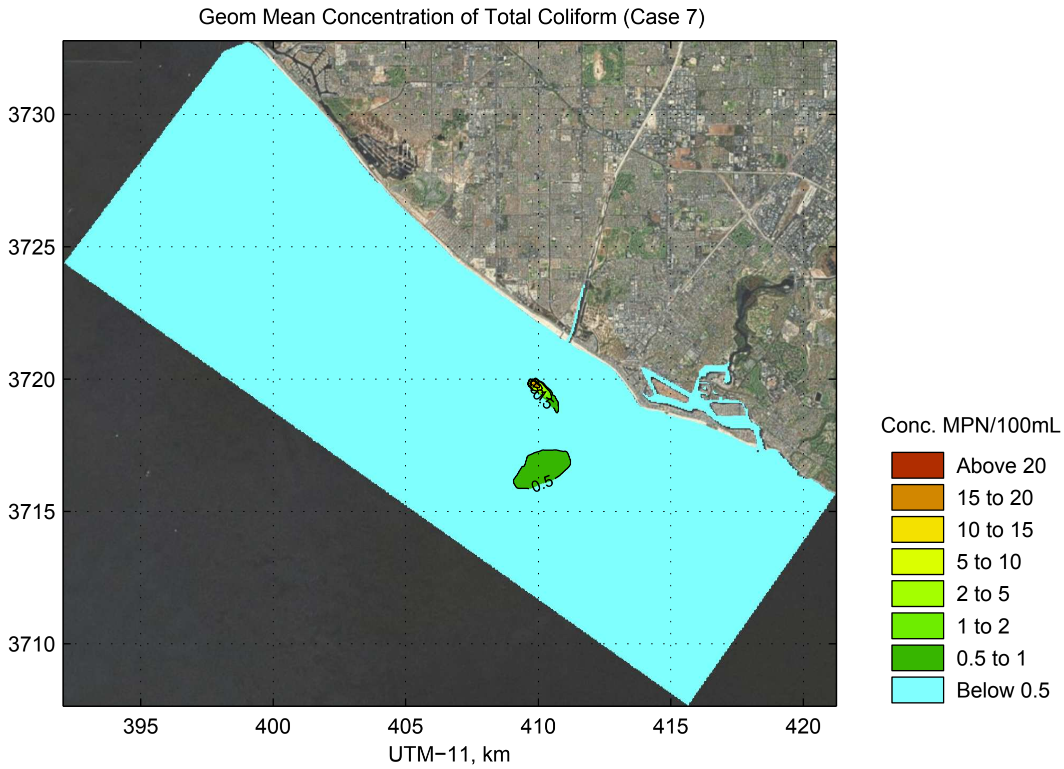

Figure B-13: Geom Mean Concentration of Total Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

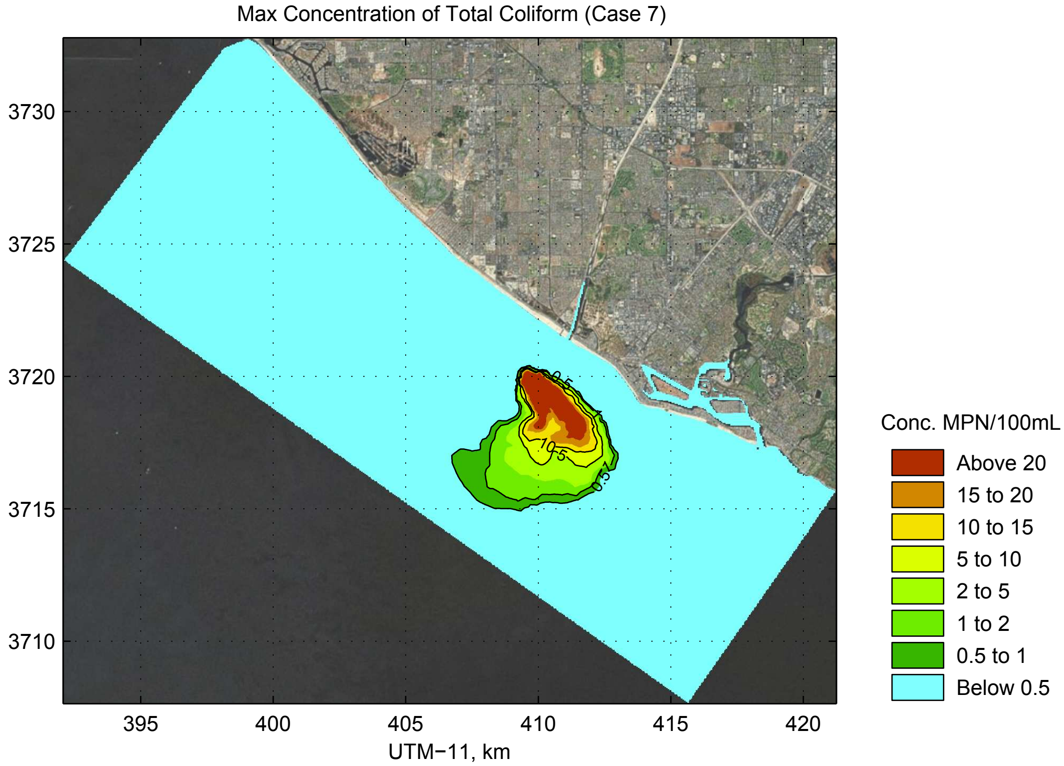

Figure B-14: Max Concentration of Total Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

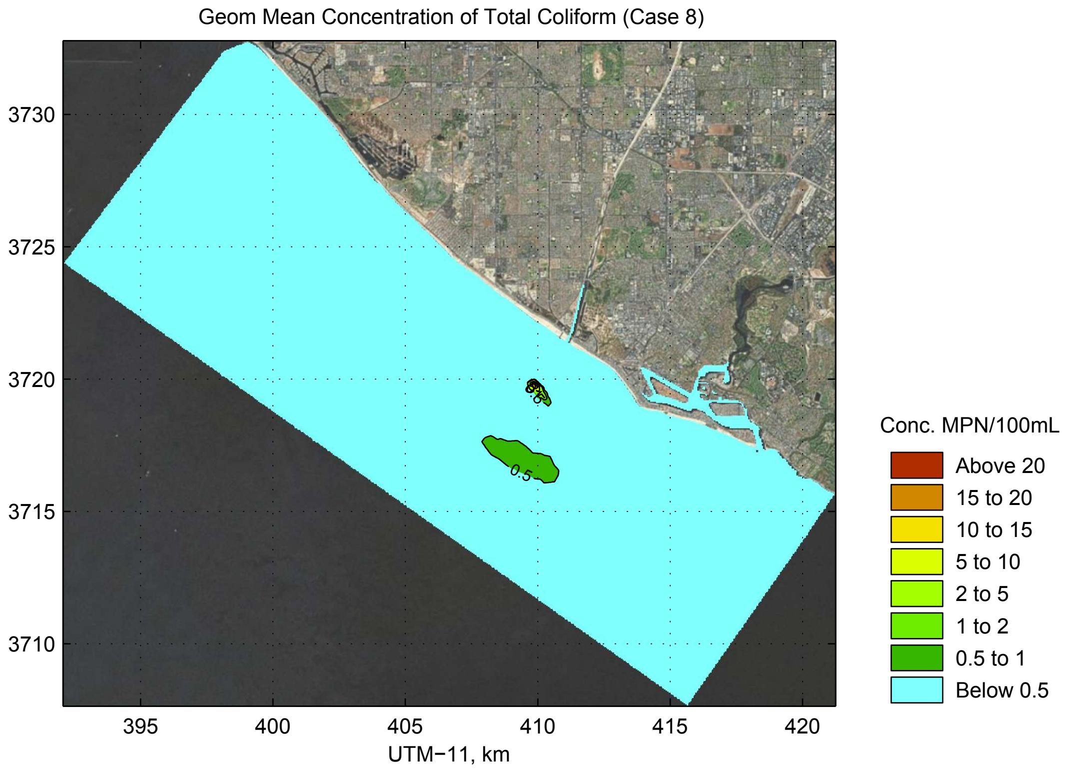

Figure B-15: Geom Mean Concentration of Total Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

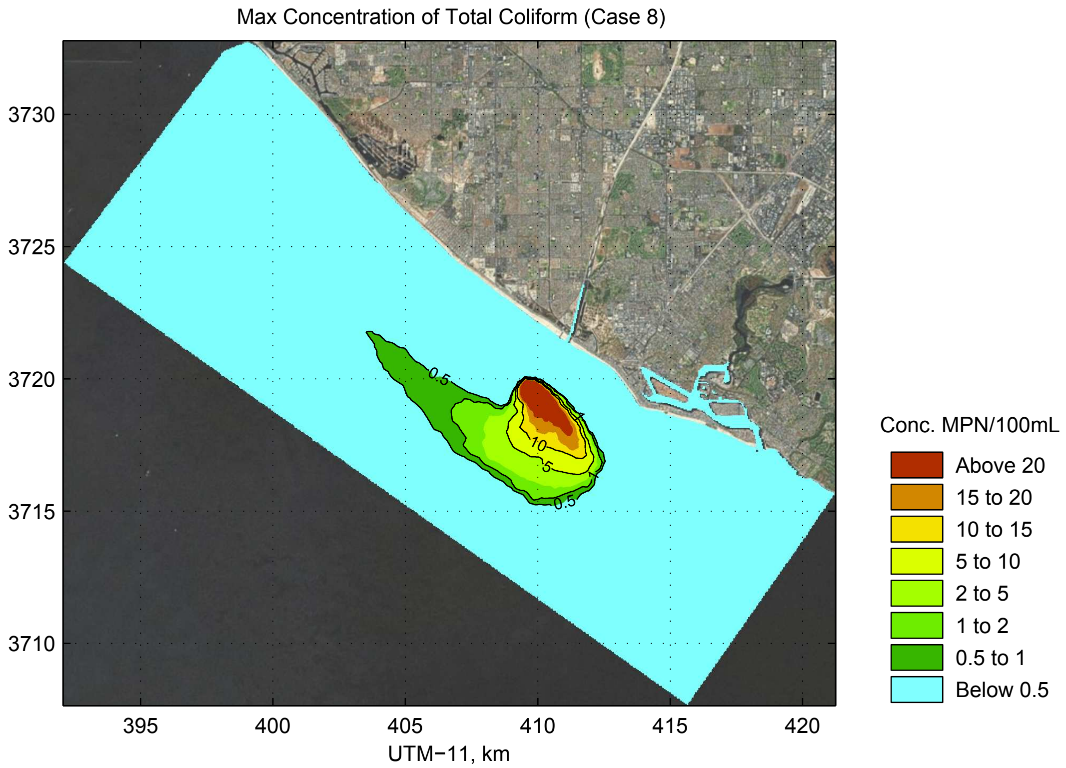

Figure B-16: Max Concentration of Total Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

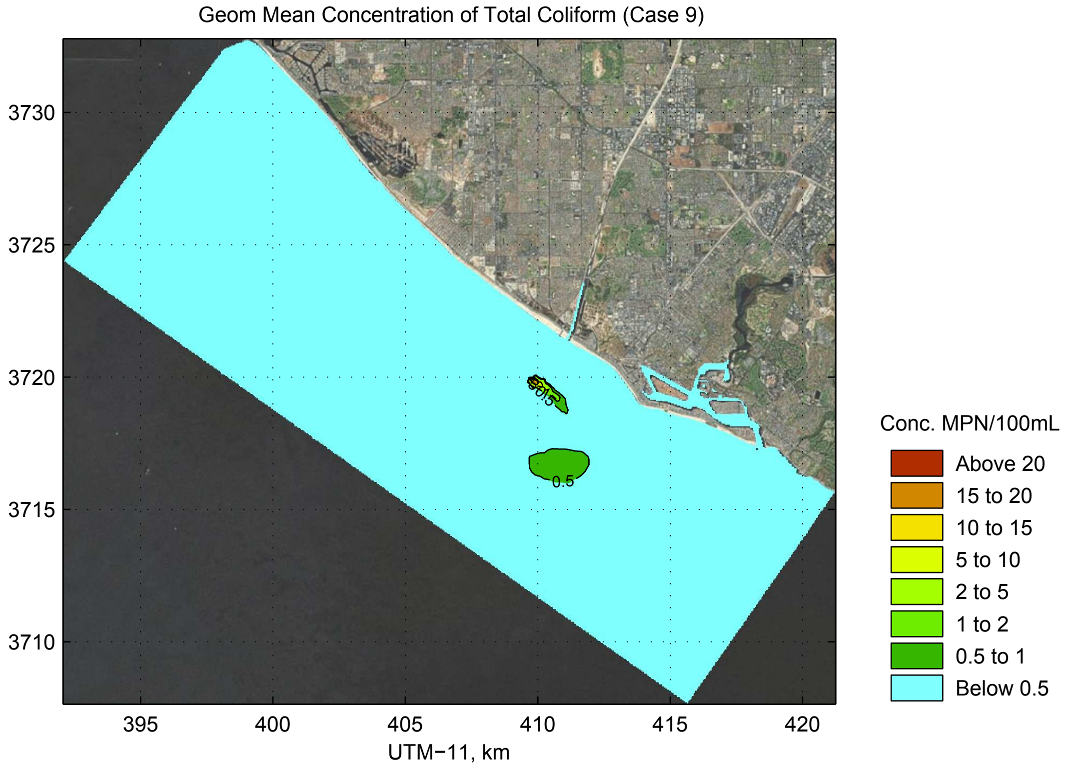

Figure B-17: Geom Mean Concentration of Total Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

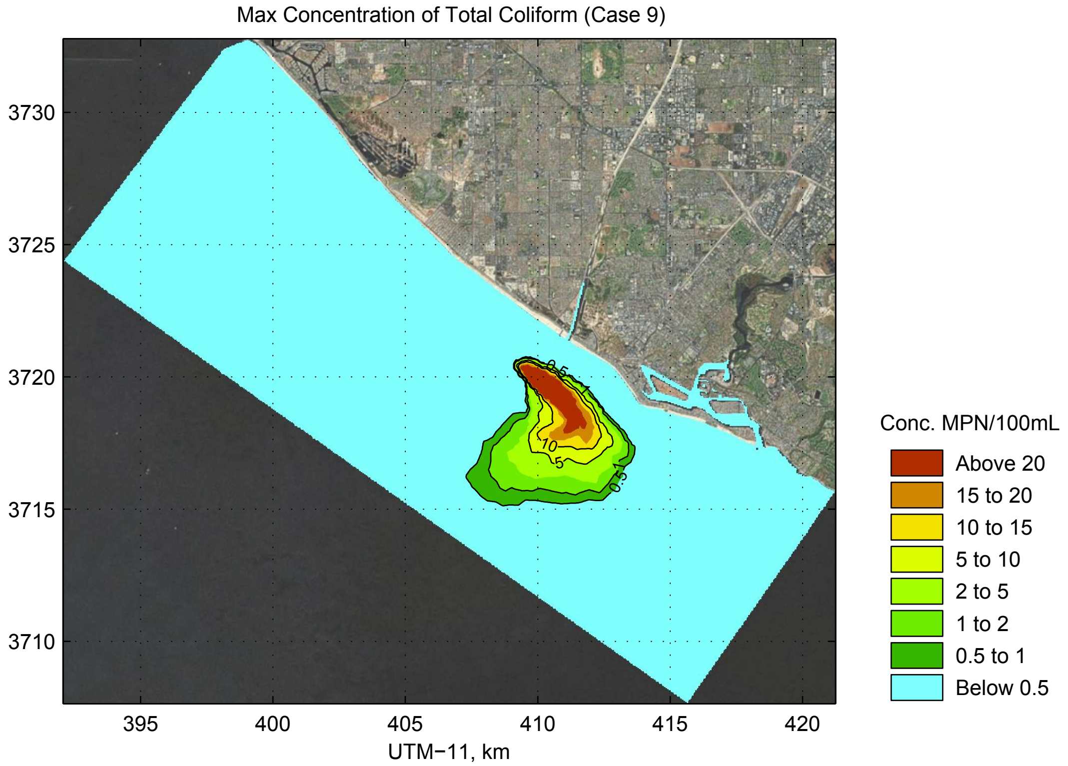

Figure B-18: Max Concentration of Total Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

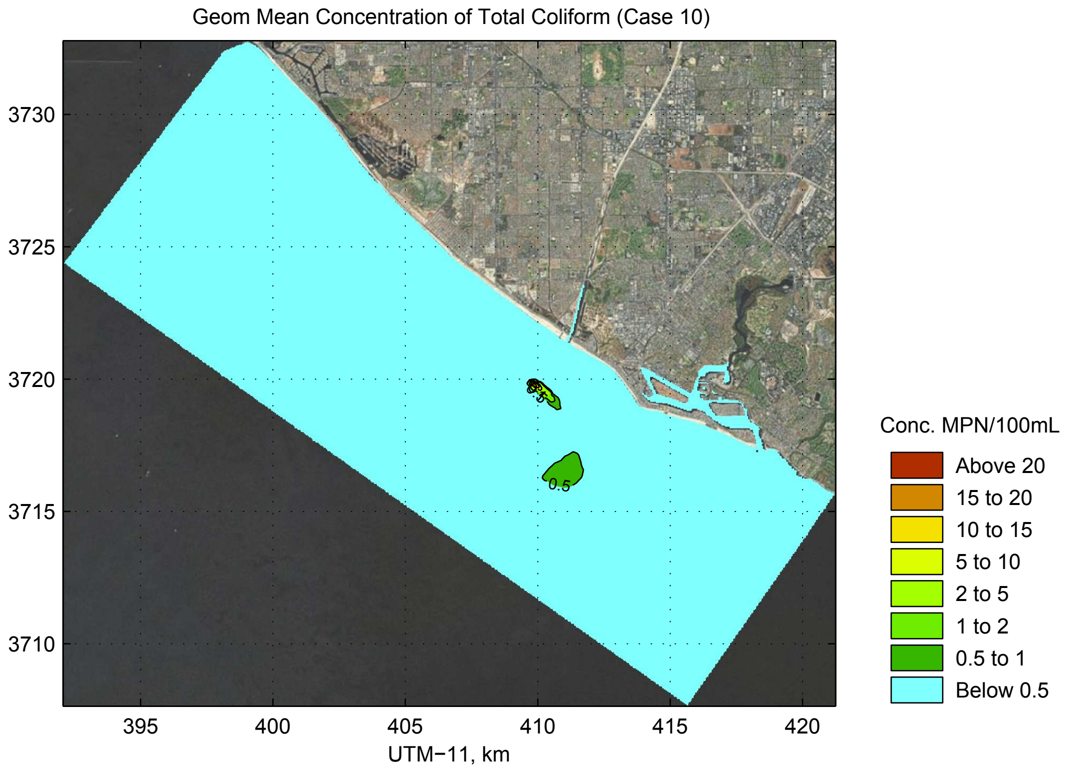

Figure B-19: Geom Mean Concentration of Total Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

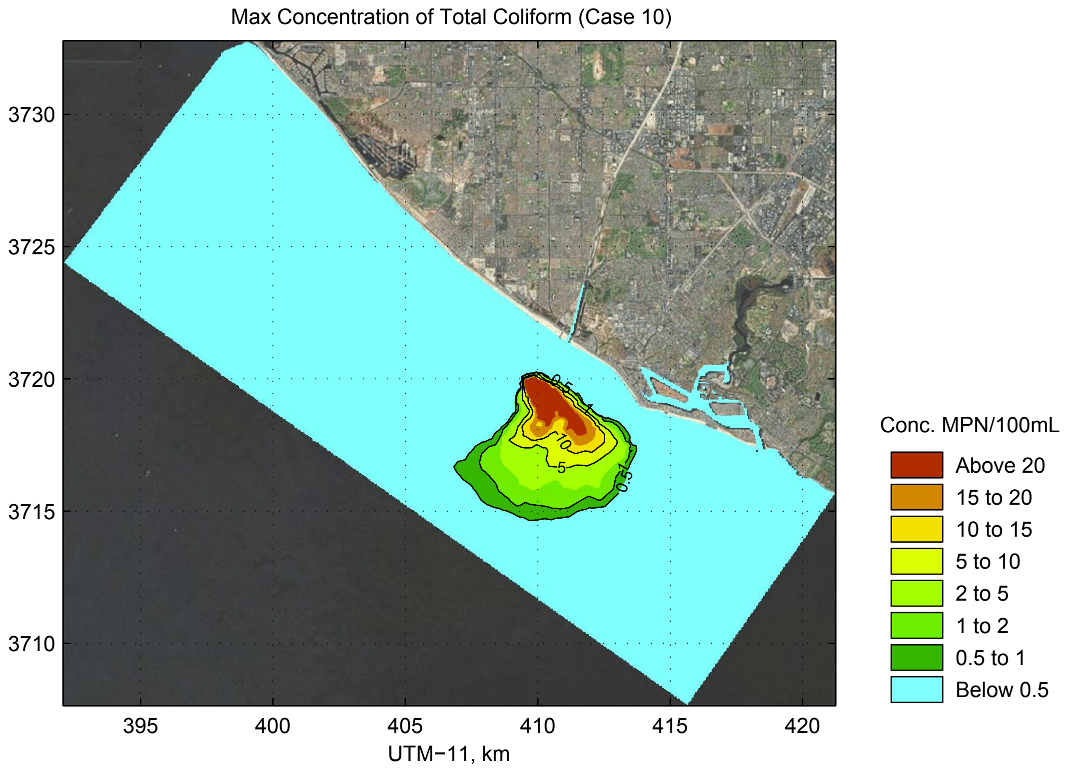

Figure B-20: Max Concentration of Total Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

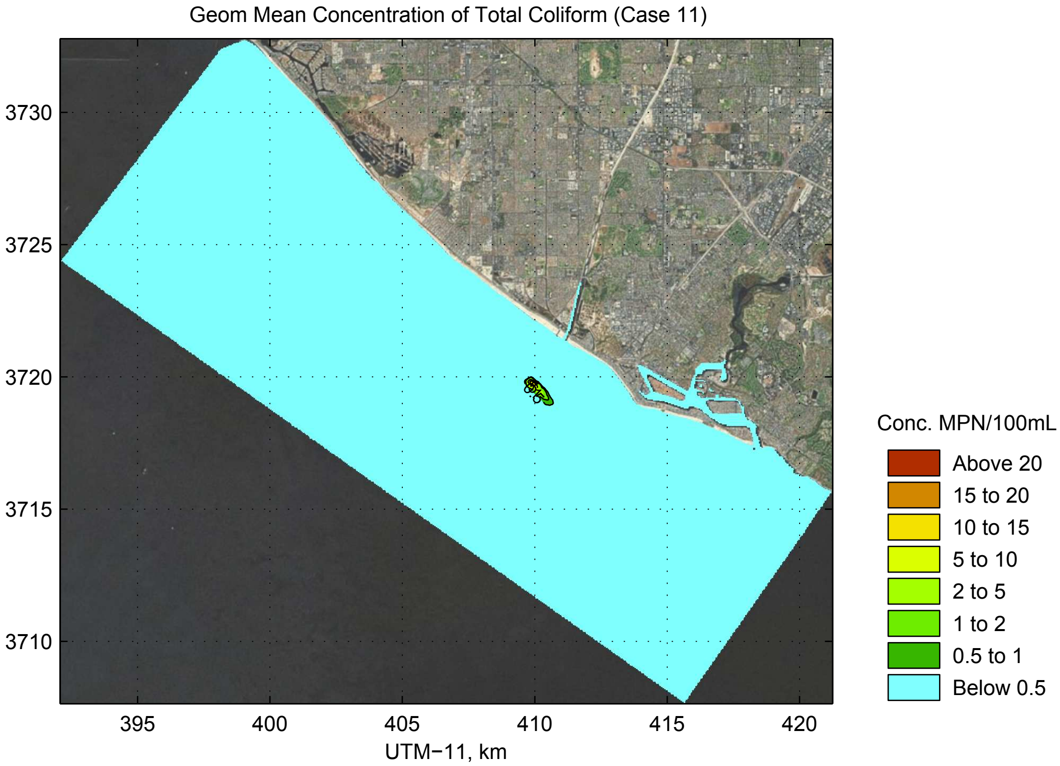

Figure B-21: Geom Mean Concentration of Total Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

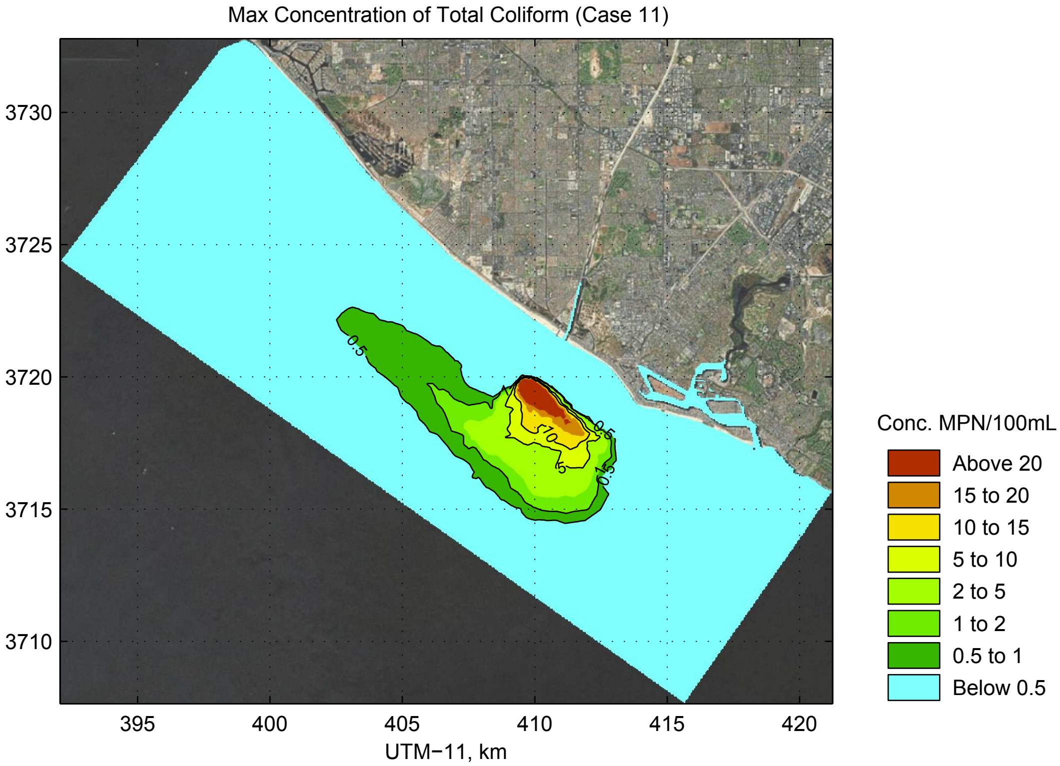

Figure B-22: Max Concentration of Total Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

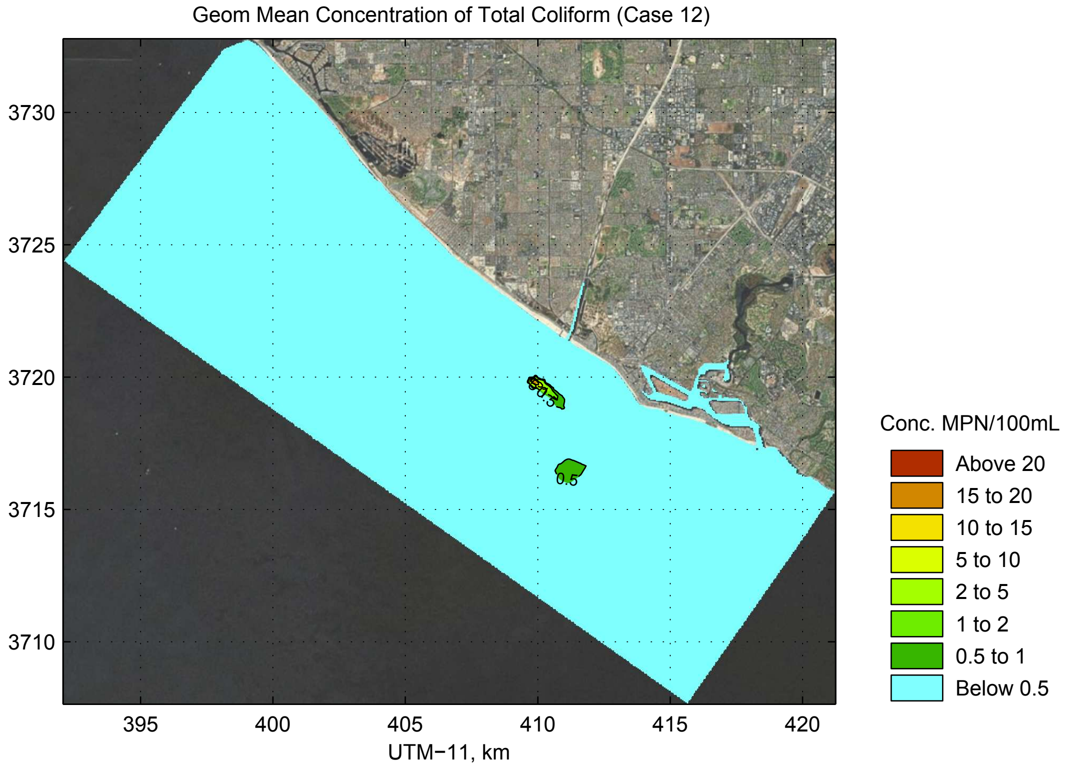

Figure B-23: Geom Mean Concentration of Total Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

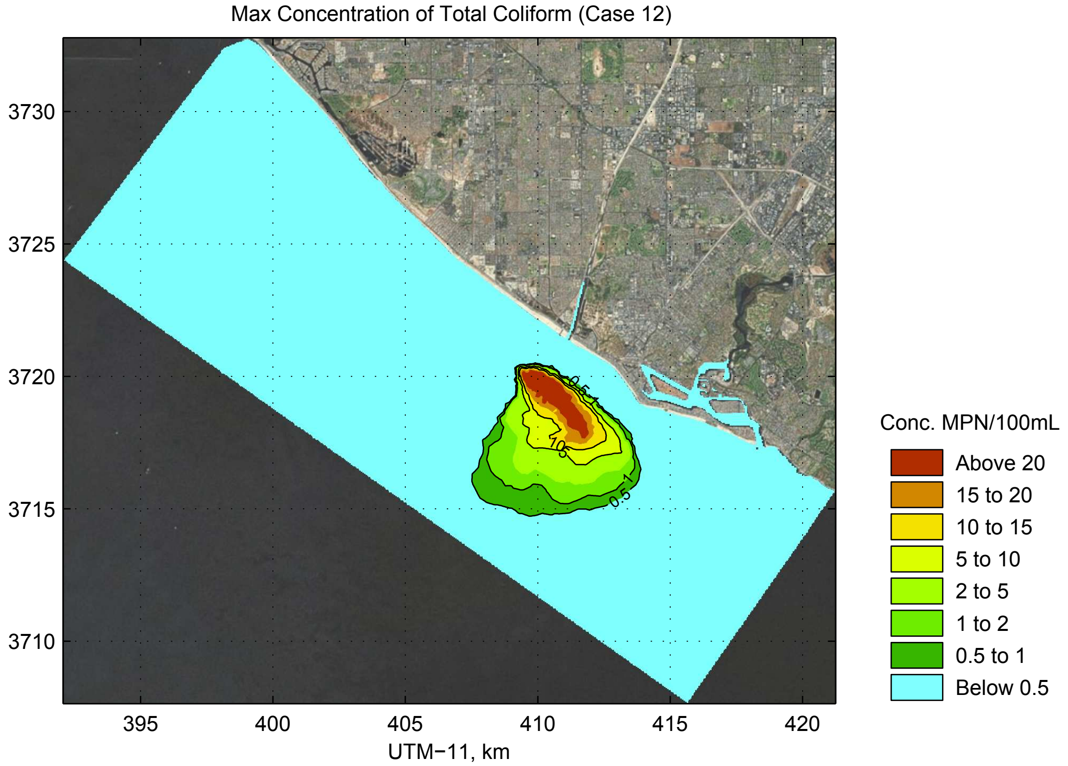

Figure B-24: Max Concentration of Total Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

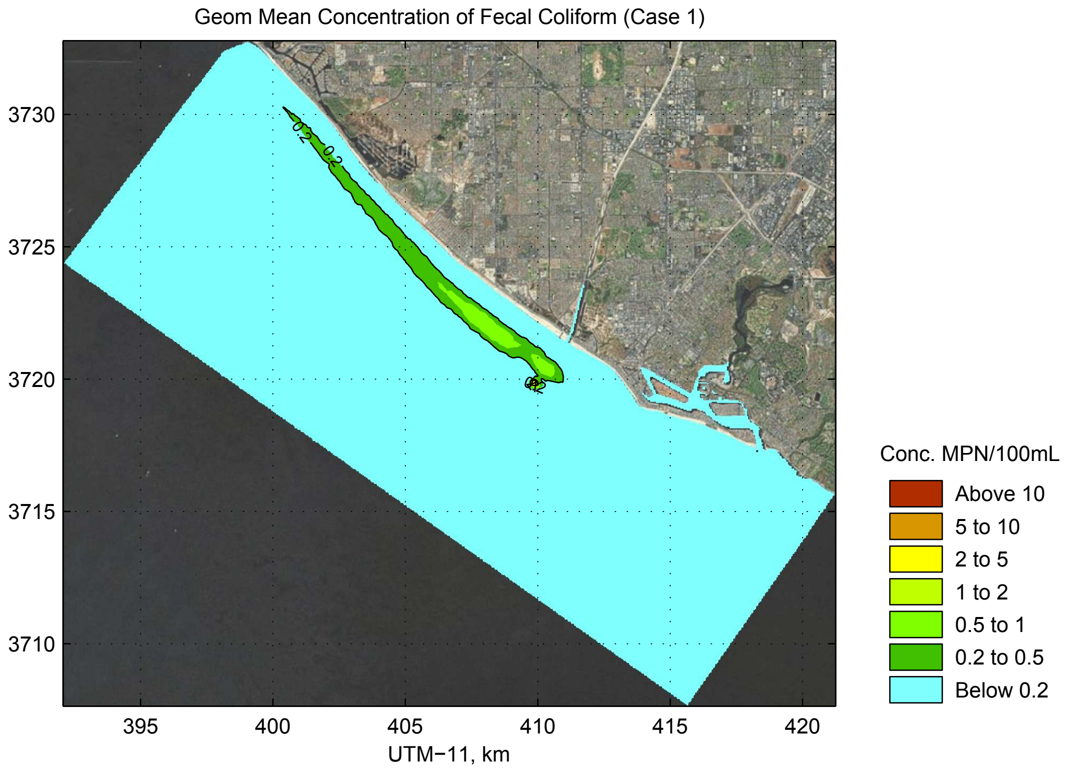

Figure B-25: Geom Mean Concentration of Fecal Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

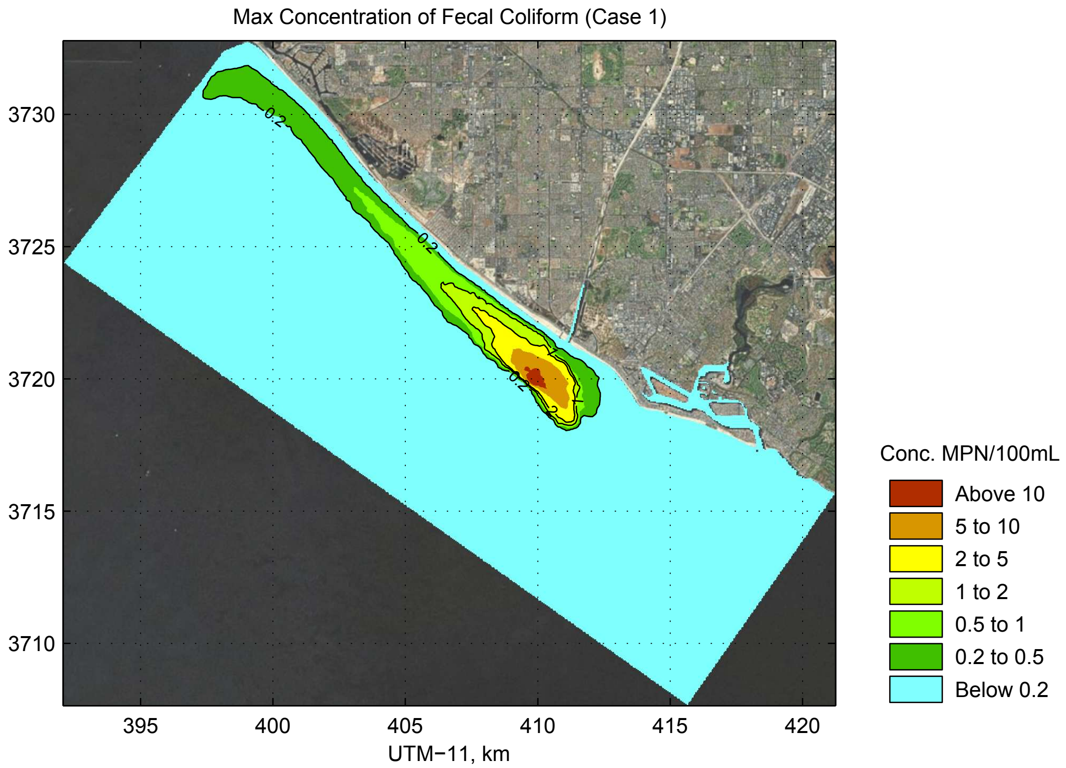

Figure B-26: Max Concentration of Fecal Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

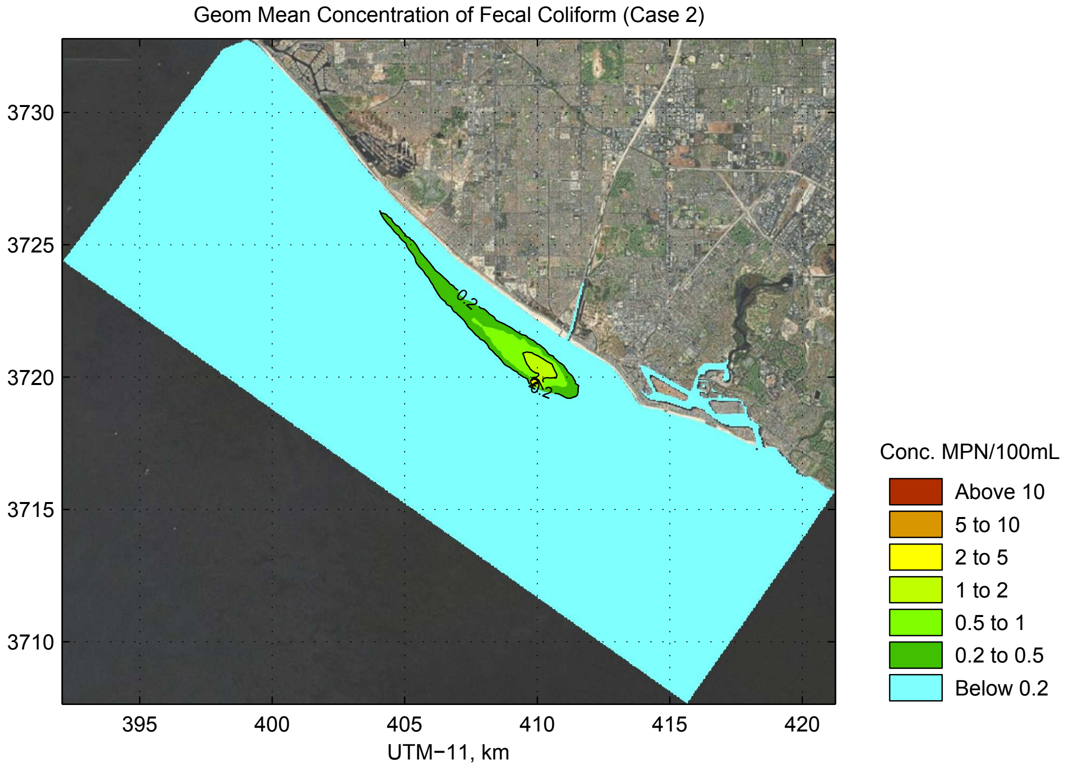

Figure B-27: Geom Mean Concentration of Fecal Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

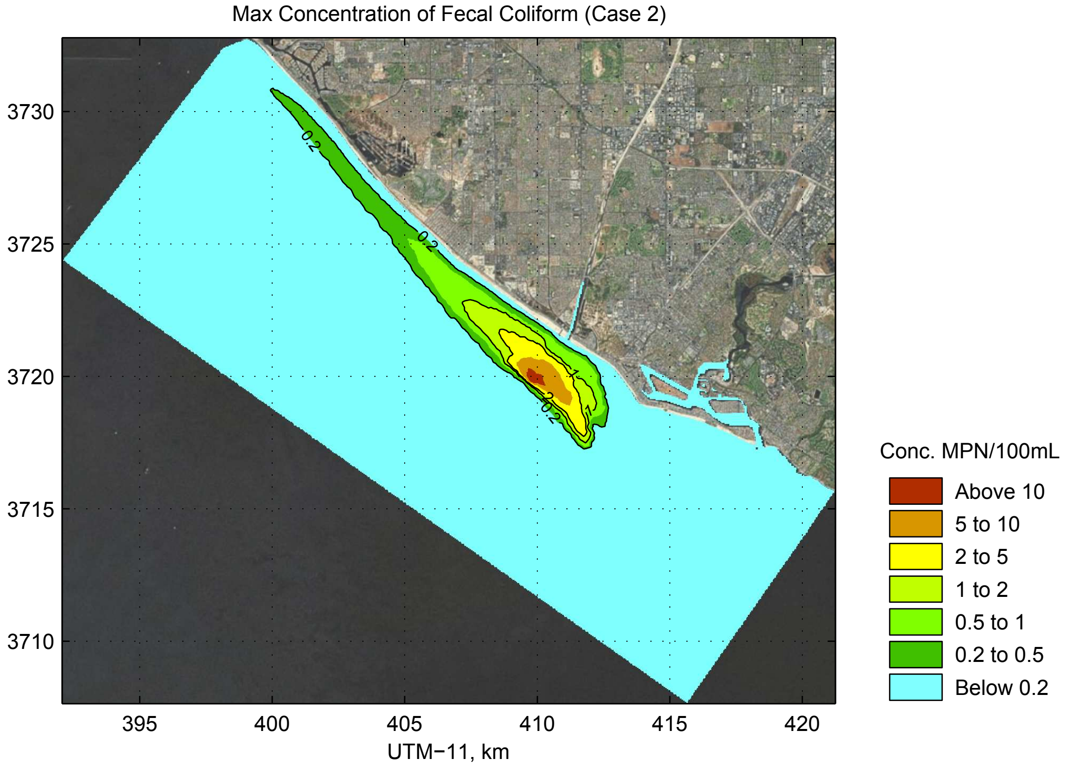

Figure B-28: Max Concentration of Fecal Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

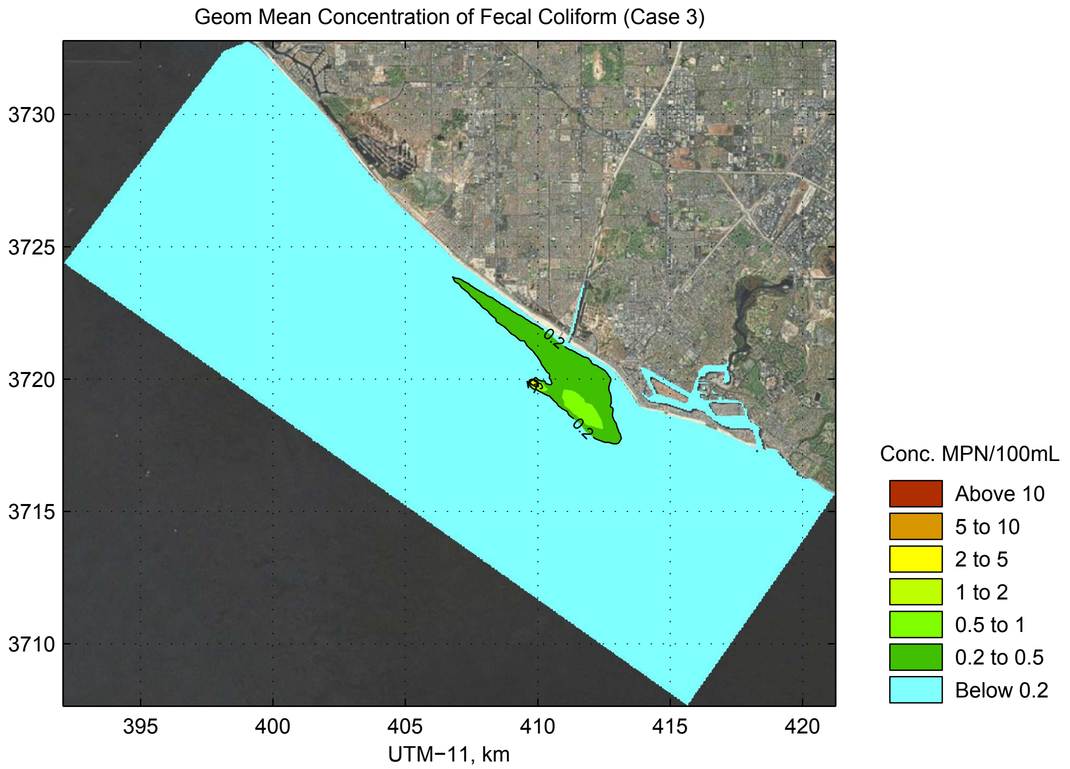

Figure B-29: Geom Mean Concentration of Fecal Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

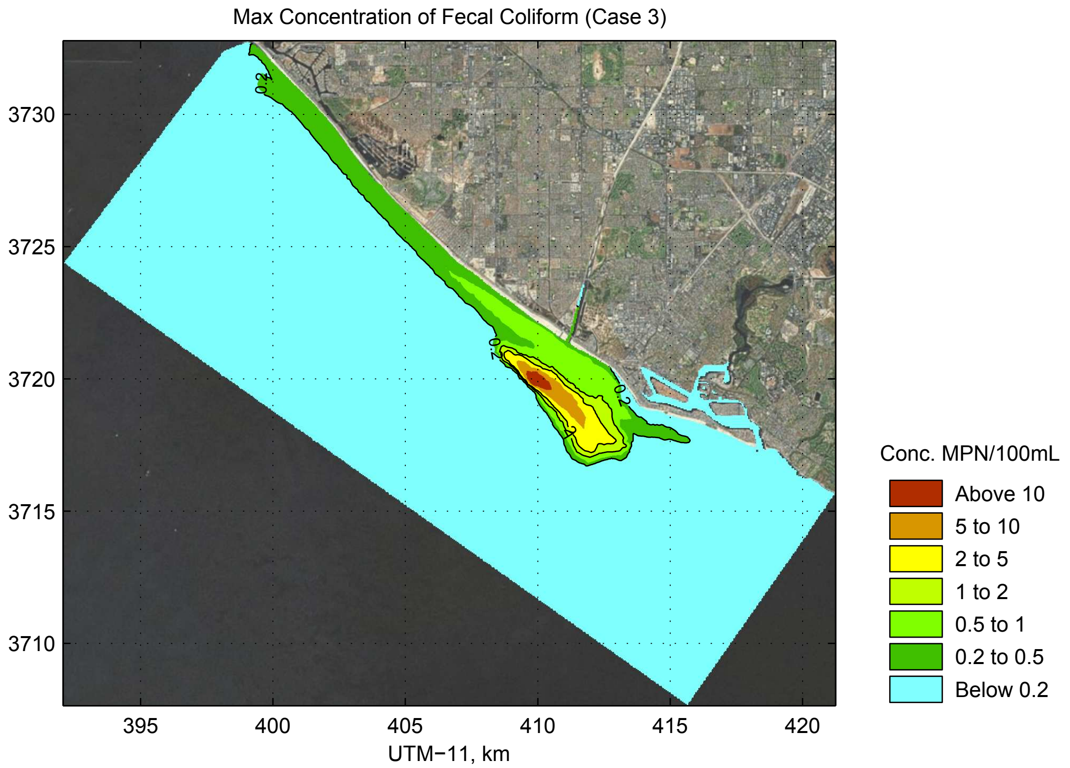

Figure B-30: Max Concentration of Fecal Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

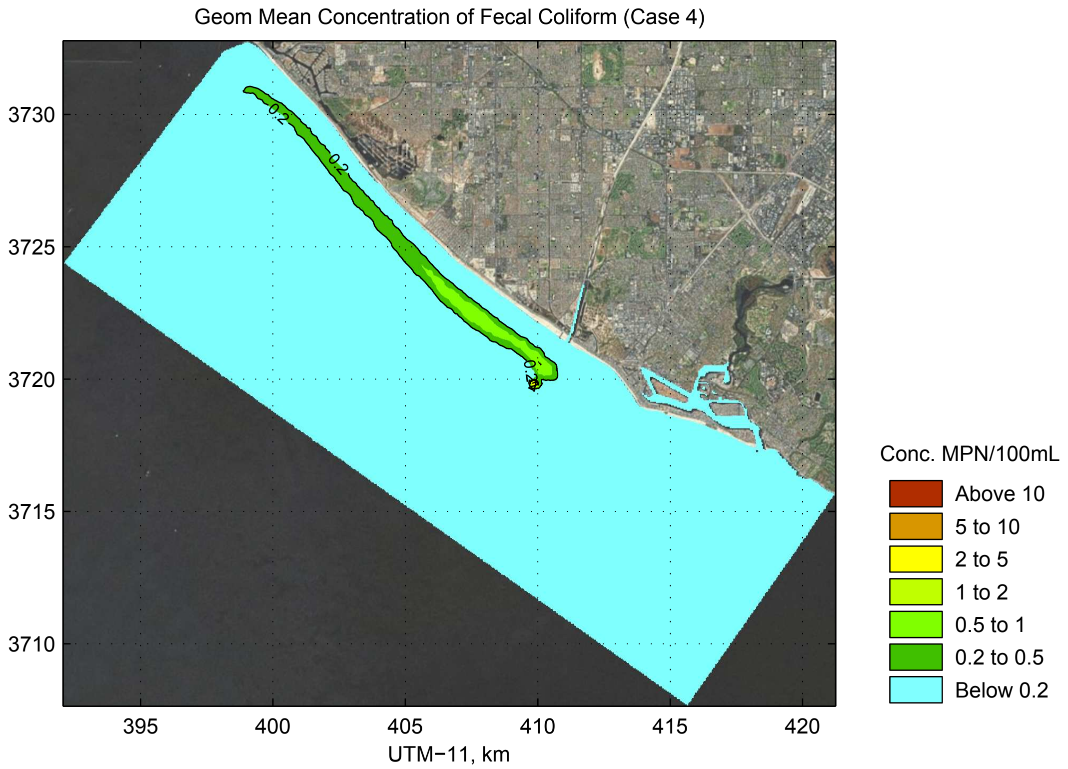

Figure B-31: Geom Mean Concentration of Fecal Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

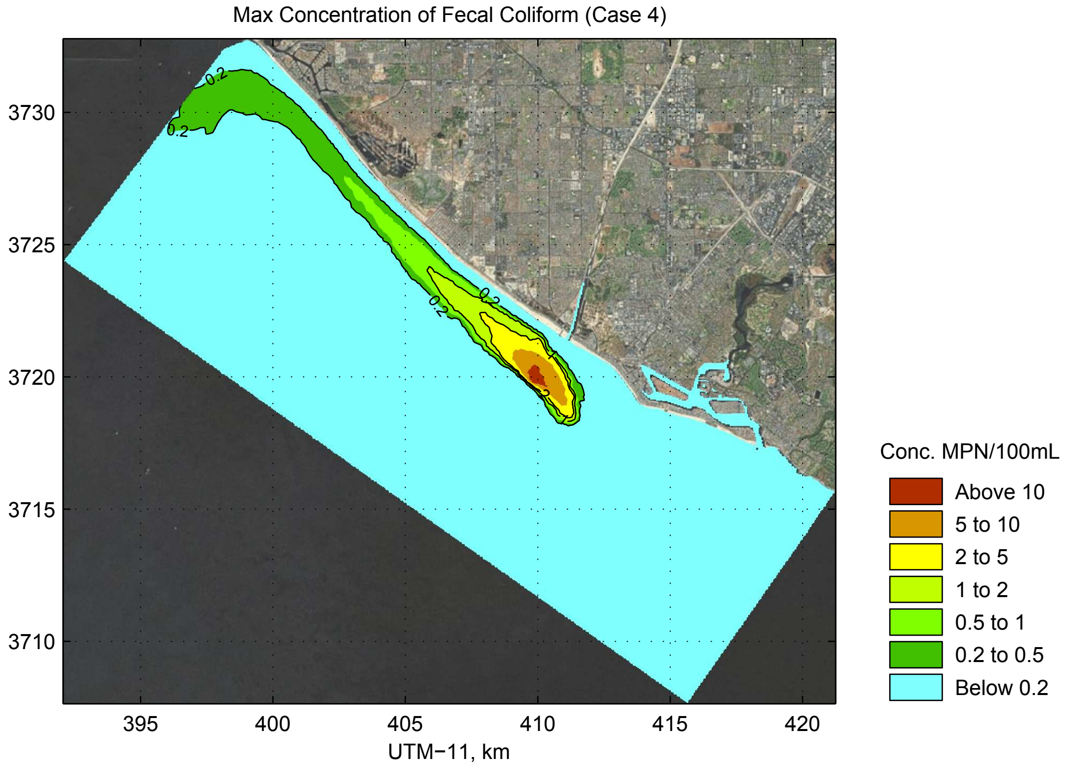

Figure B-32: Max Concentration of Fecal Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

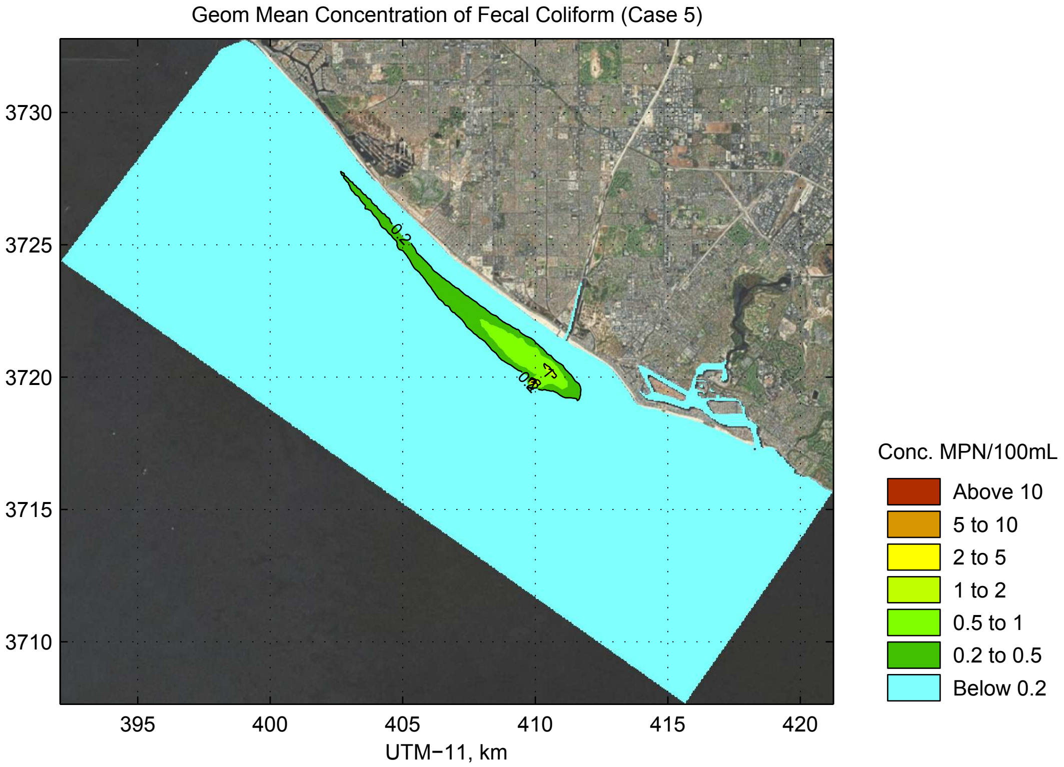

Figure B-33: Geom Mean Concentration of Fecal Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

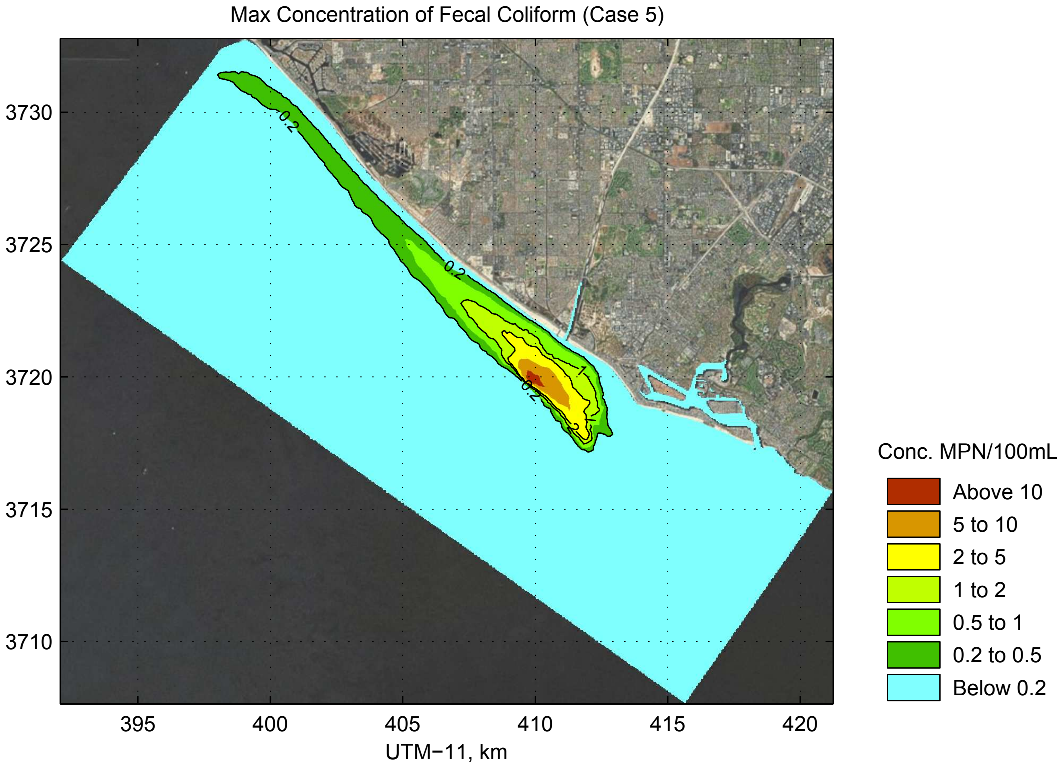

Figure B-34: Max Concentration of Fecal Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

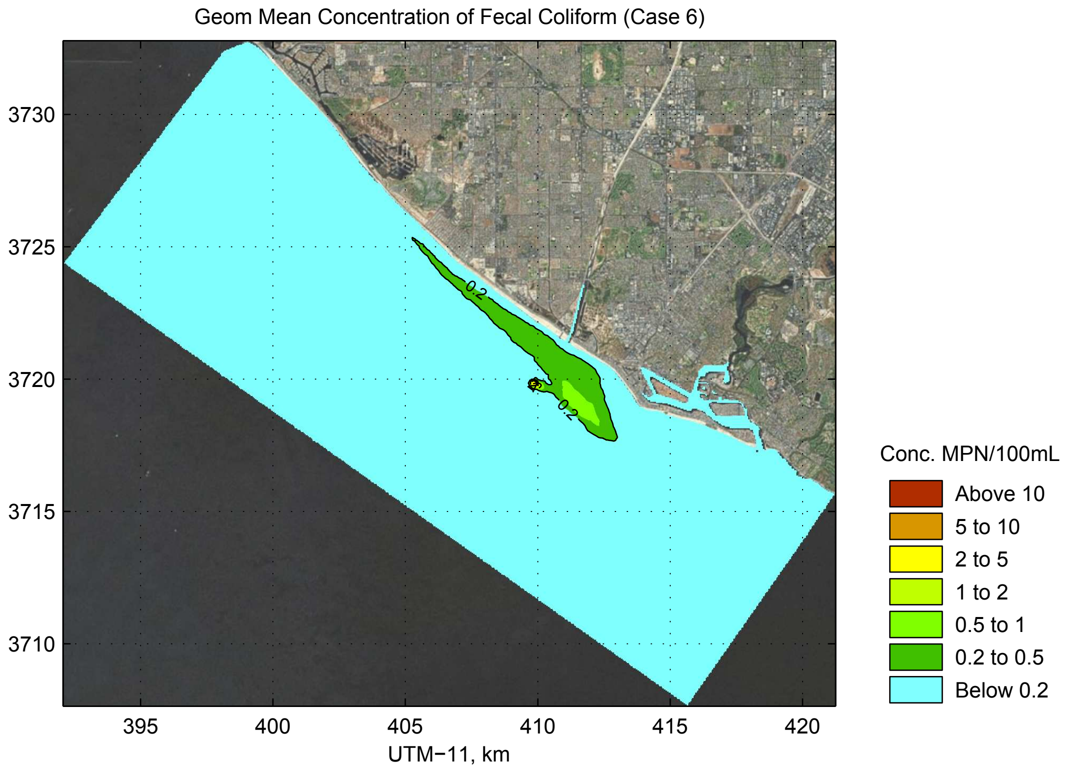

Figure B-35: Geom Mean Concentration of Fecal Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

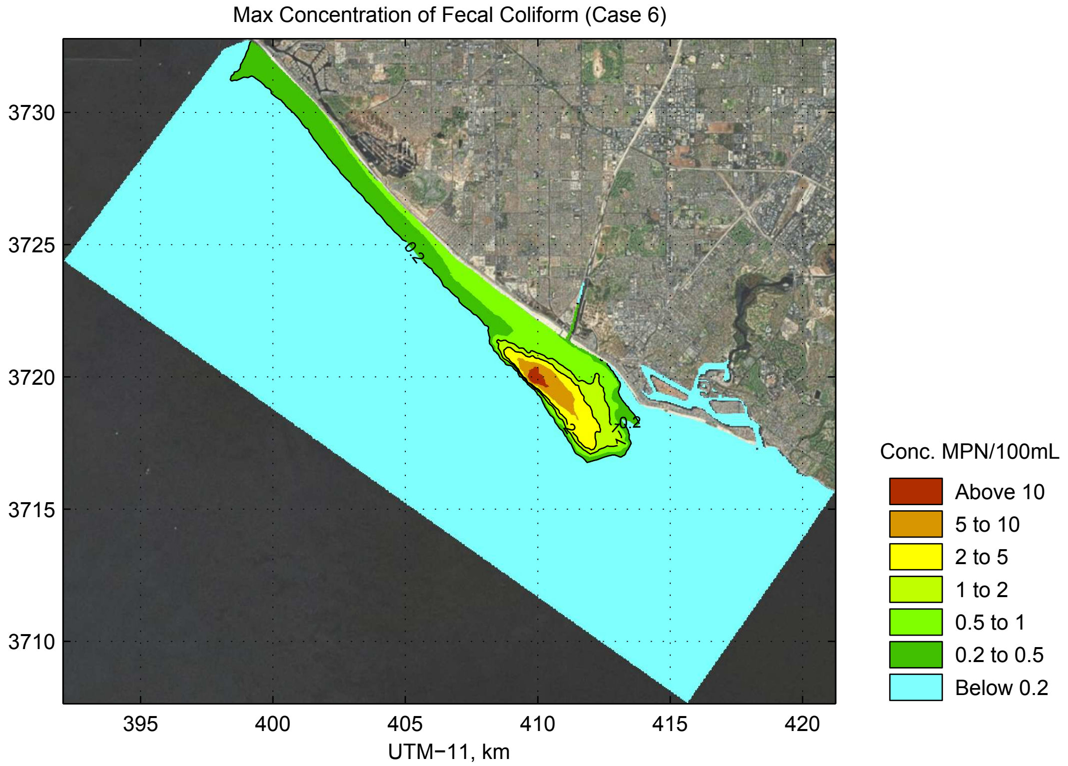

Figure B-36: Max Concentration of Fecal Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

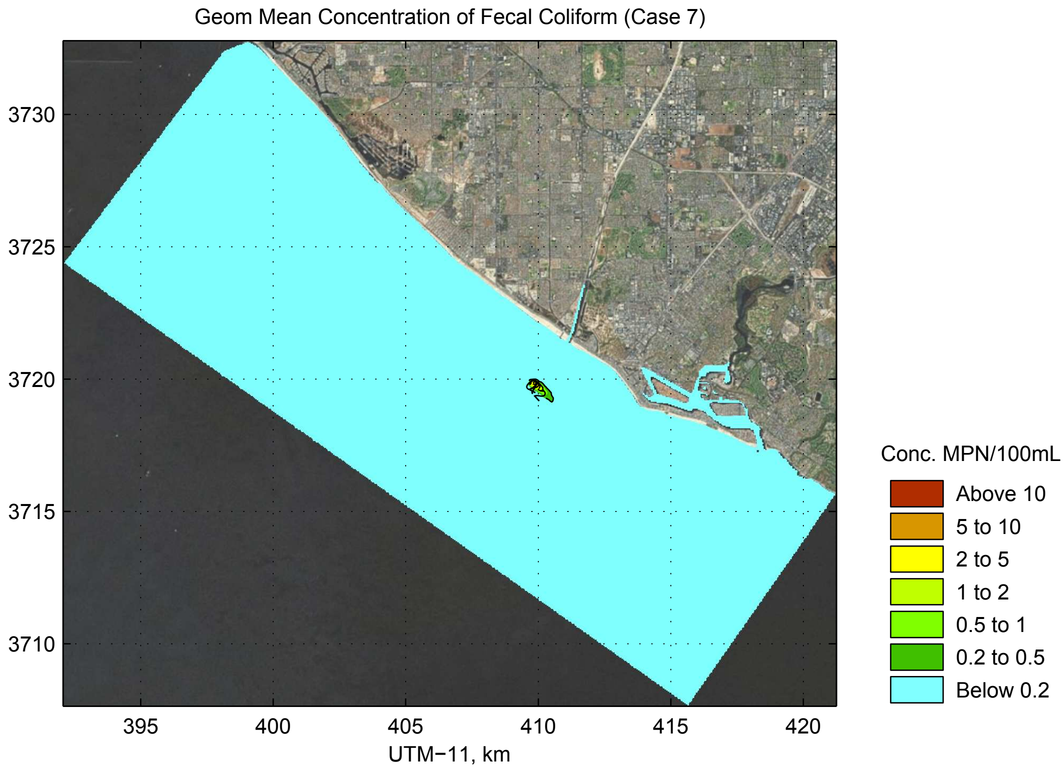

Figure B-37: Geom Mean Concentration of Fecal Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

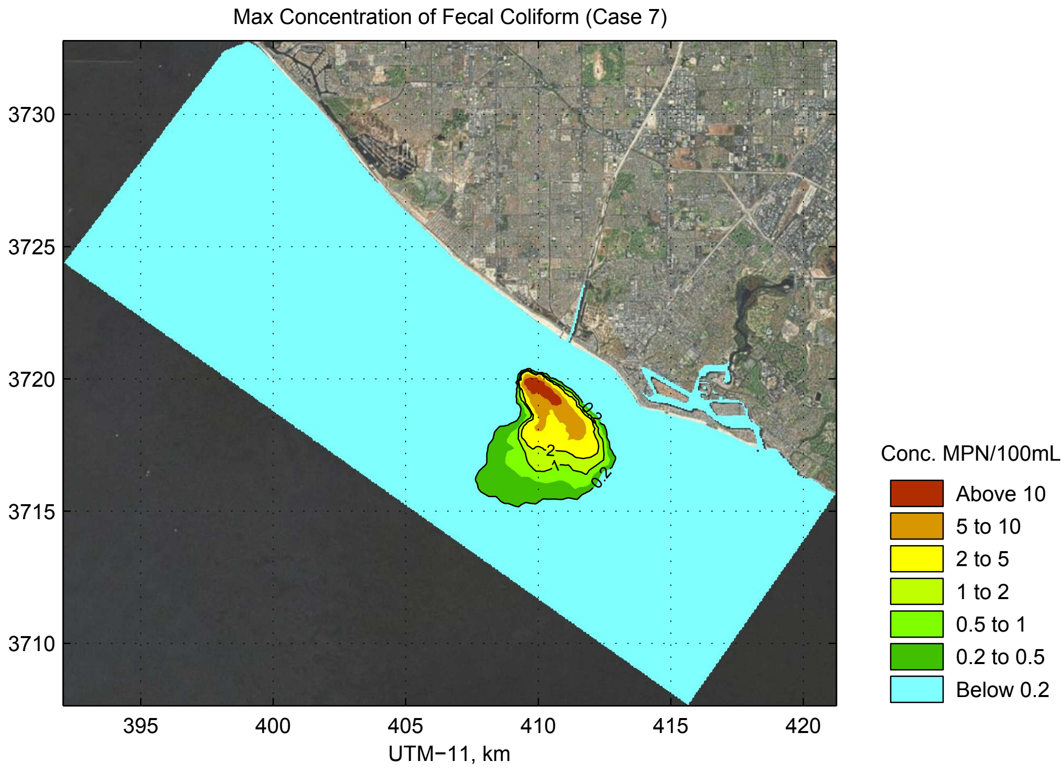

Figure B-38: Max Concentration of Fecal Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

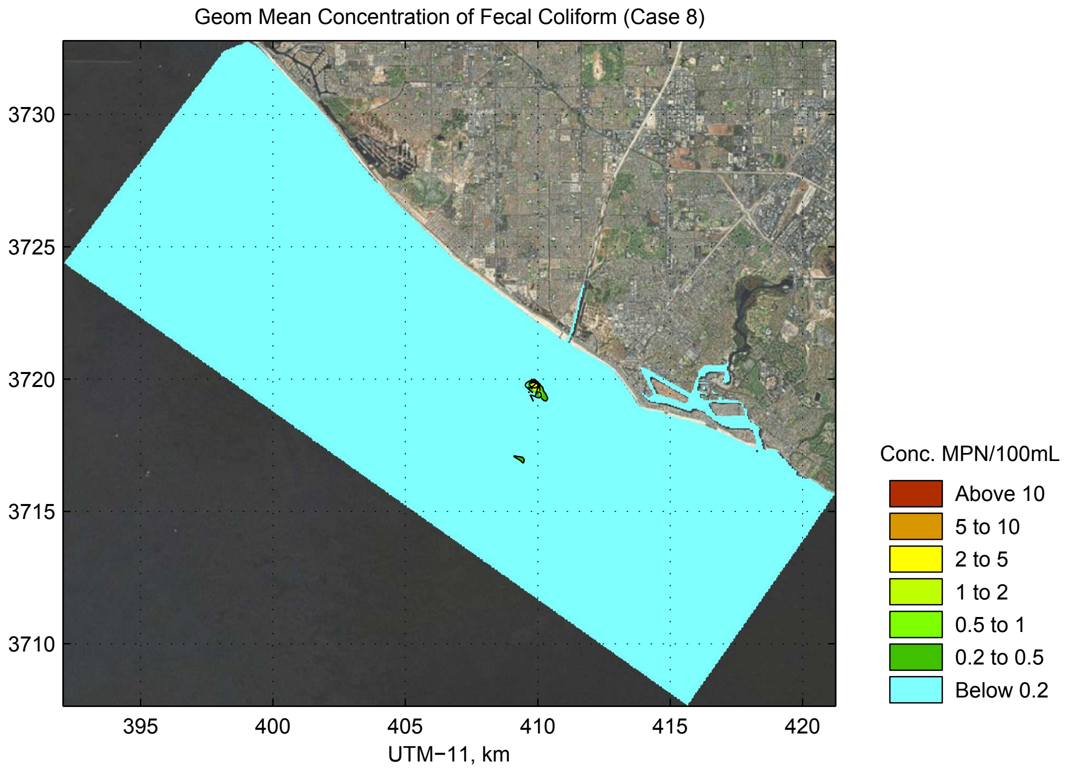

Figure B-39: Geom Mean Concentration of Fecal Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

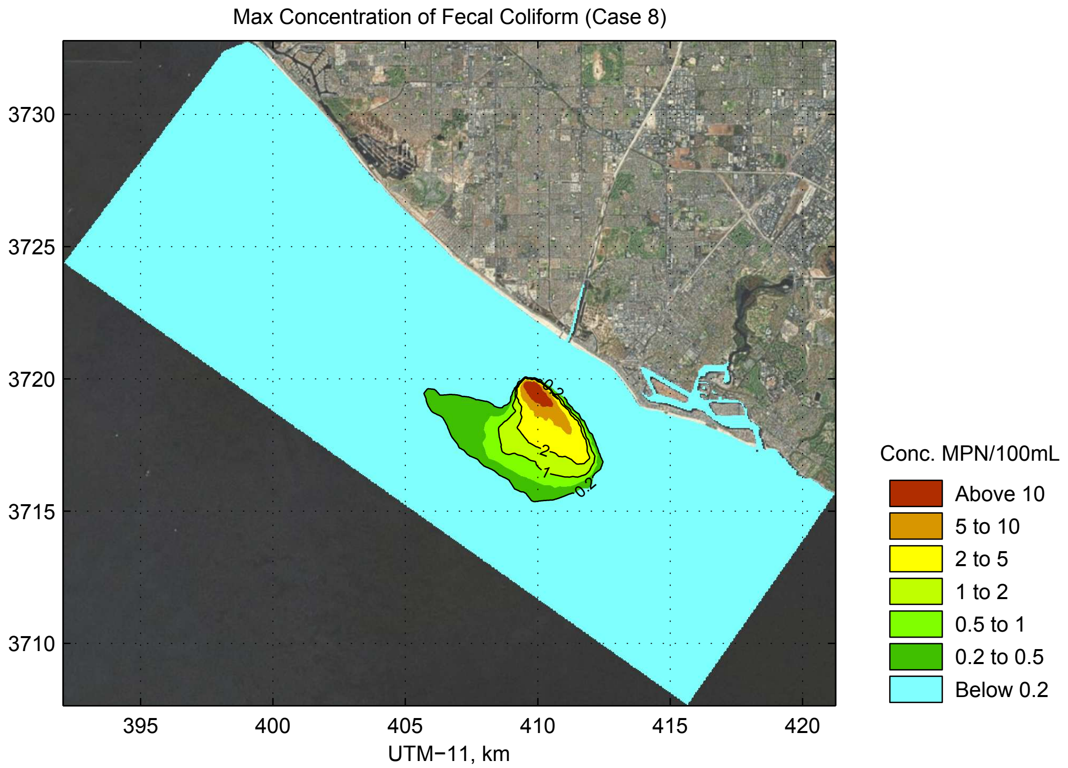

Figure B-40: Max Concentration of Fecal Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

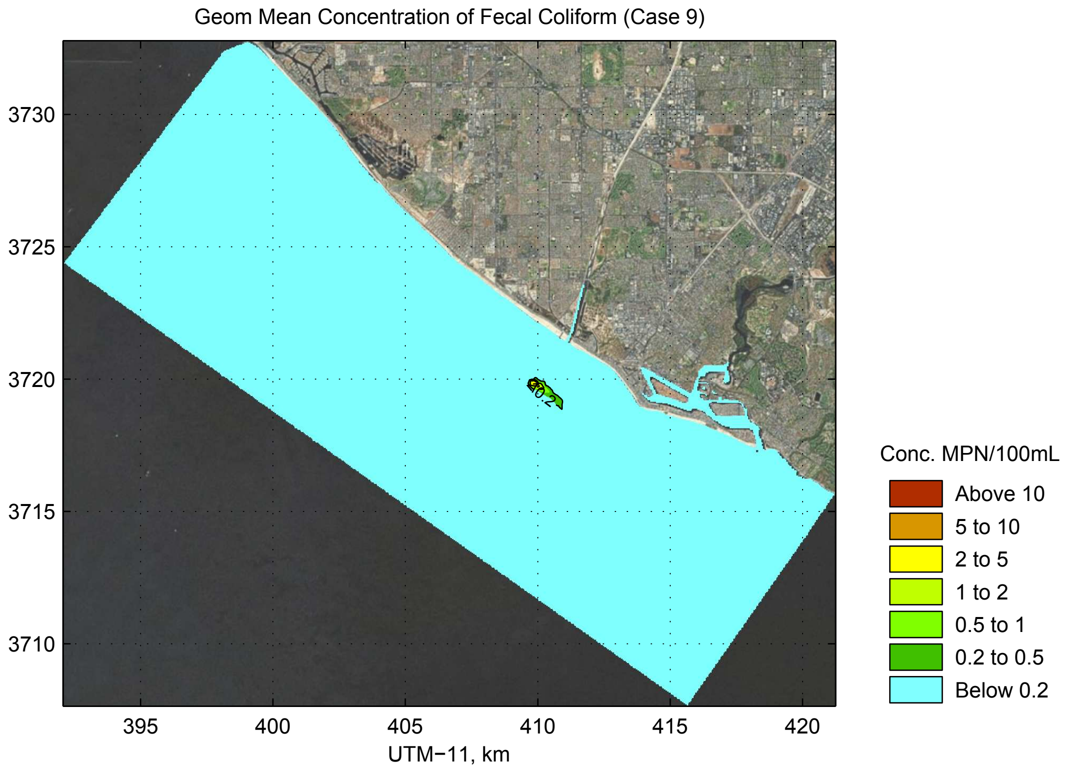

Figure B-41: Geom Mean Concentration of Fecal Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

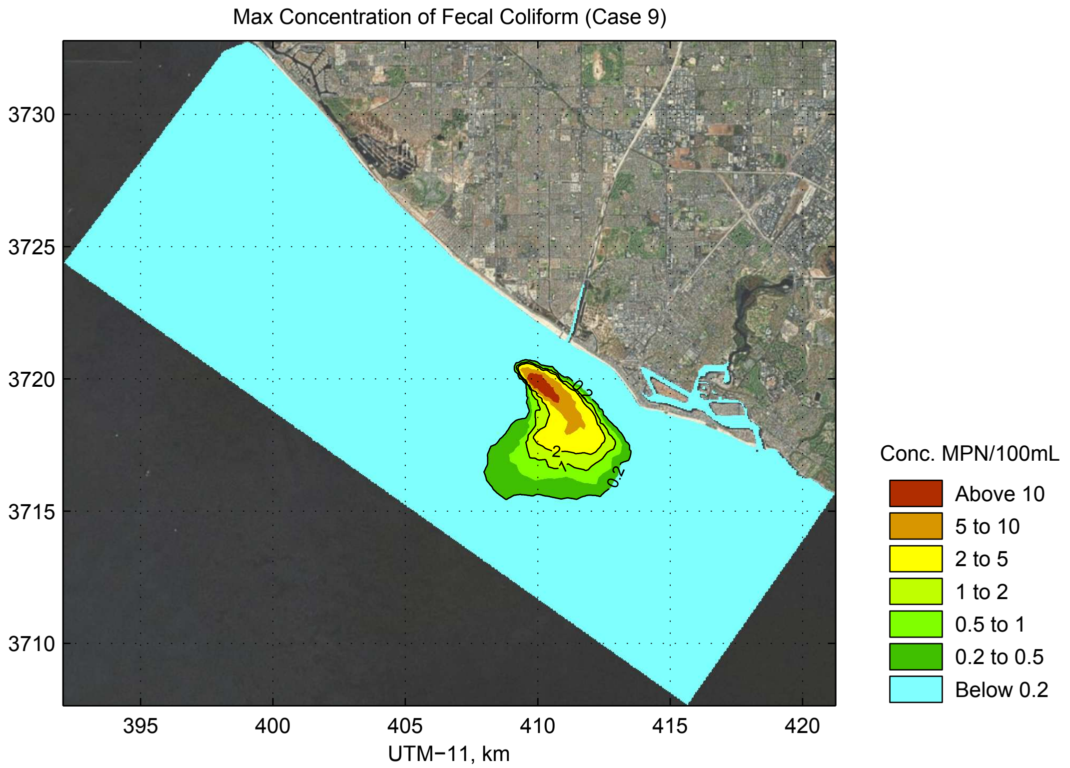

Figure B-42: Max Concentration of Fecal Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

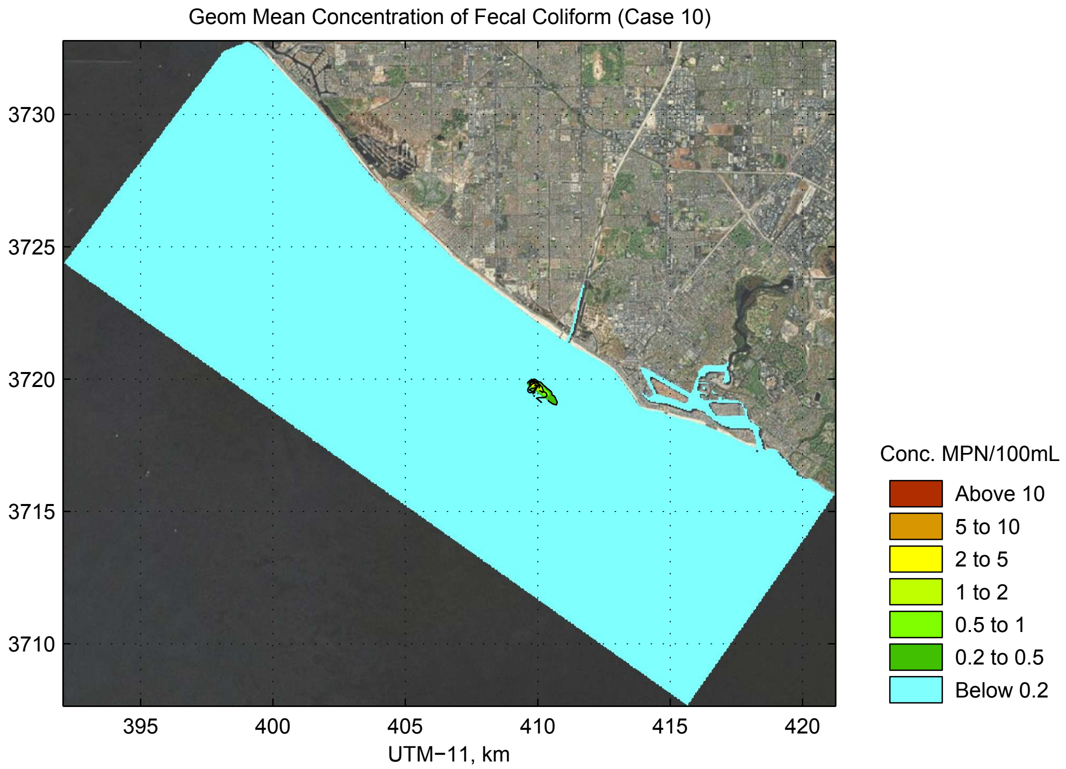

Figure B-43: Geom Mean Concentration of Fecal Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

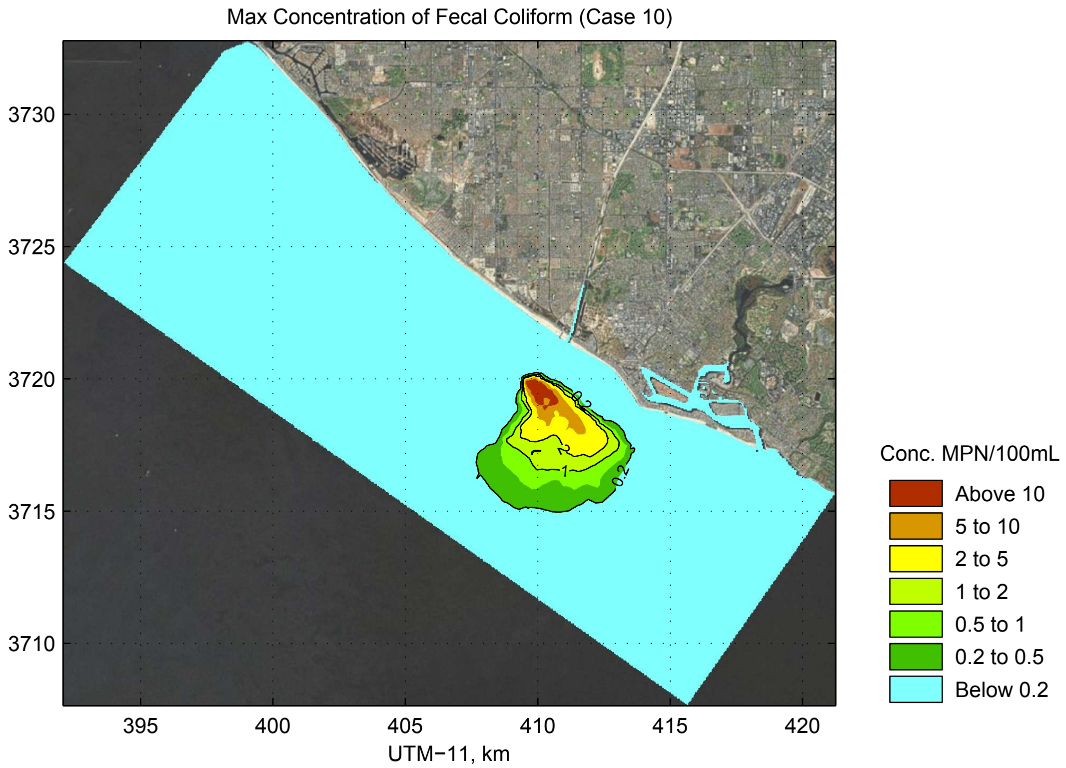

Figure B-44: Max Concentration of Fecal Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

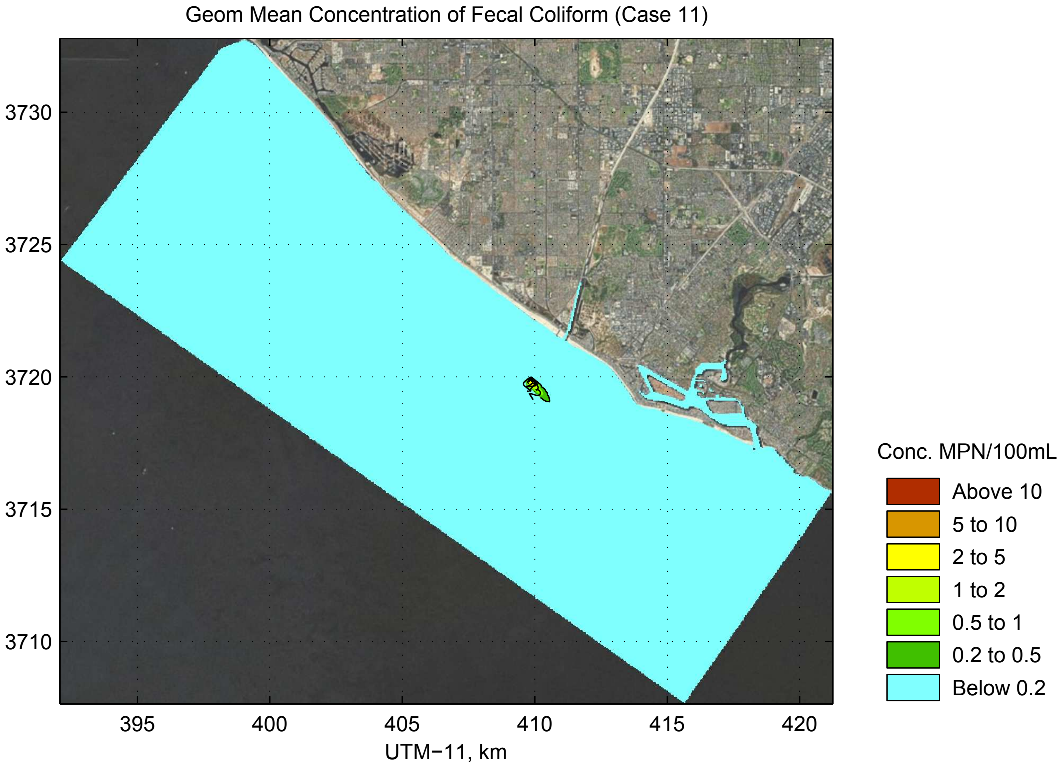

Figure B-45: Geom Mean Concentration of Fecal Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

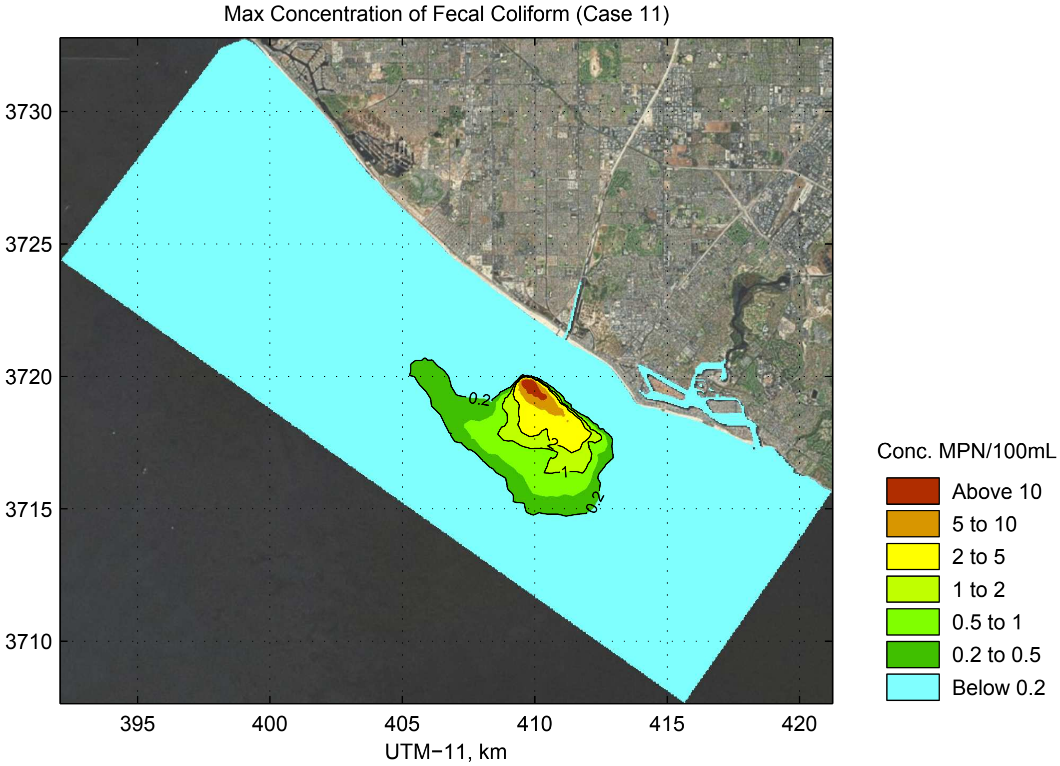

Figure B-46: Max Concentration of Fecal Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

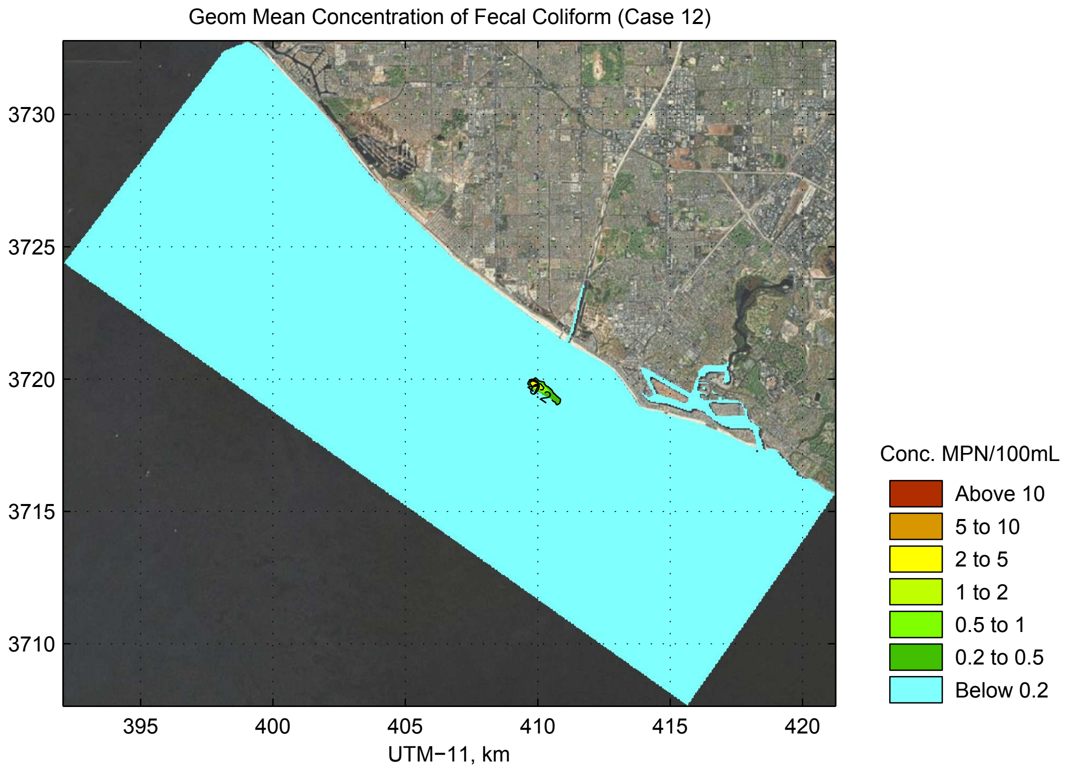

Figure B-47: Geom Mean Concentration of Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

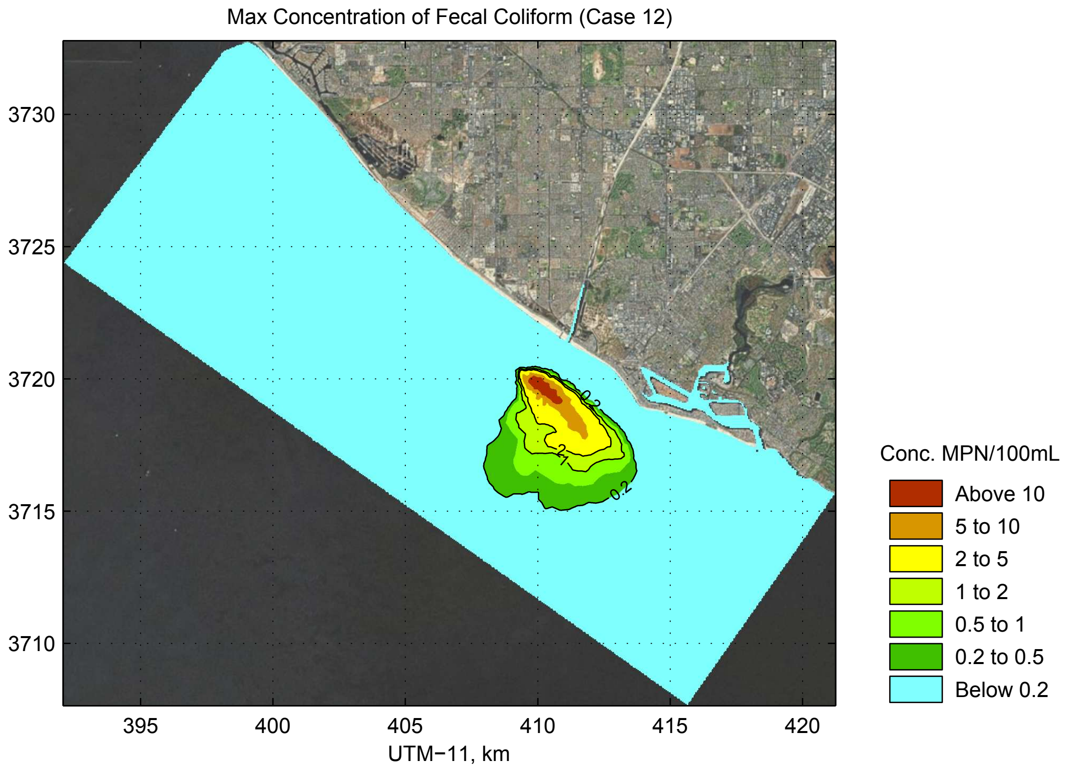

Figure B-48: Max Concentration of Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

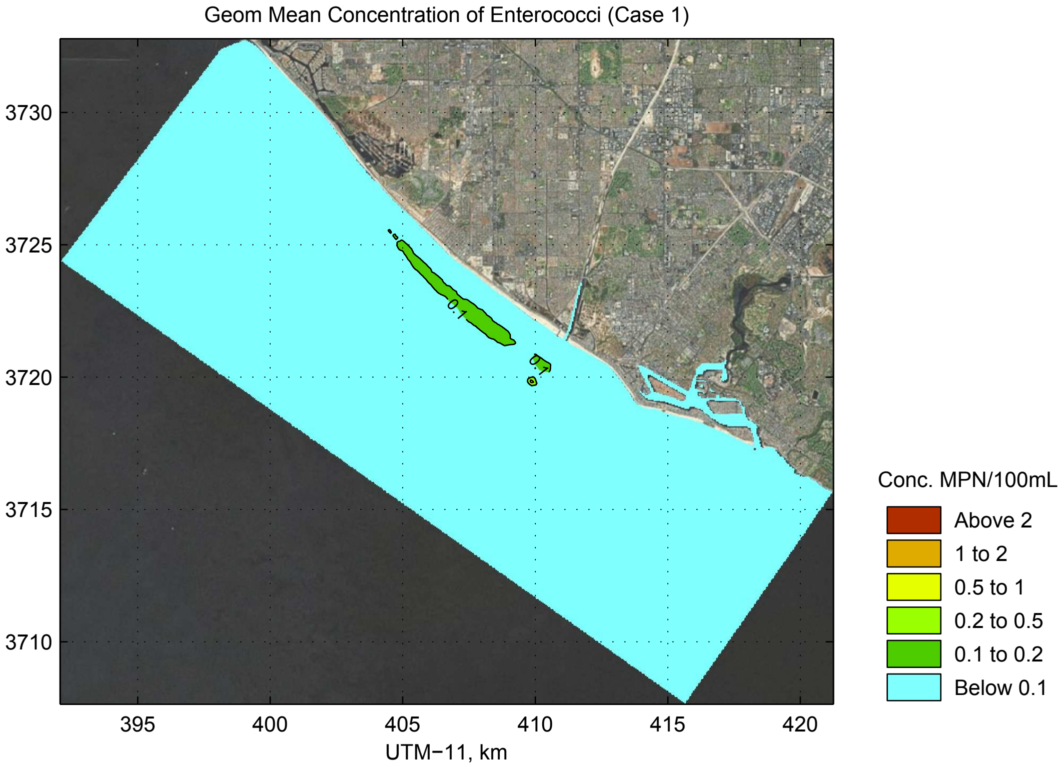

Figure B-49: Geom Mean Concentration of Enterococci for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

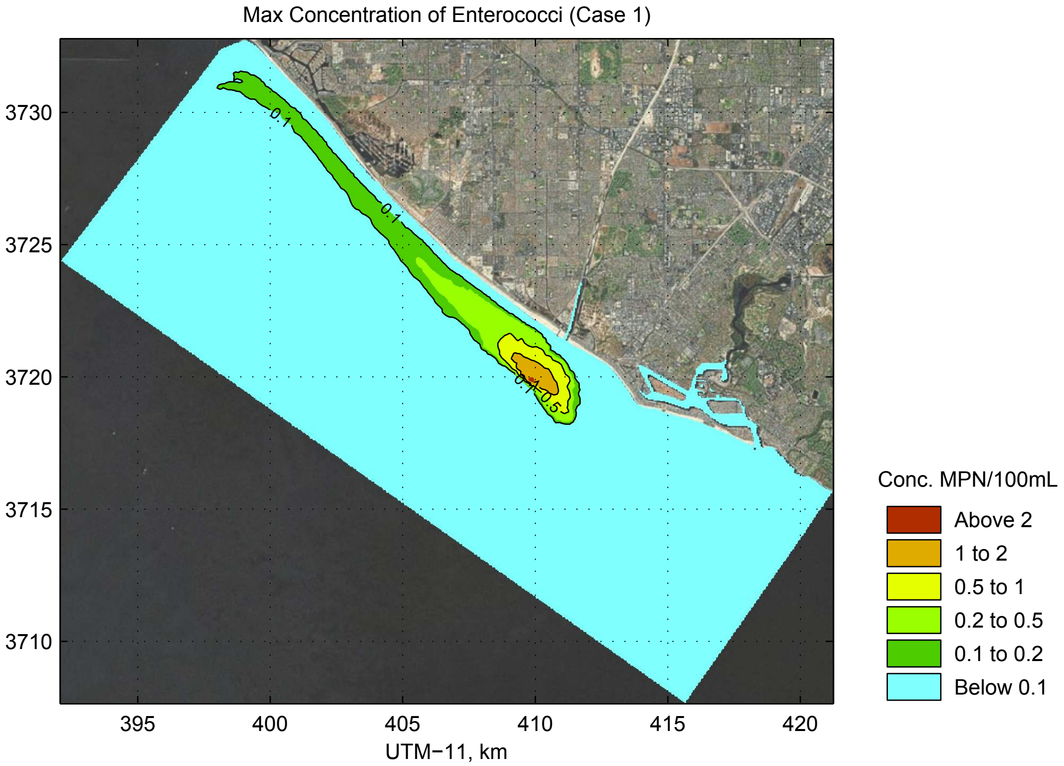

Figure B-50: Max Concentration of Enterococci for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

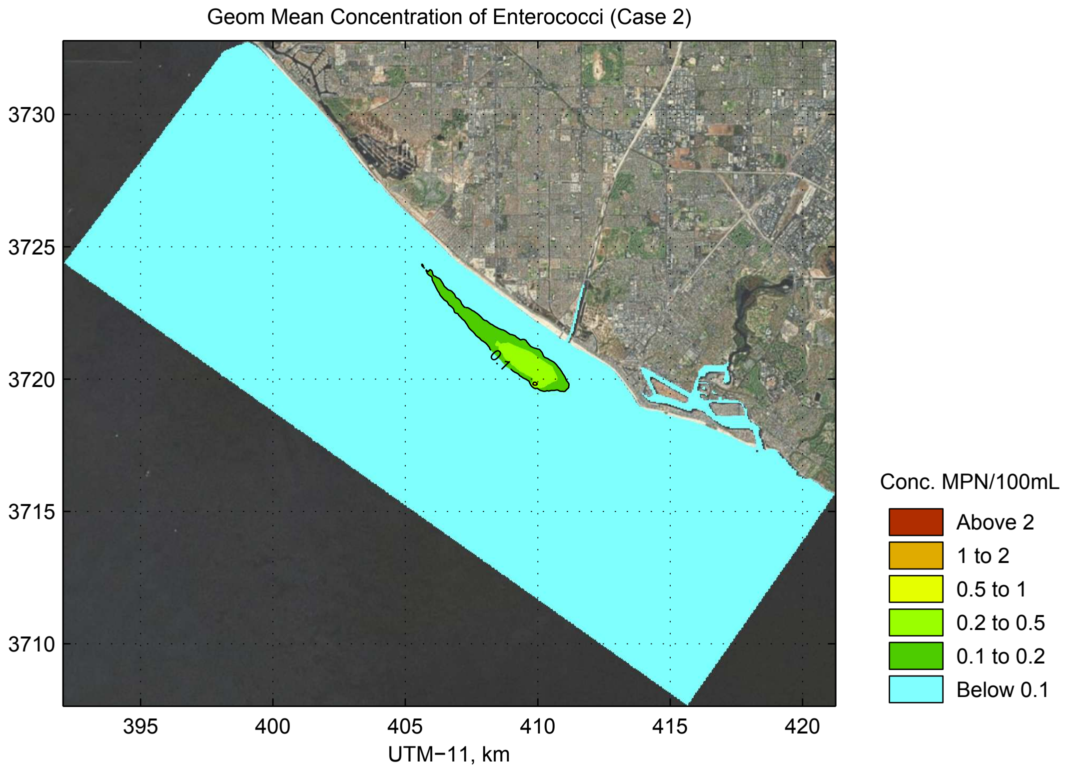

Figure B-51: Geom Mean Concentration of Enterococci for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

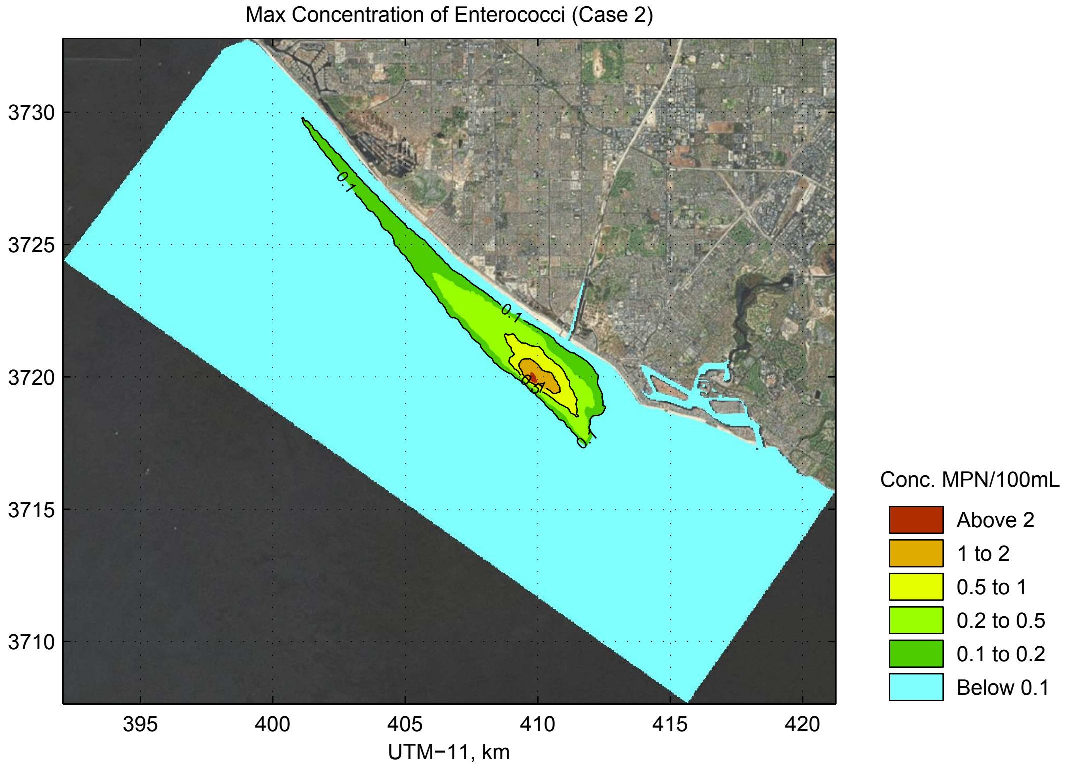

Figure B-52: Max Concentration of Enterococci for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

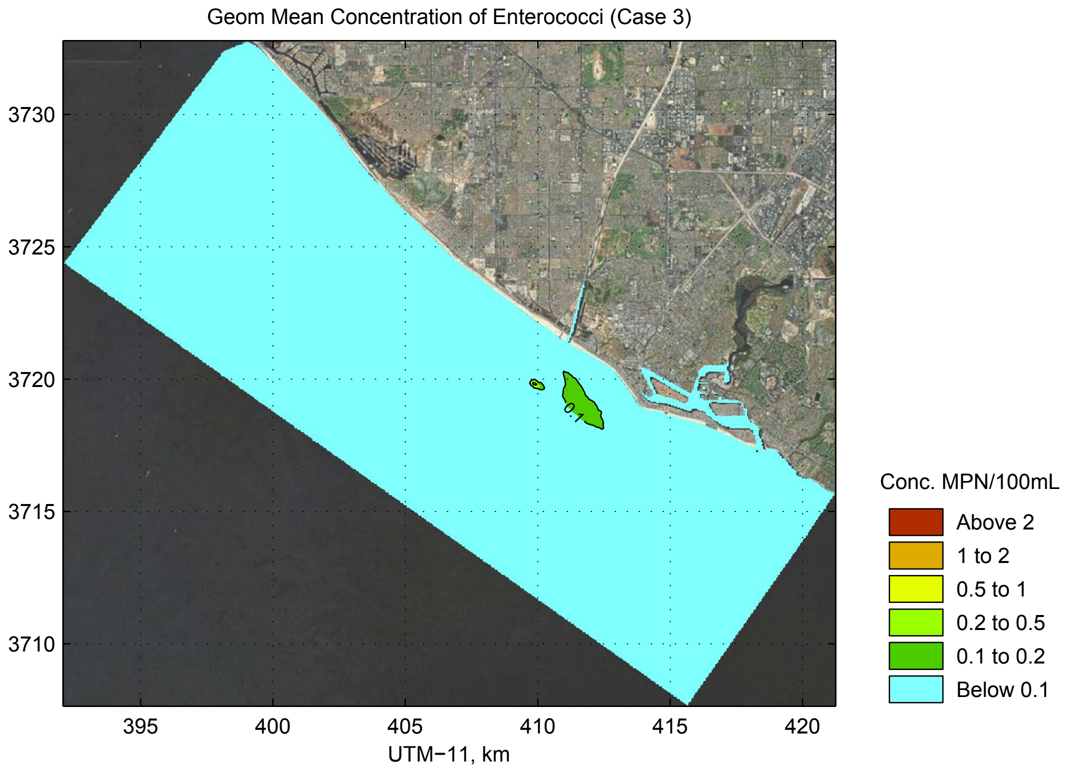

Figure B-53: Geom Mean Concentration of Enterococci for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

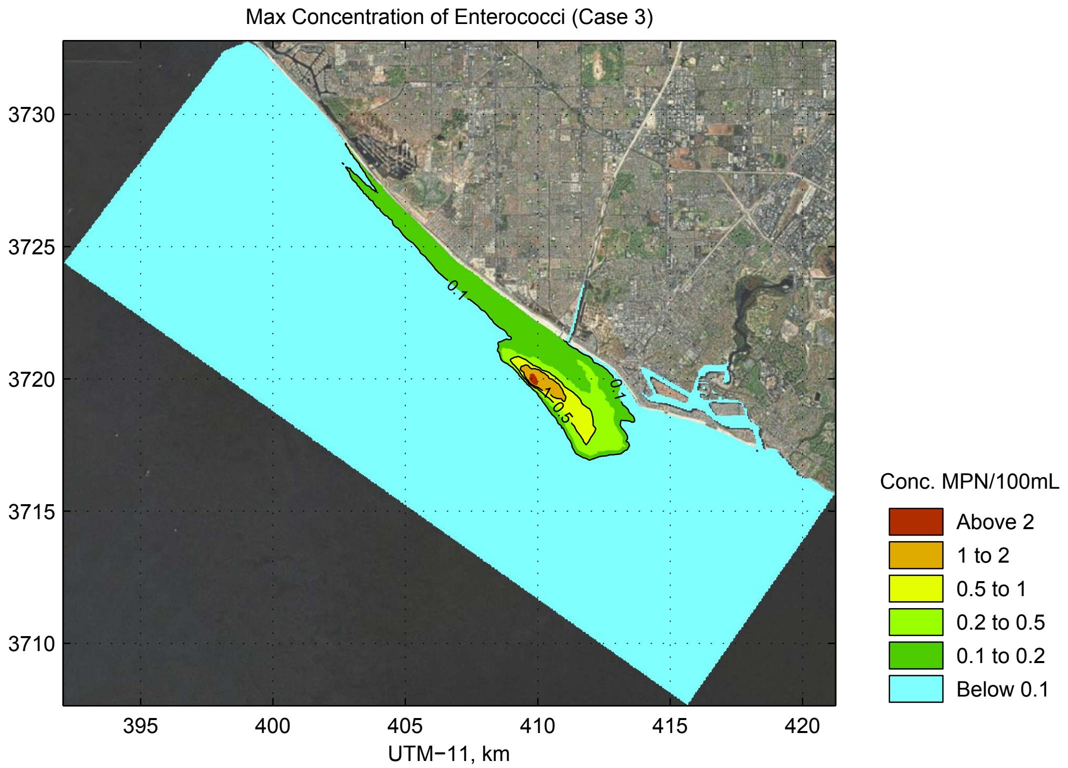

Figure B-54: Max Concentration of Enterococci for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

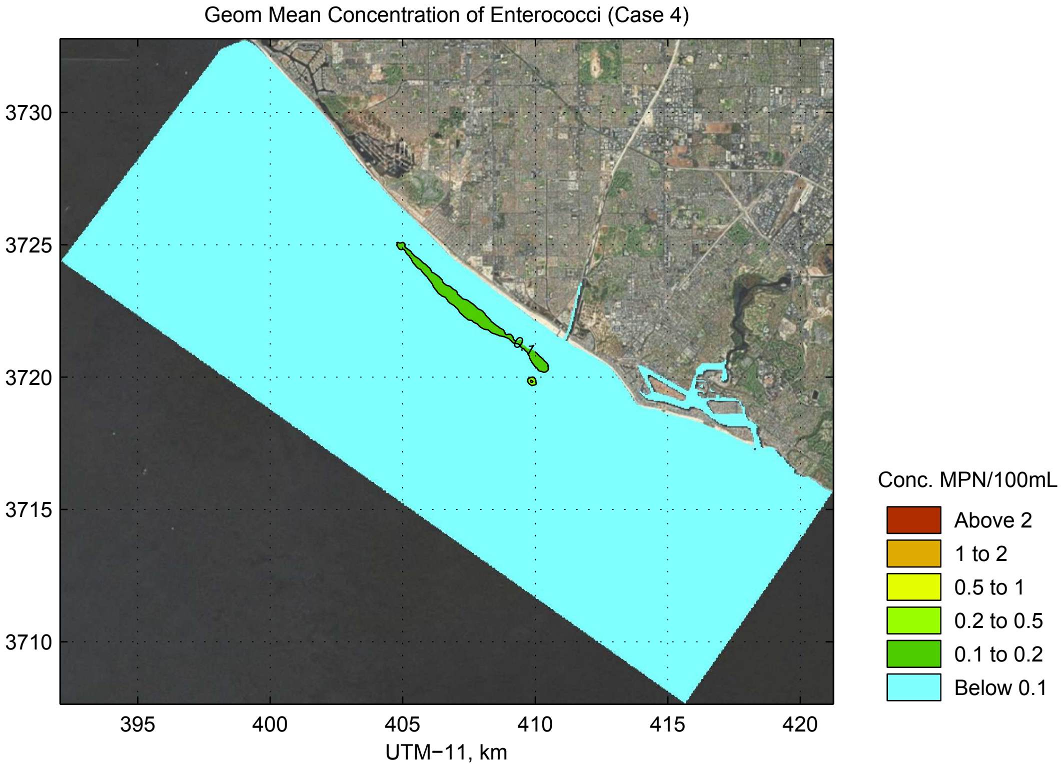

Figure B-55: Geom Mean Concentration of Enterococci for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

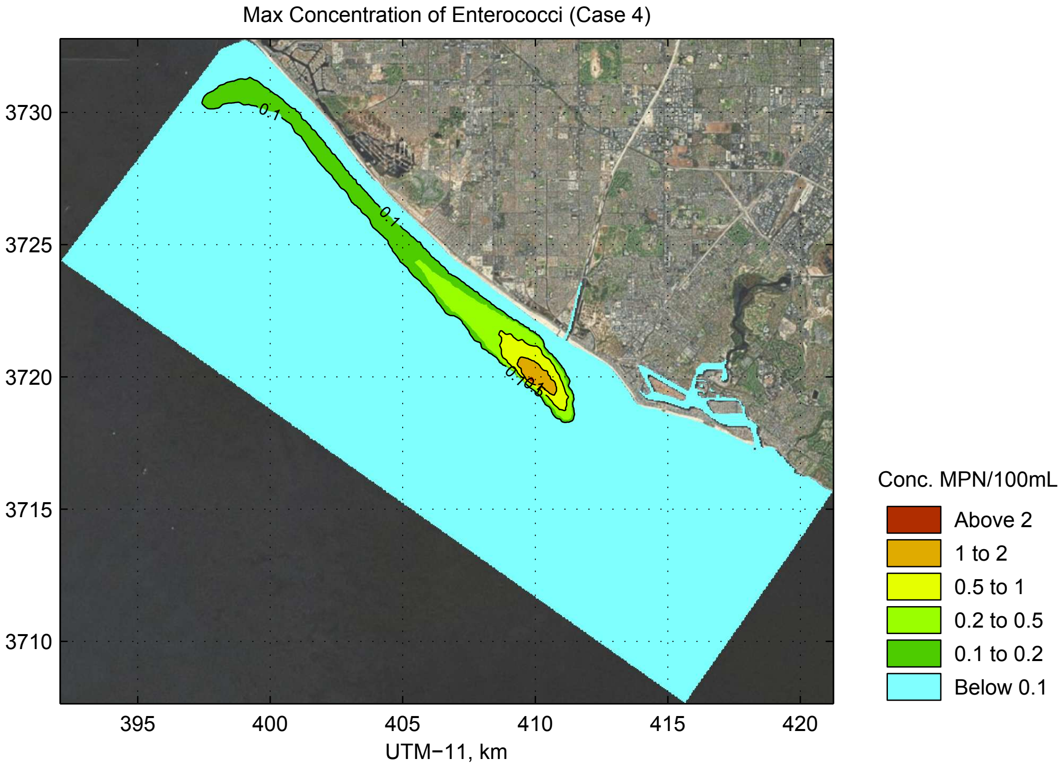

Figure B-56: Max Concentration of Enterococci for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

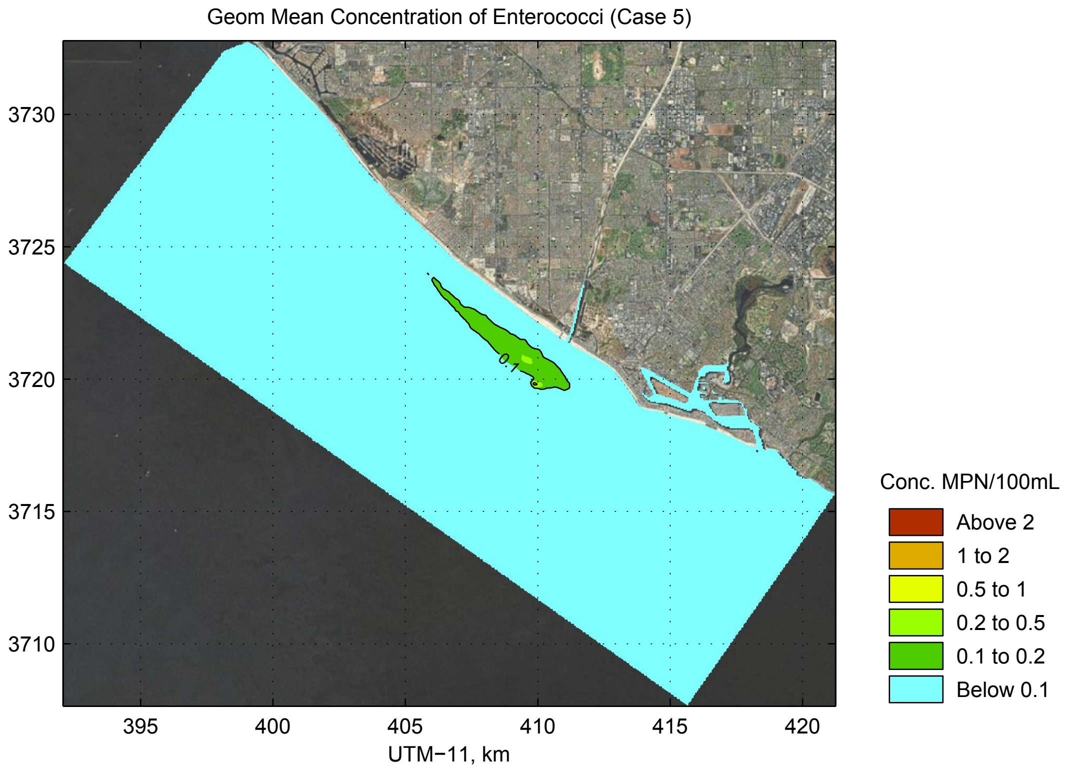

Figure B-57: Geom Mean Concentration of Enterococci for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

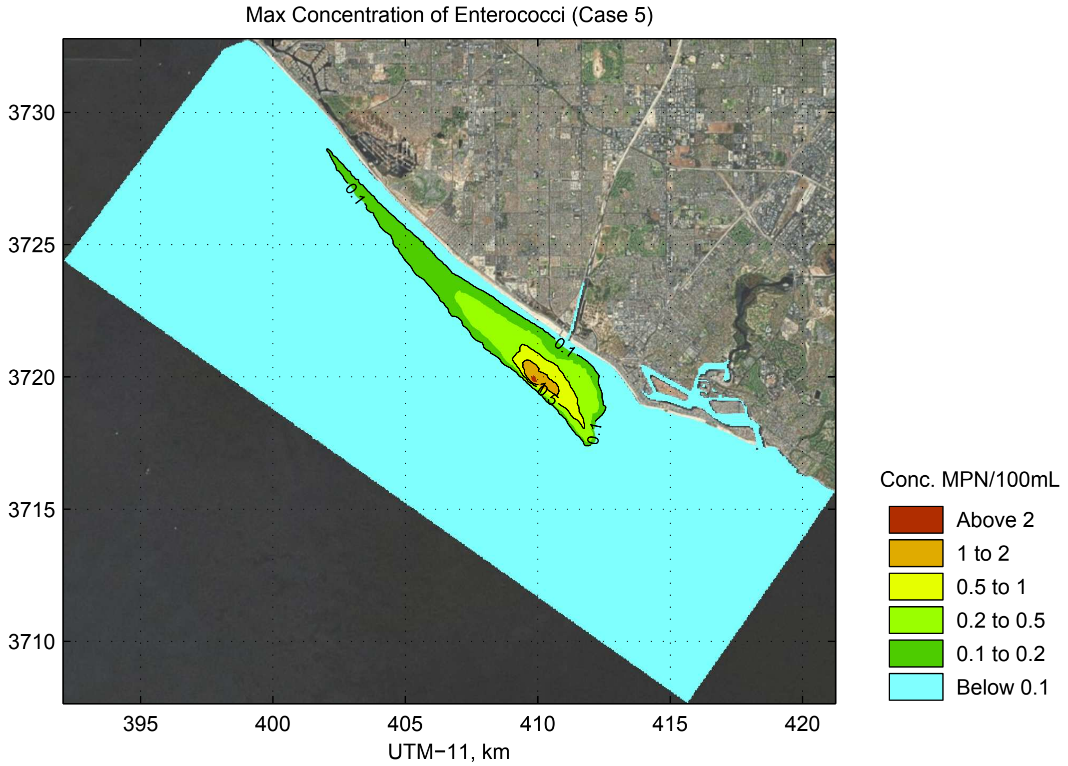

Figure B-58: Max Concentration of Enterococci for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

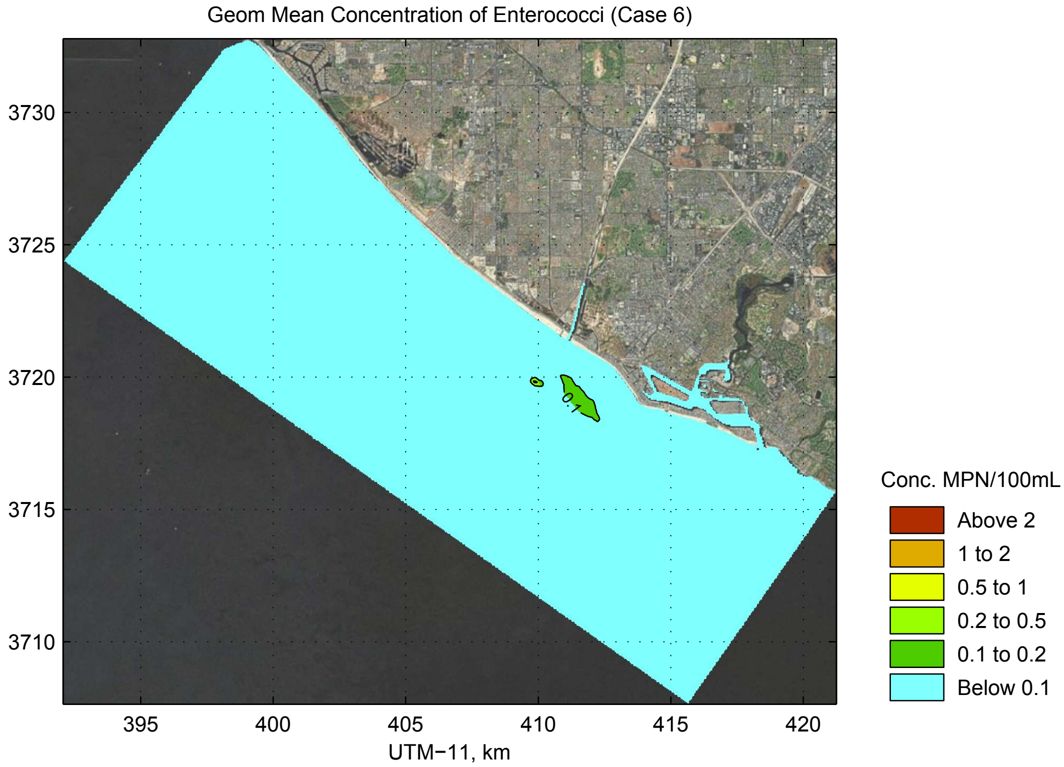

Figure B-59: Geom Mean Concentration of Enterococci for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

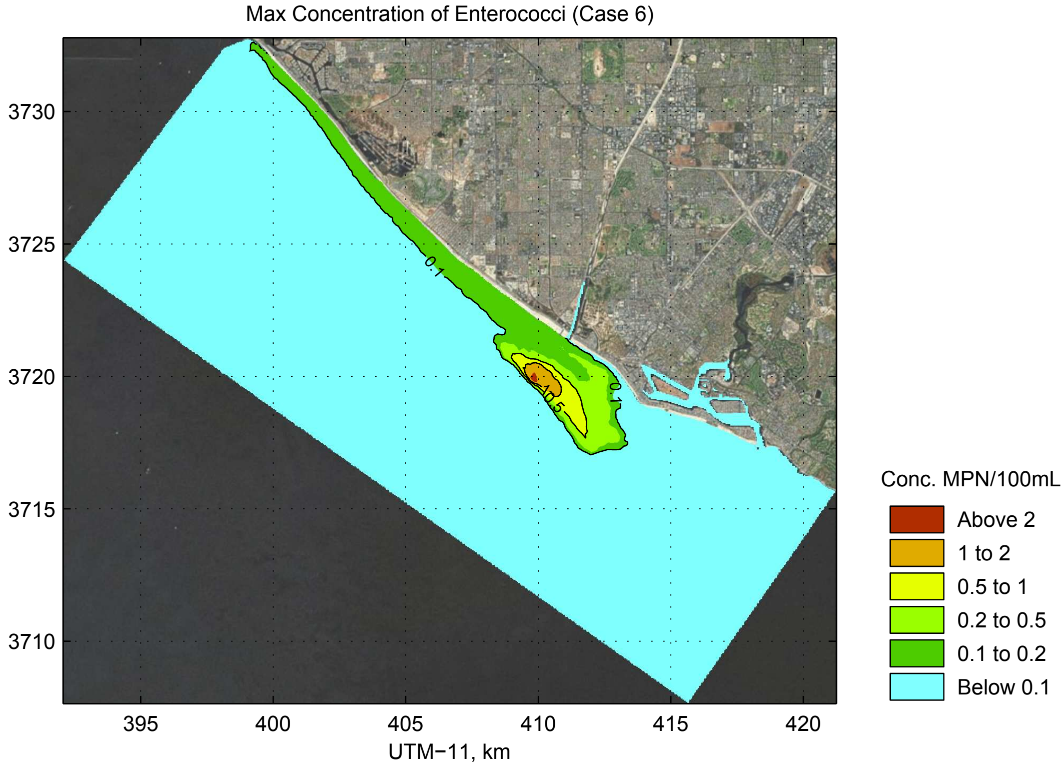

Figure B-60: Max Concentration of Enterococci for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

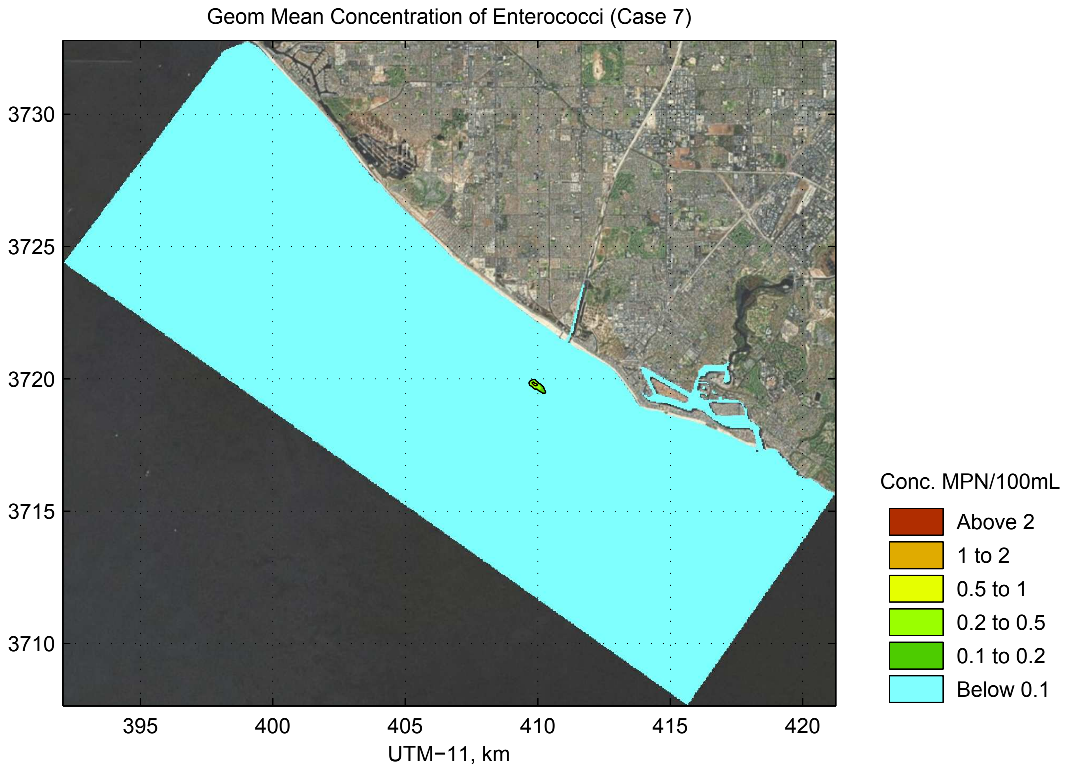

Figure B-61: Geom Mean Concentration of Enterococci for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

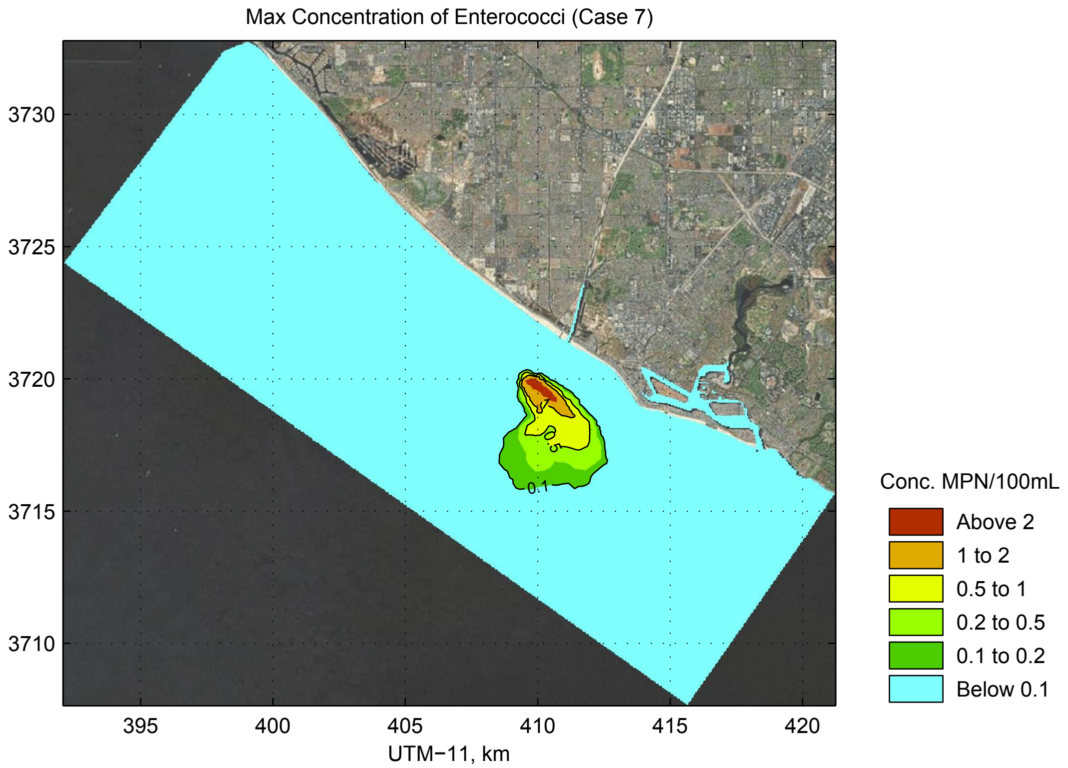

Figure B-62: Max Concentration of Enterococci for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

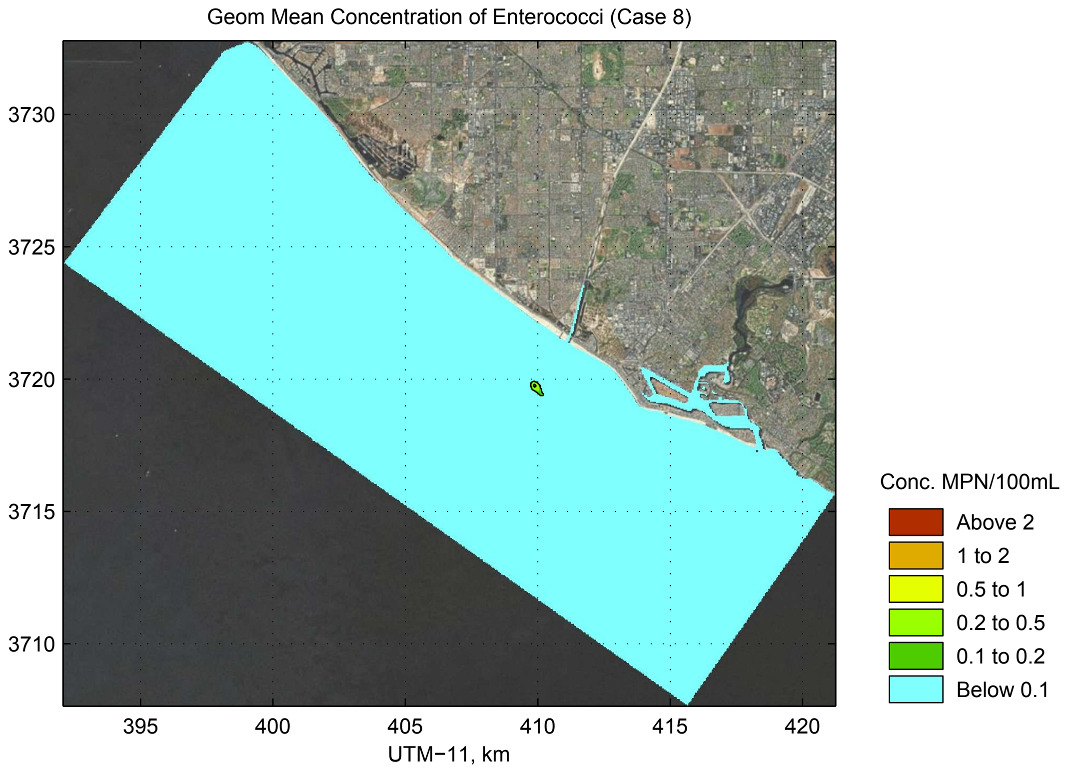

Figure B-63: Geom Mean Concentration of Enterococci for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

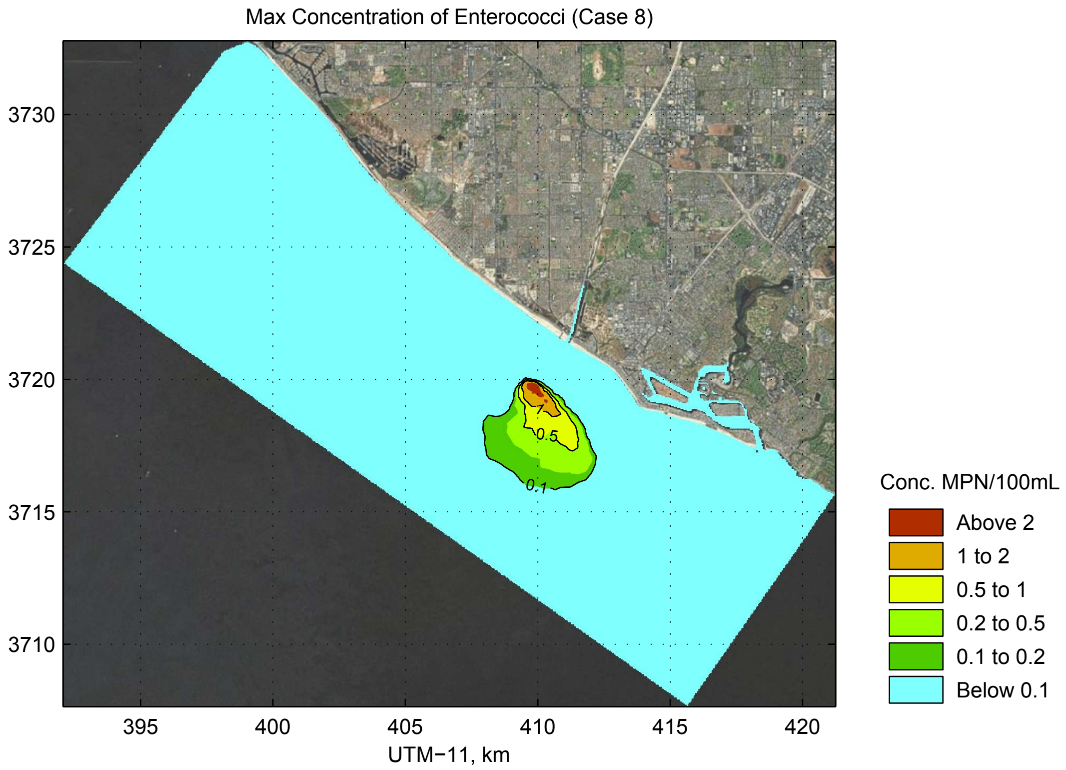

Figure B-64: Max Concentration of Enterococci for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

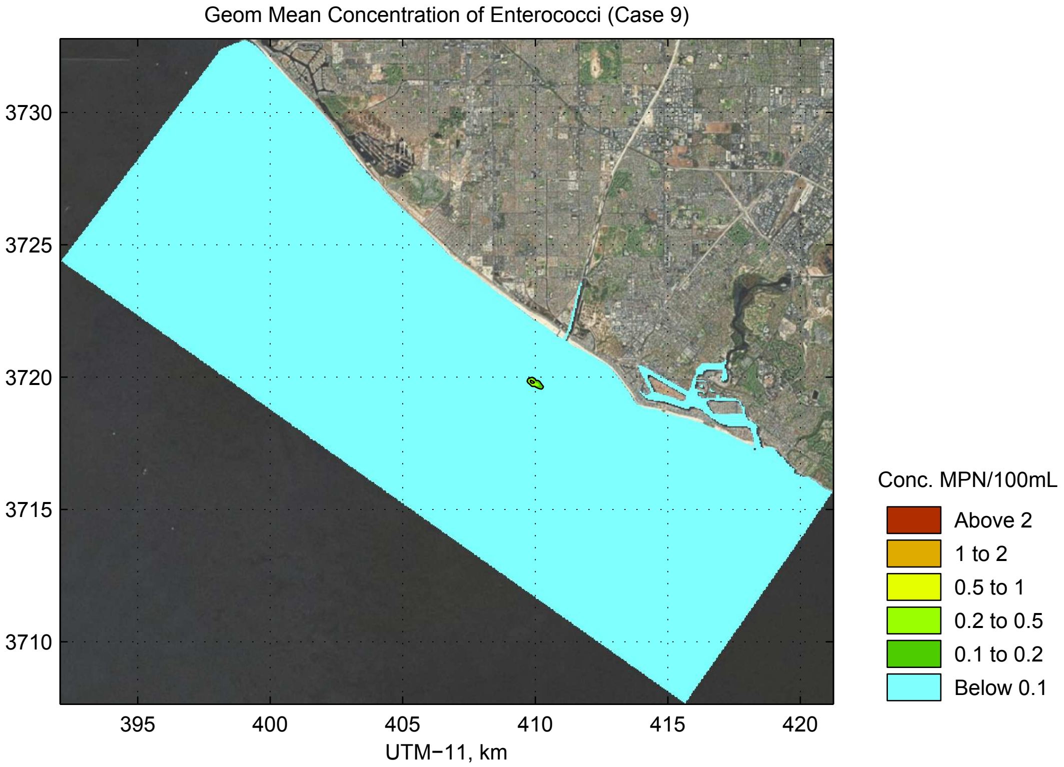

Figure B-65: Geom Mean Concentration of Enterococci for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

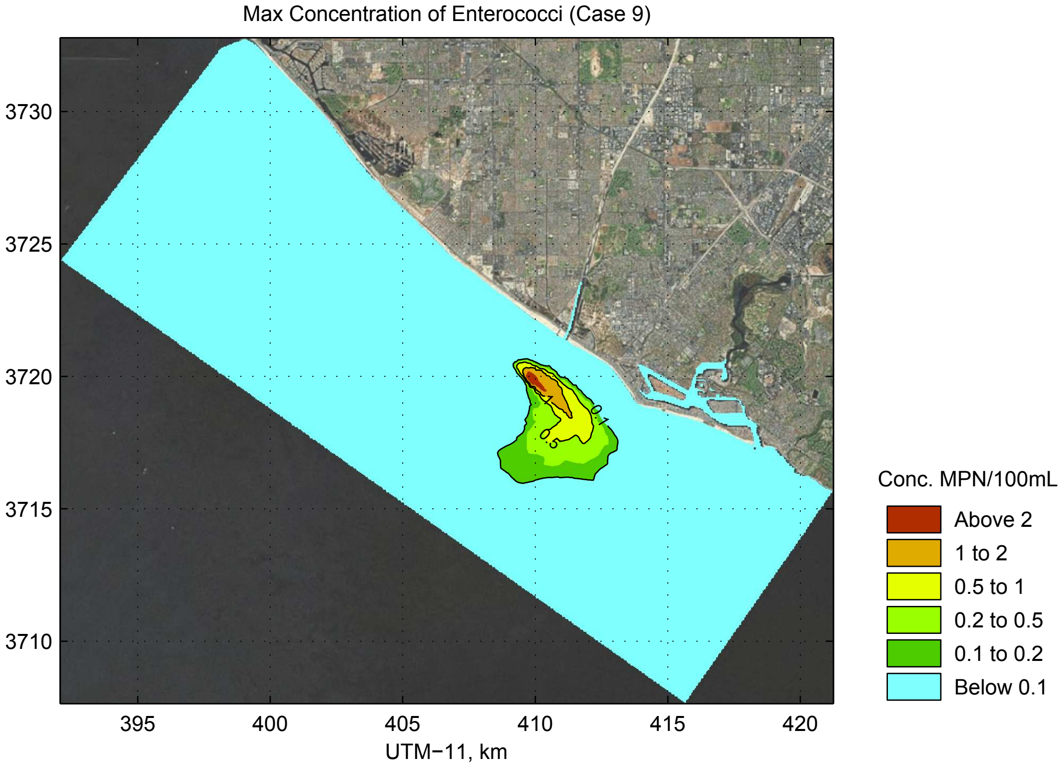

Figure B-66: Max Concentration of Enterococci for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

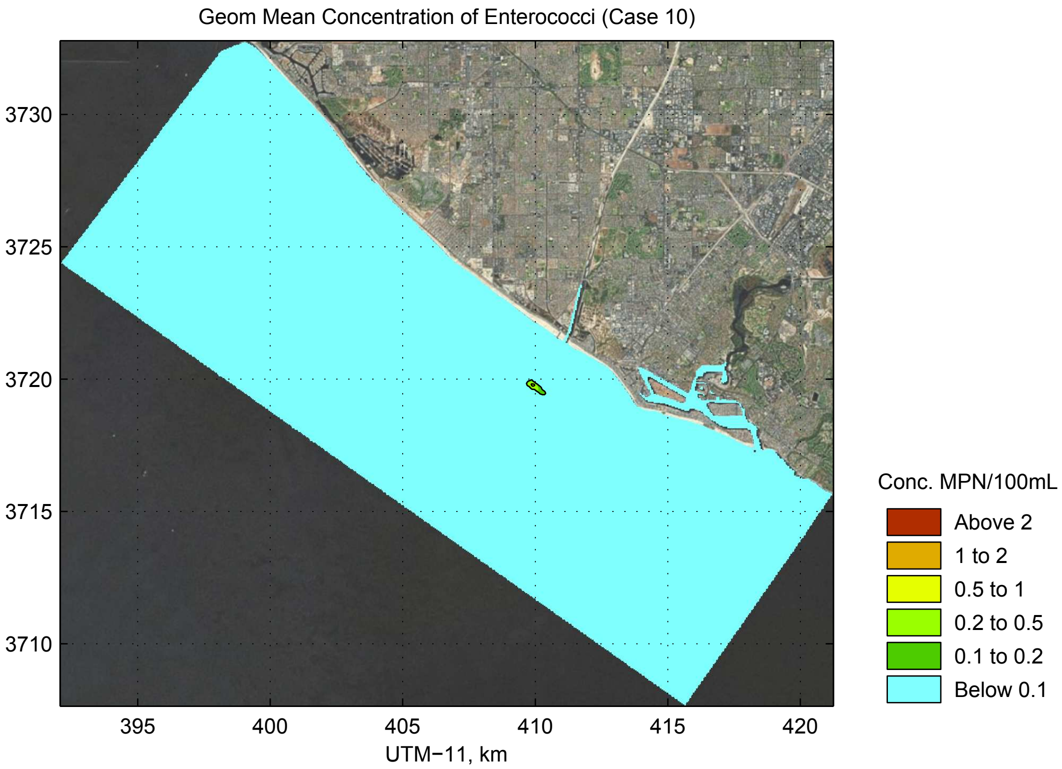

Figure B-67: Geom Mean Concentration of Enterococci for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

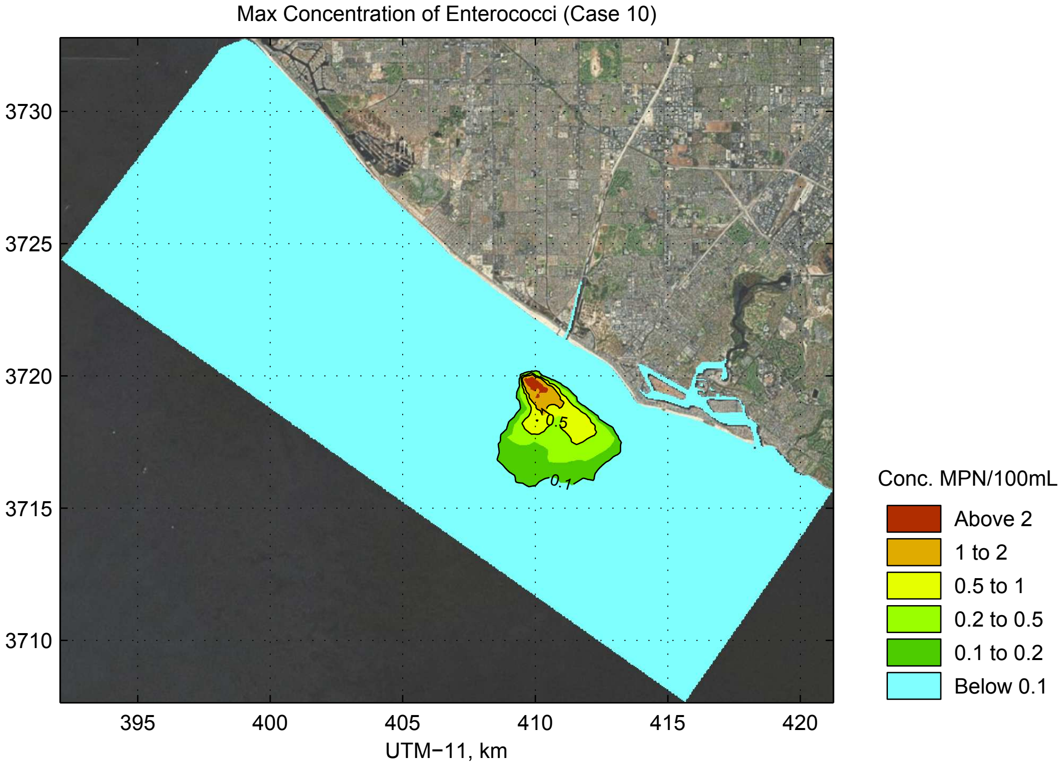

Figure B-68: Max Concentration of Enterococci for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

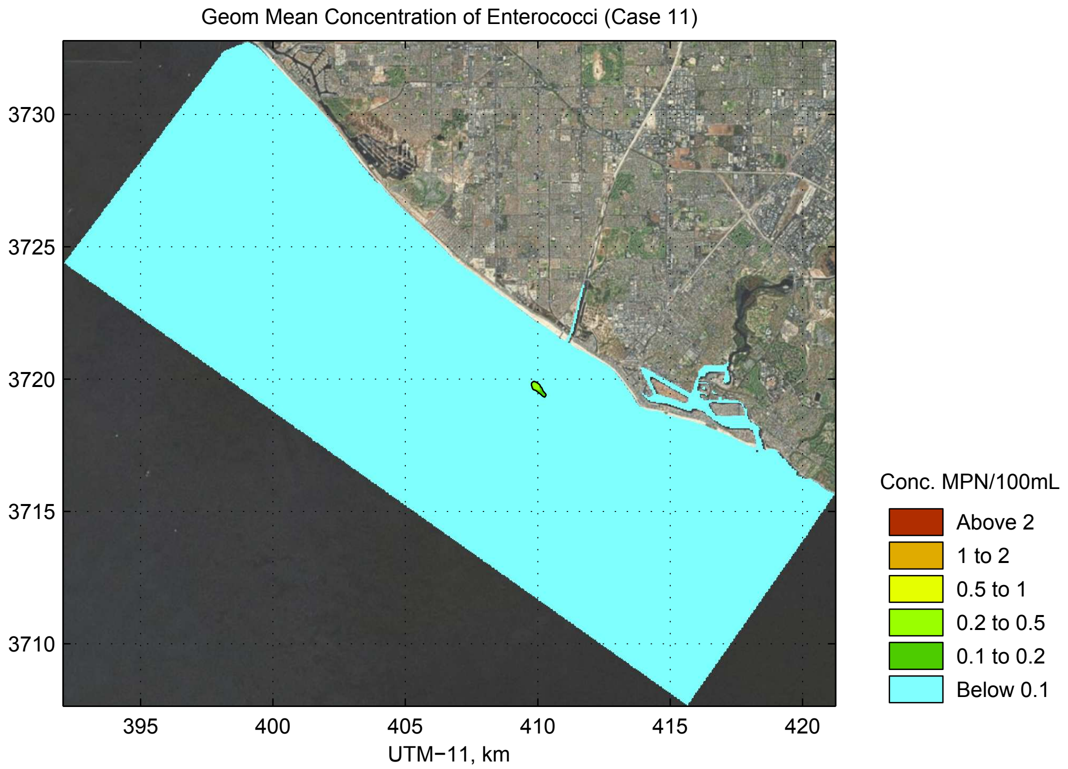

Figure B-69: Geom Mean Concentration of Enterococci for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

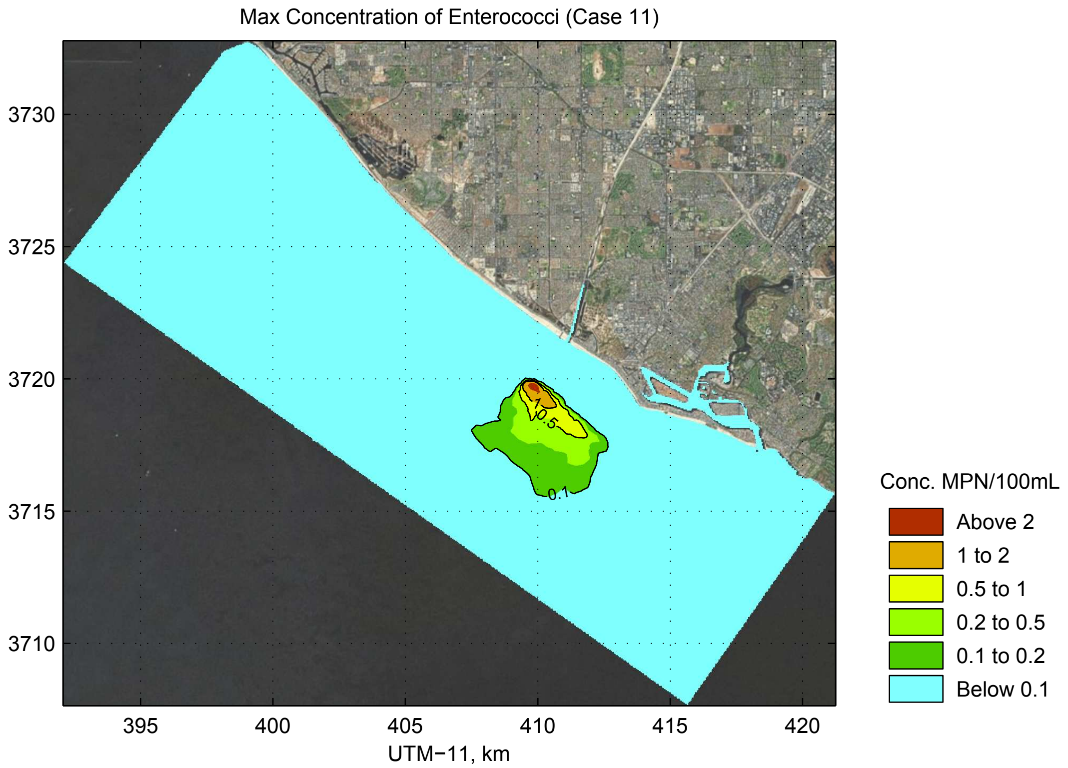

Figure B-70: Max Concentration of Enterococci for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

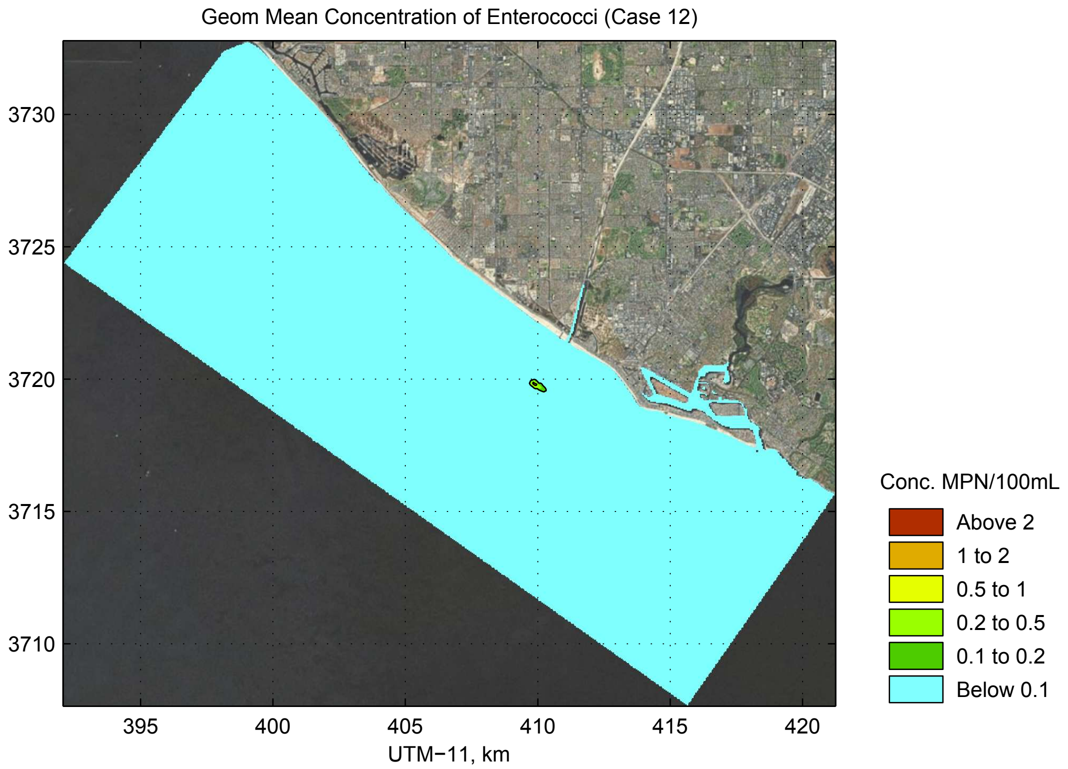

Figure B-71: Geom Mean Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

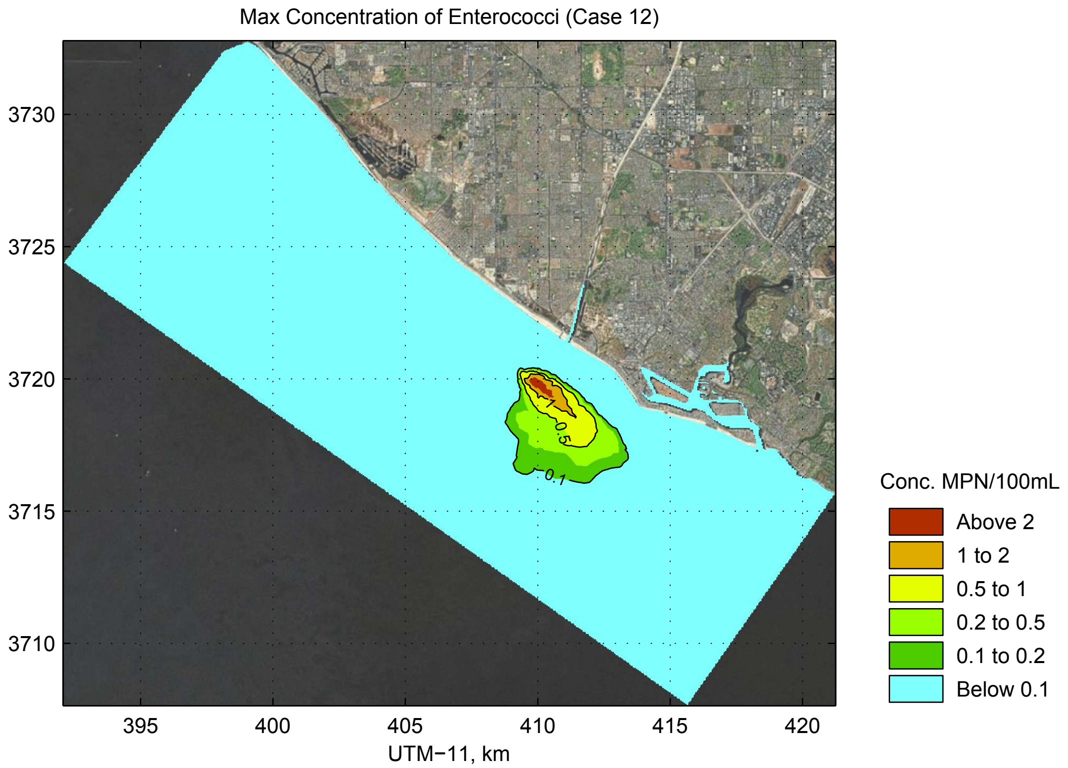

Figure B-72: Max Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

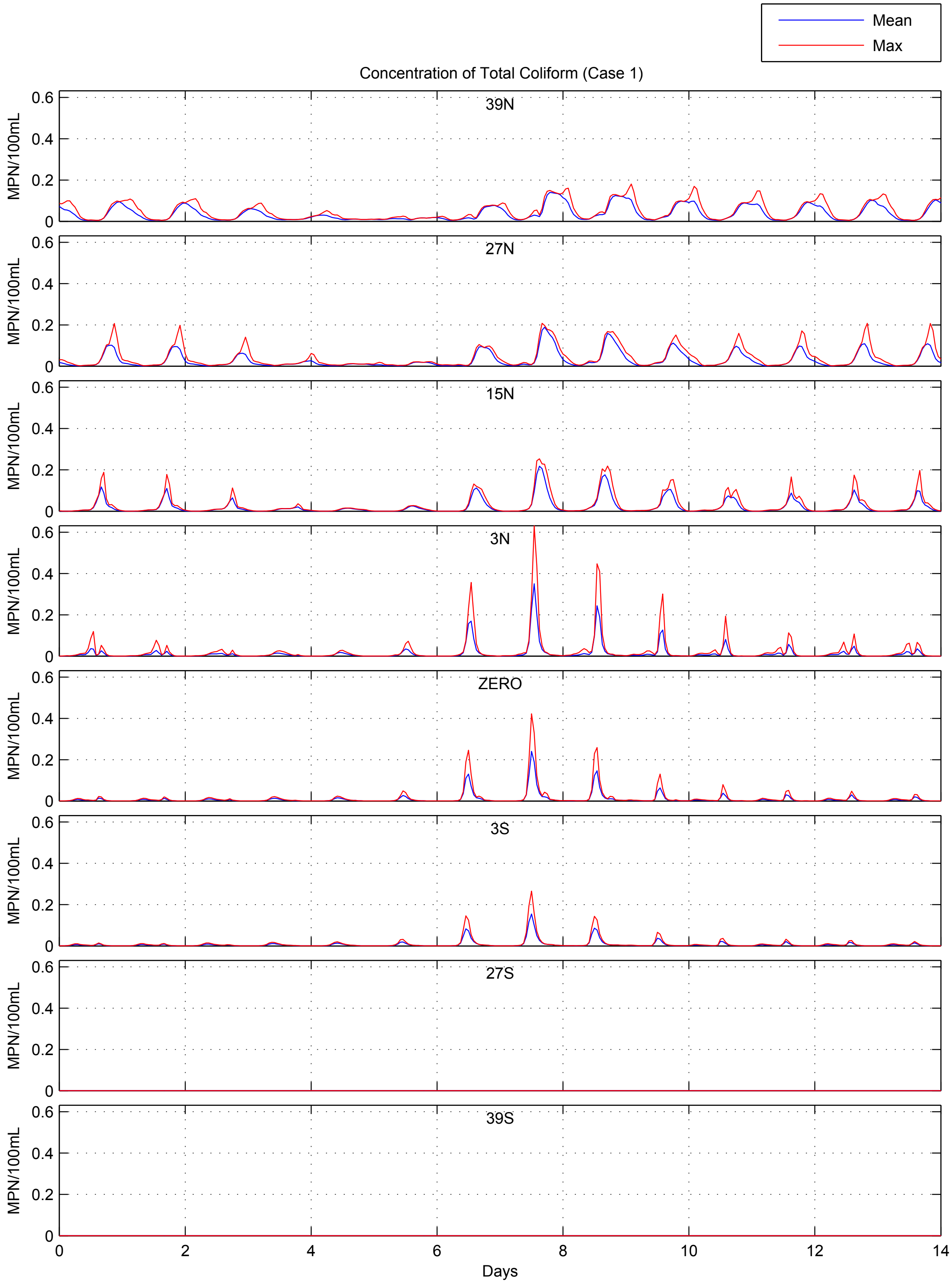

Figure B-73: Concentration of Total Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

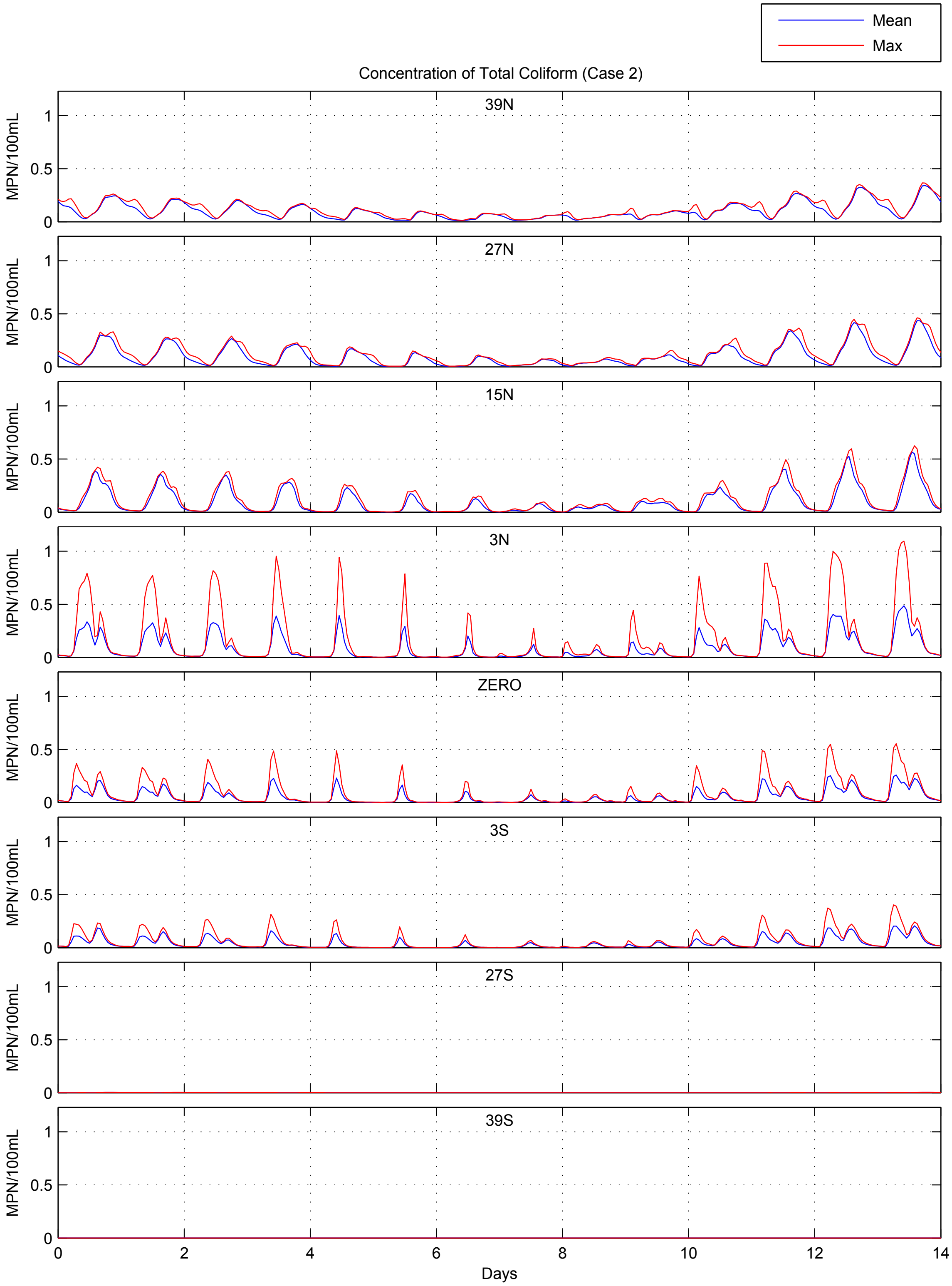

Figure B-74: Concentration of Total Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

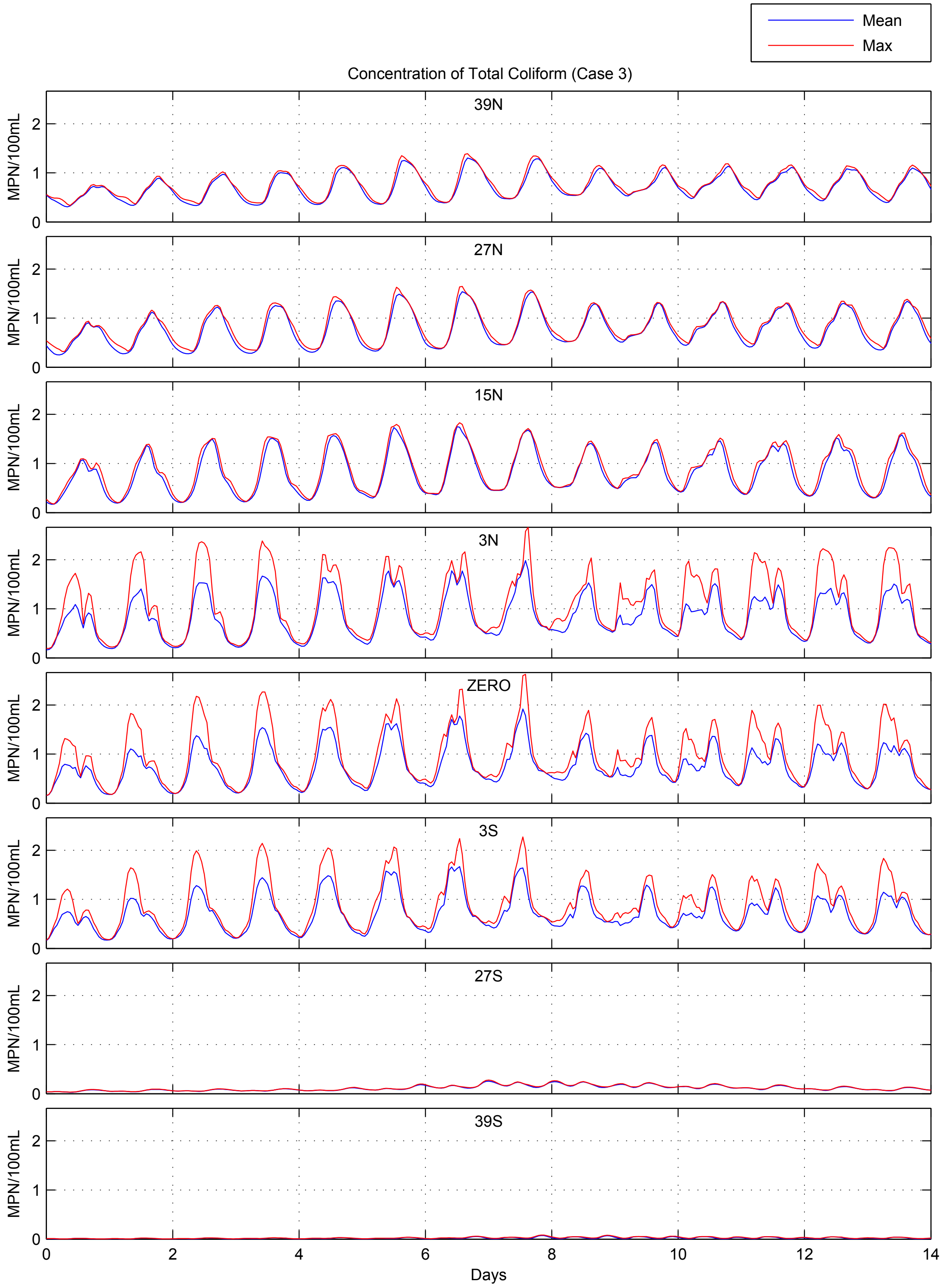

Figure B-75: Concentration of Total Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

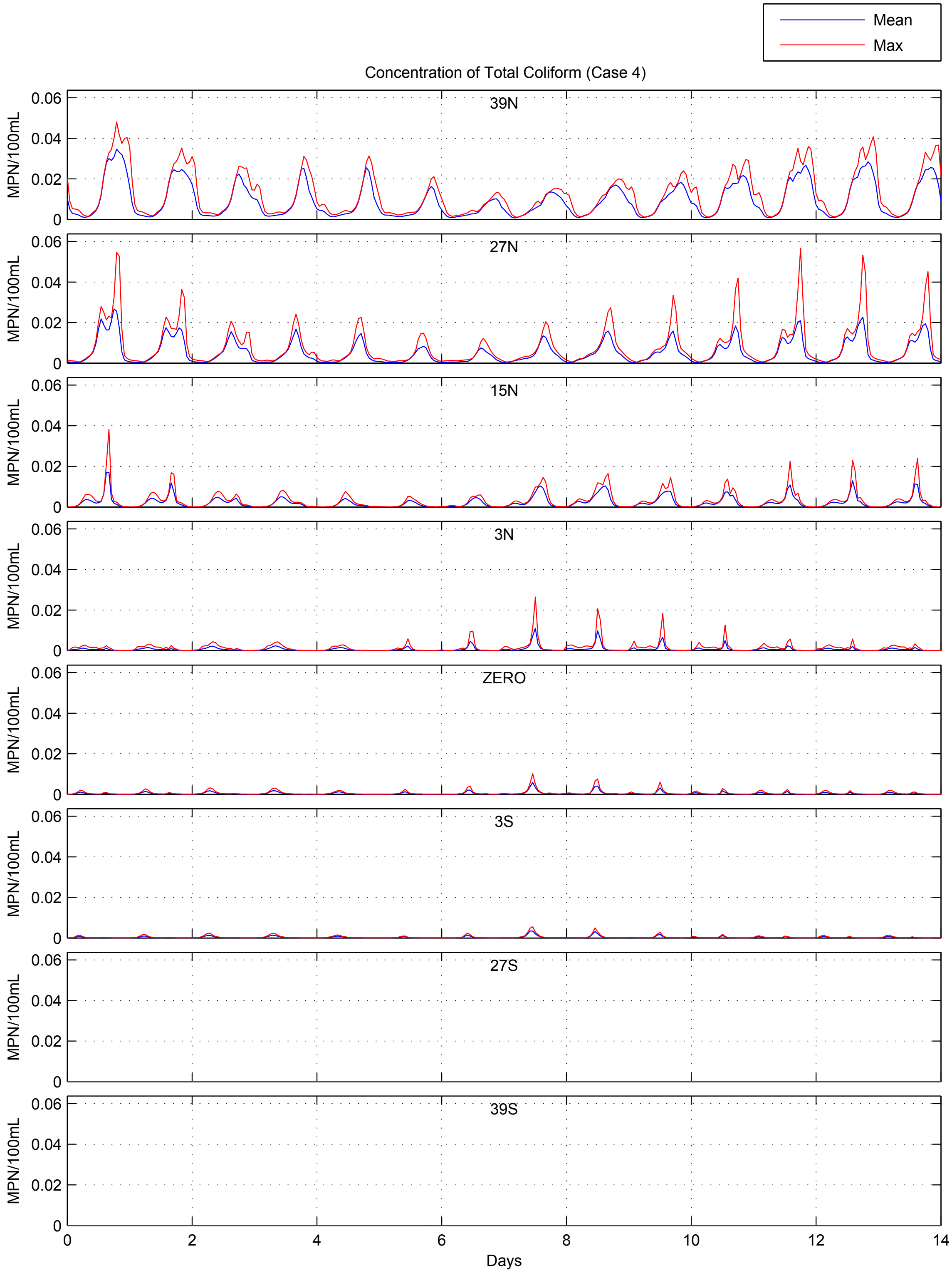

Figure B-76: Concentration of Total Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

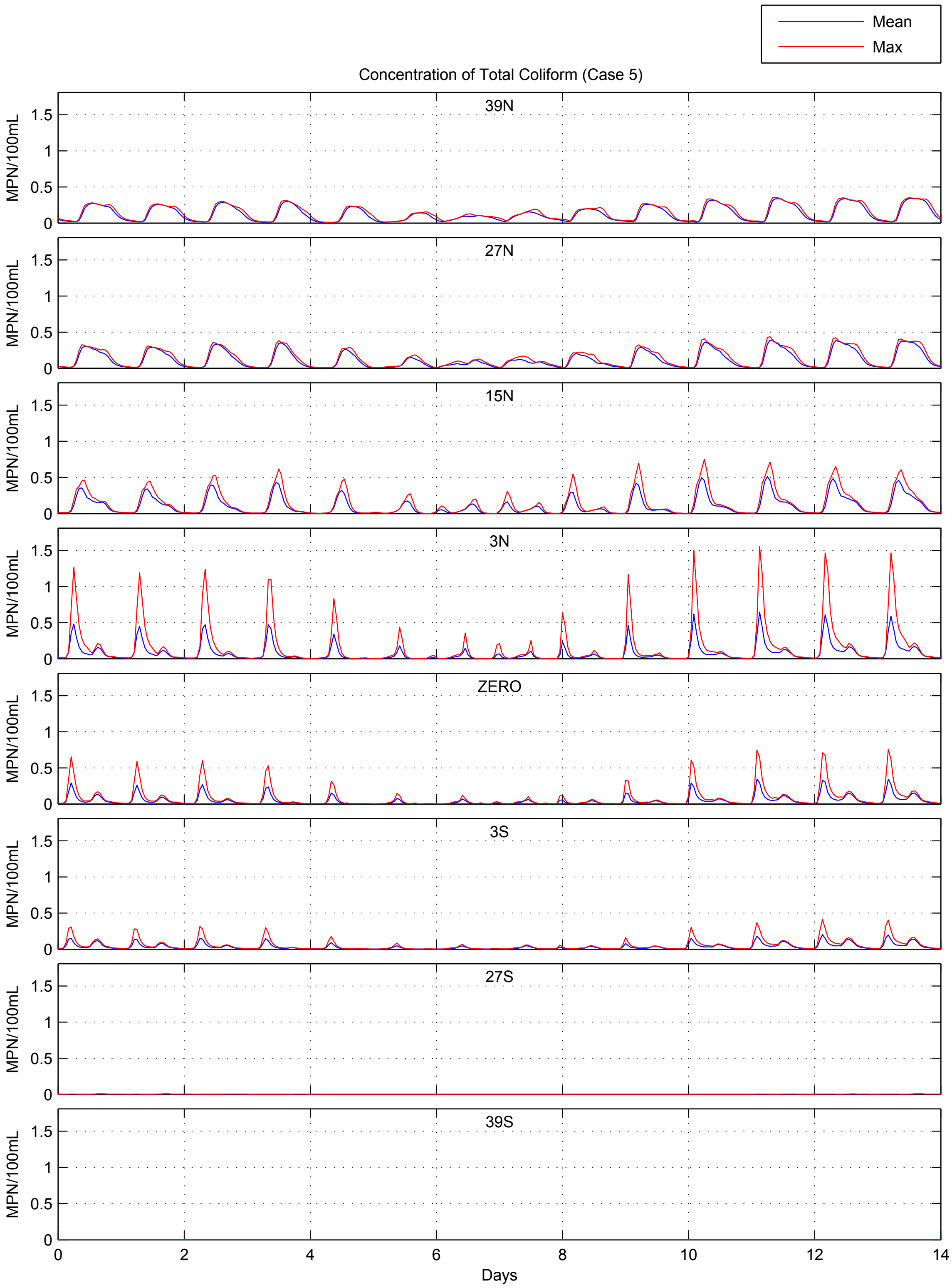

Figure B-77: Concentration of Total Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

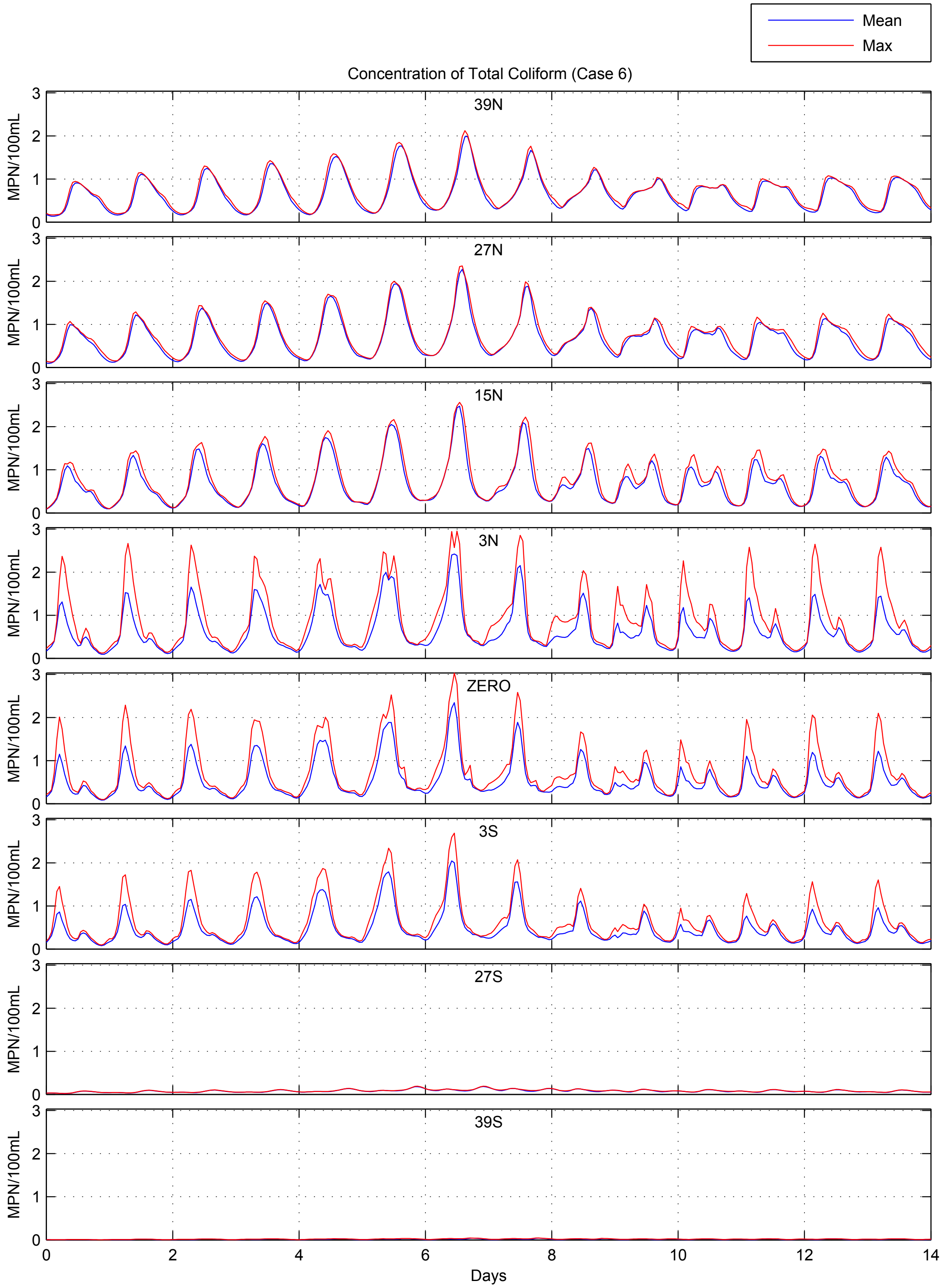

Figure B-78: Concentration of Total Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

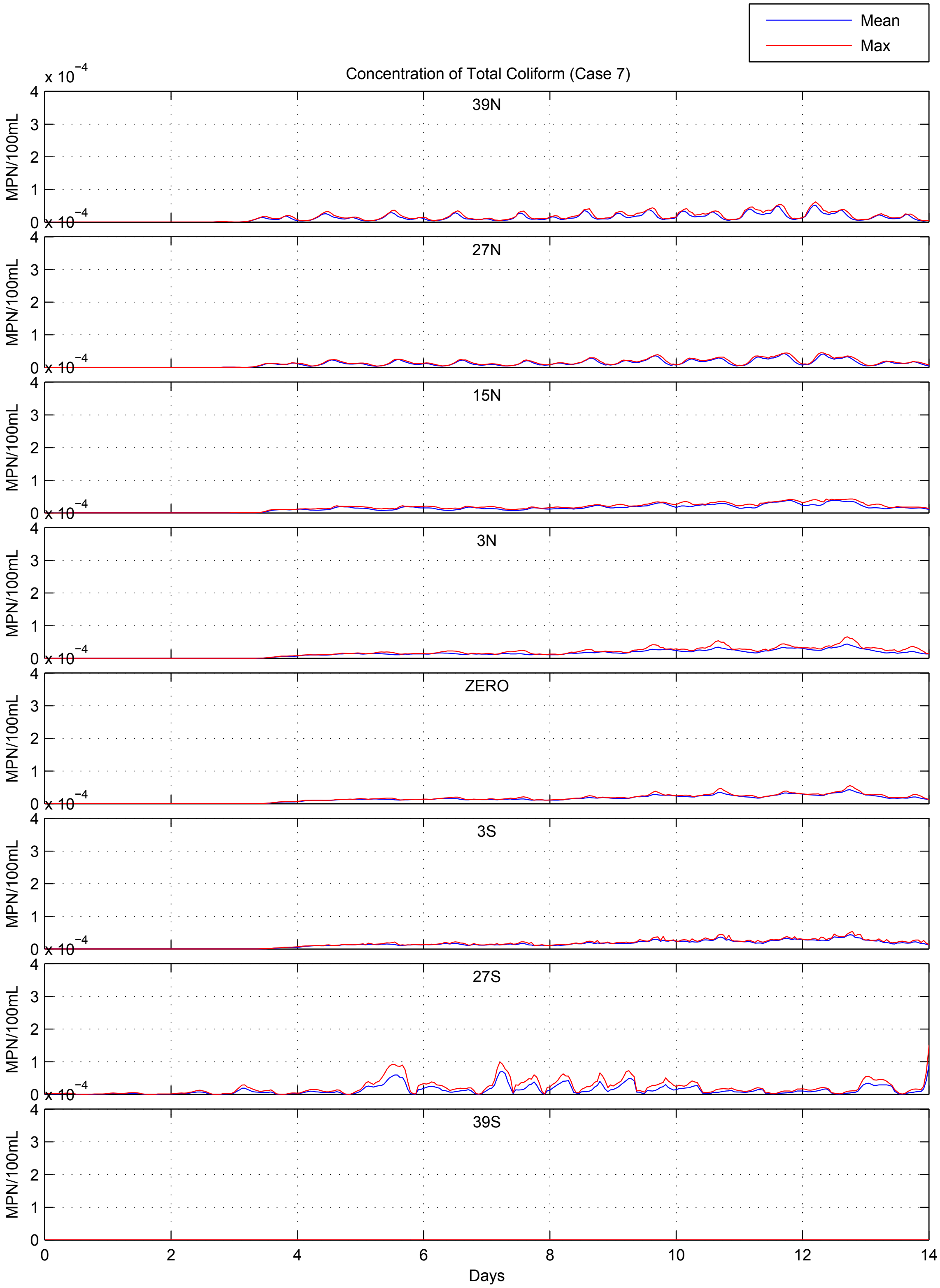

Figure B-79: Concentration of Total Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

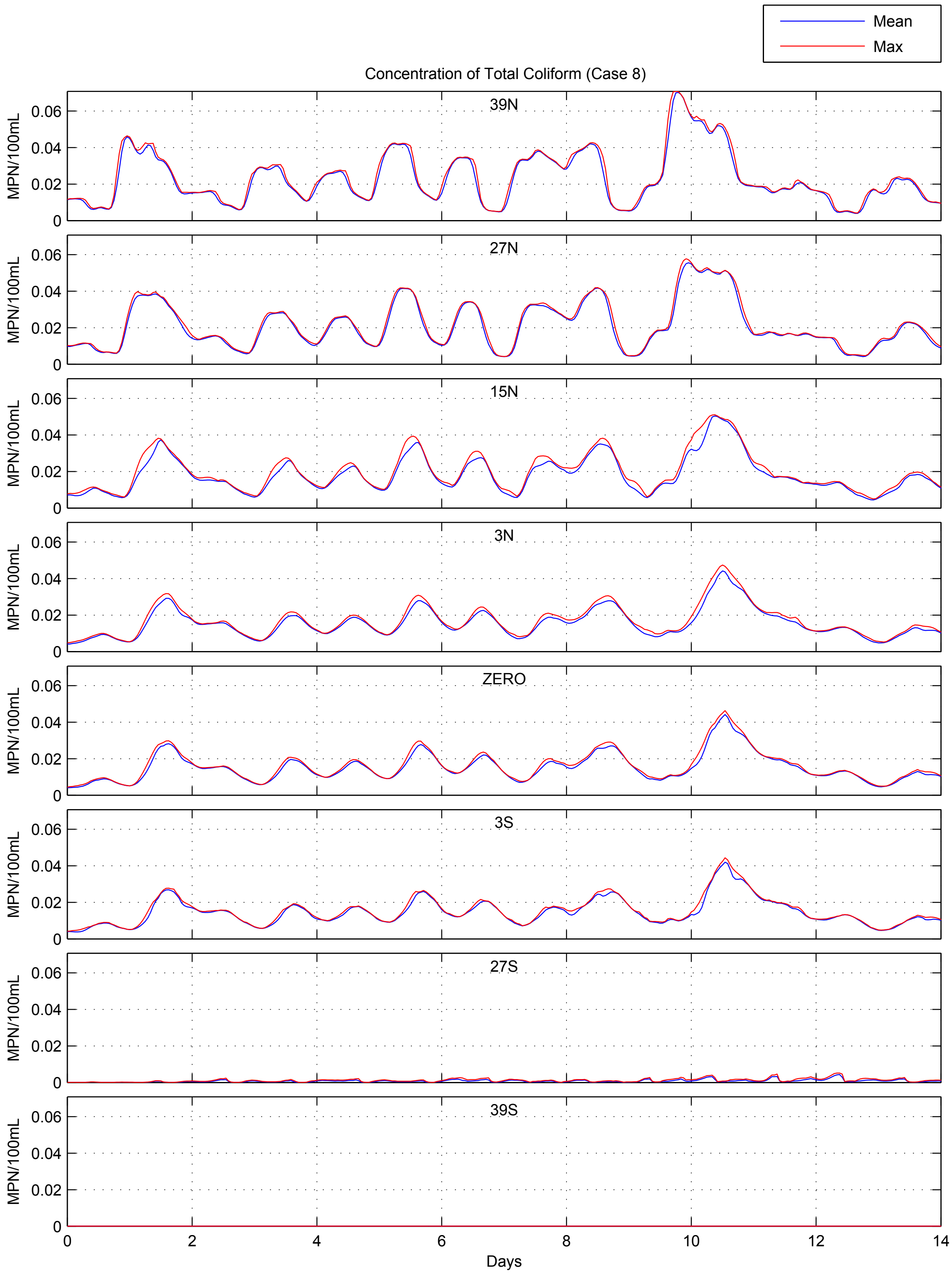

Figure B-80: Concentration of Total Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

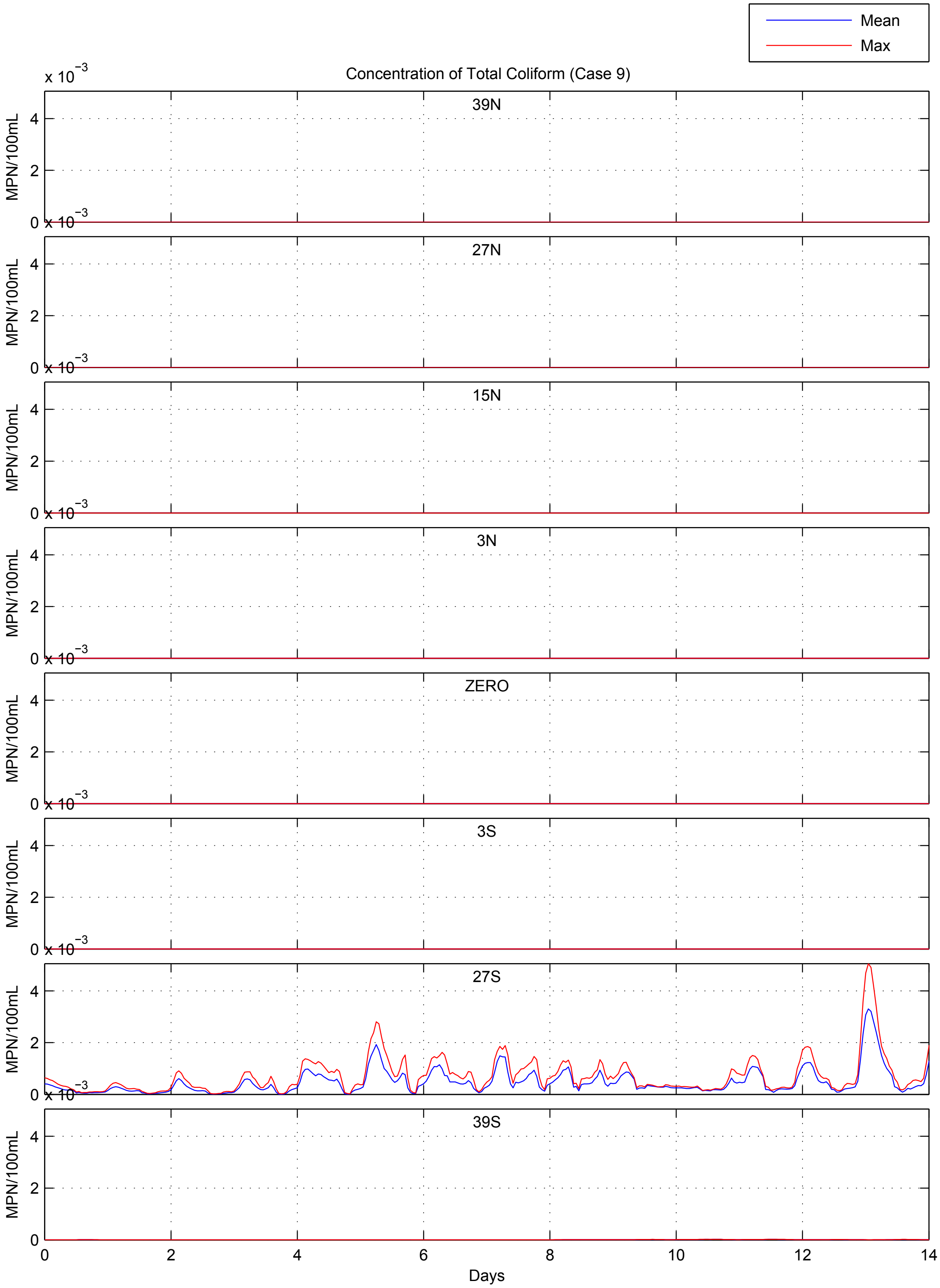

Figure B-81: Concentration of Total Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

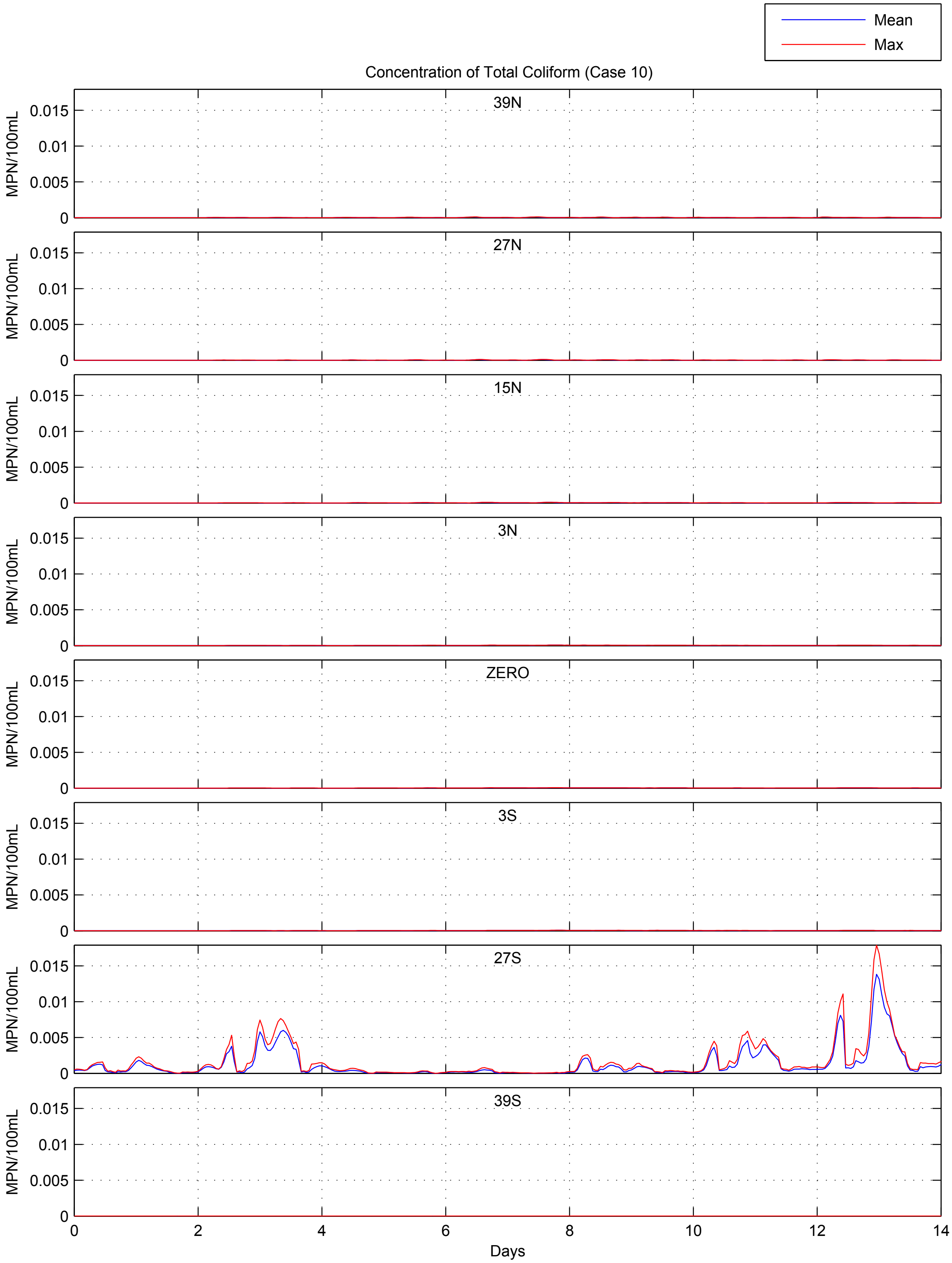

Figure B-82: Concentration of Total Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

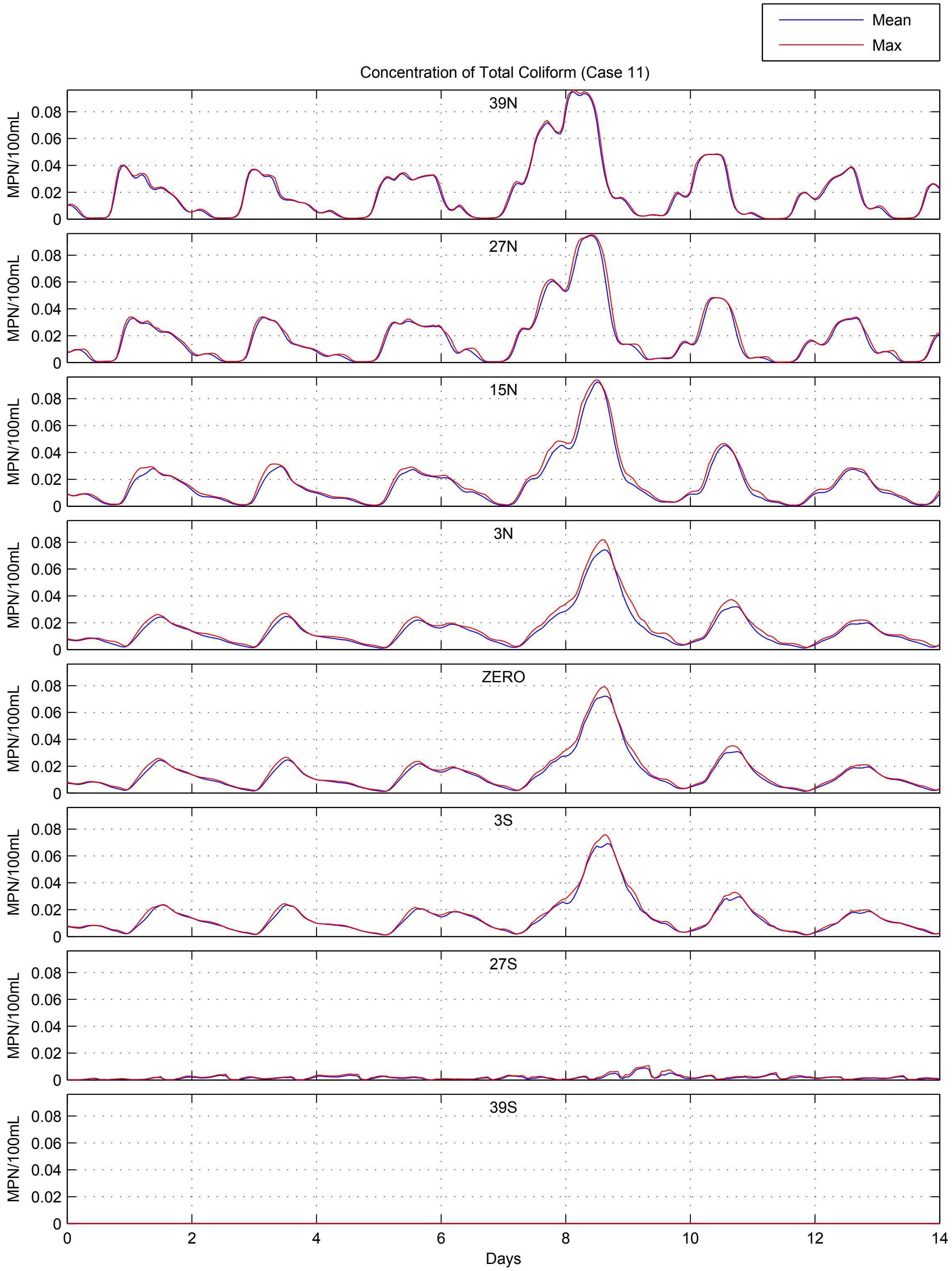

Figure B-83: Concentration of Total Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

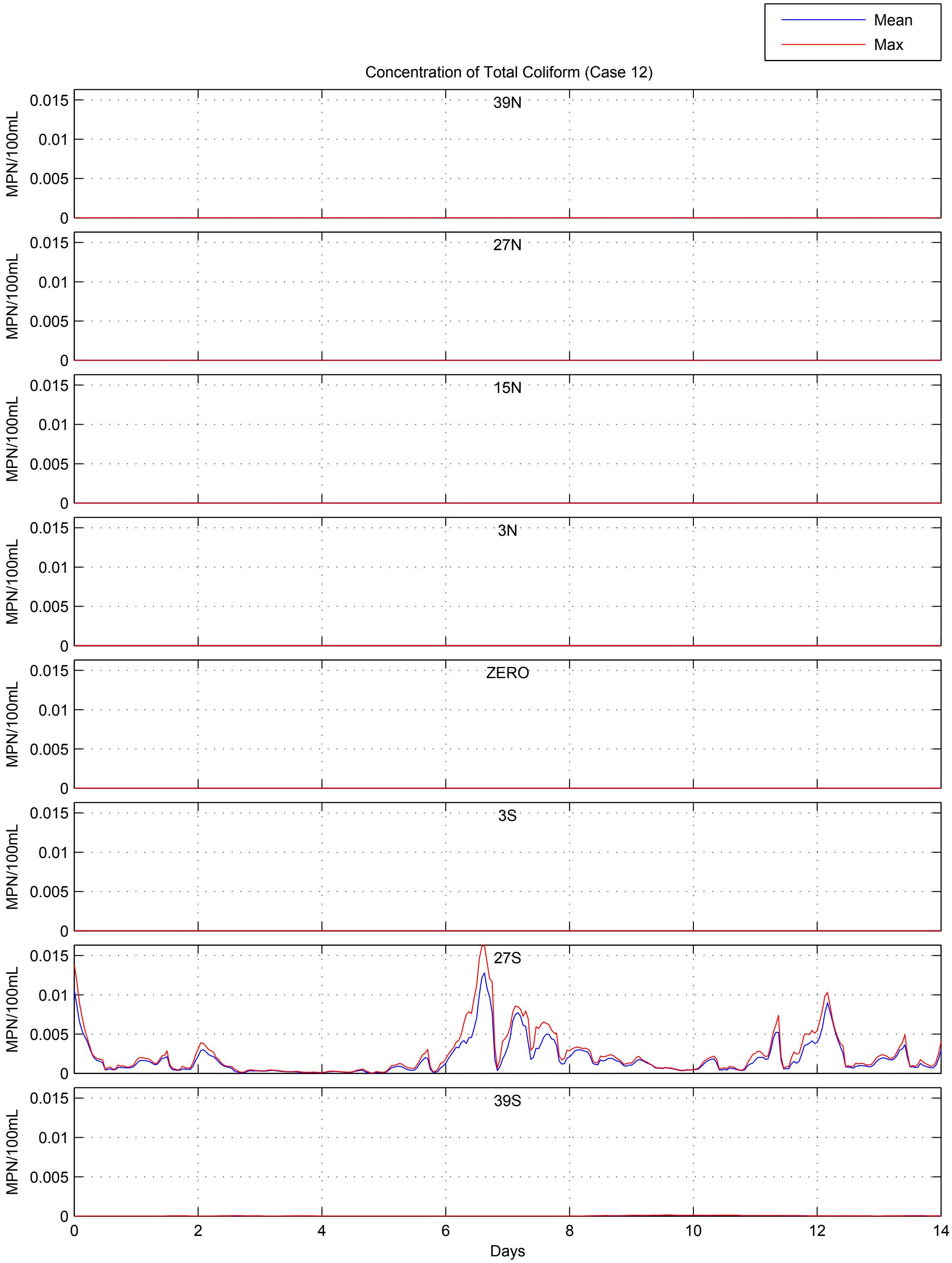

Figure B-84: Concentration of Total Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

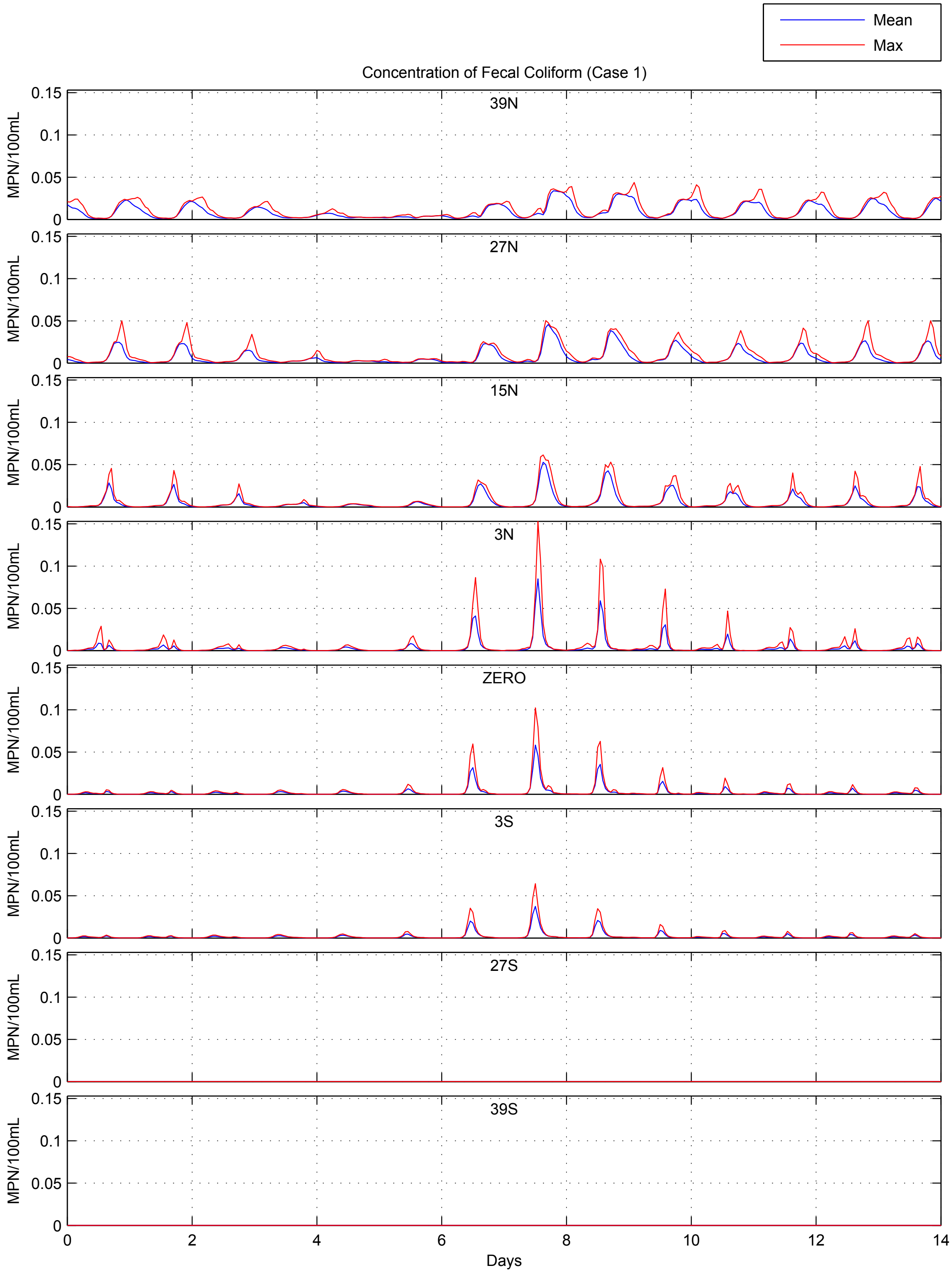

Figure B-85: Concentration of Fecal Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

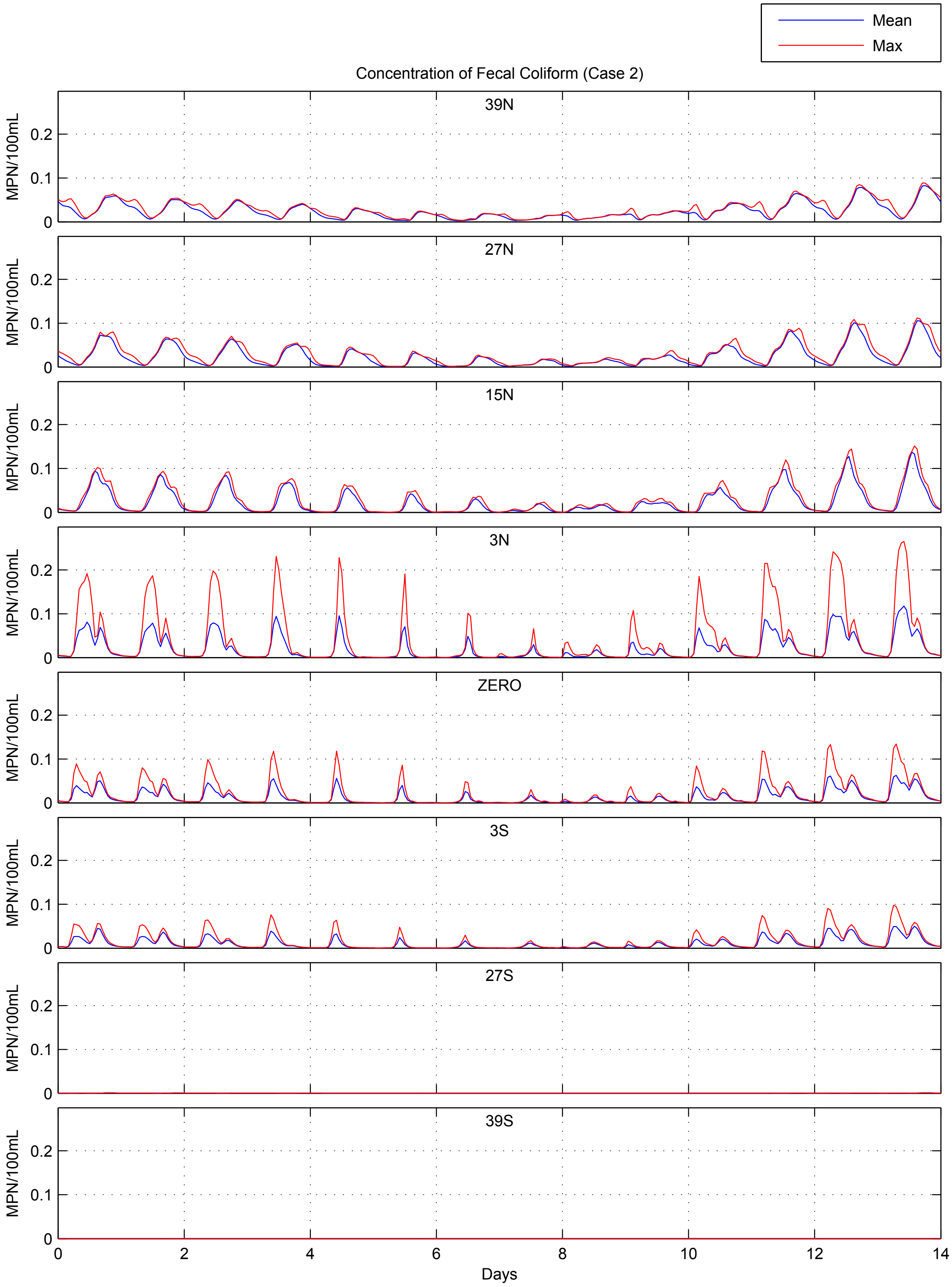

Figure B-86: Concentration of Fecal Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

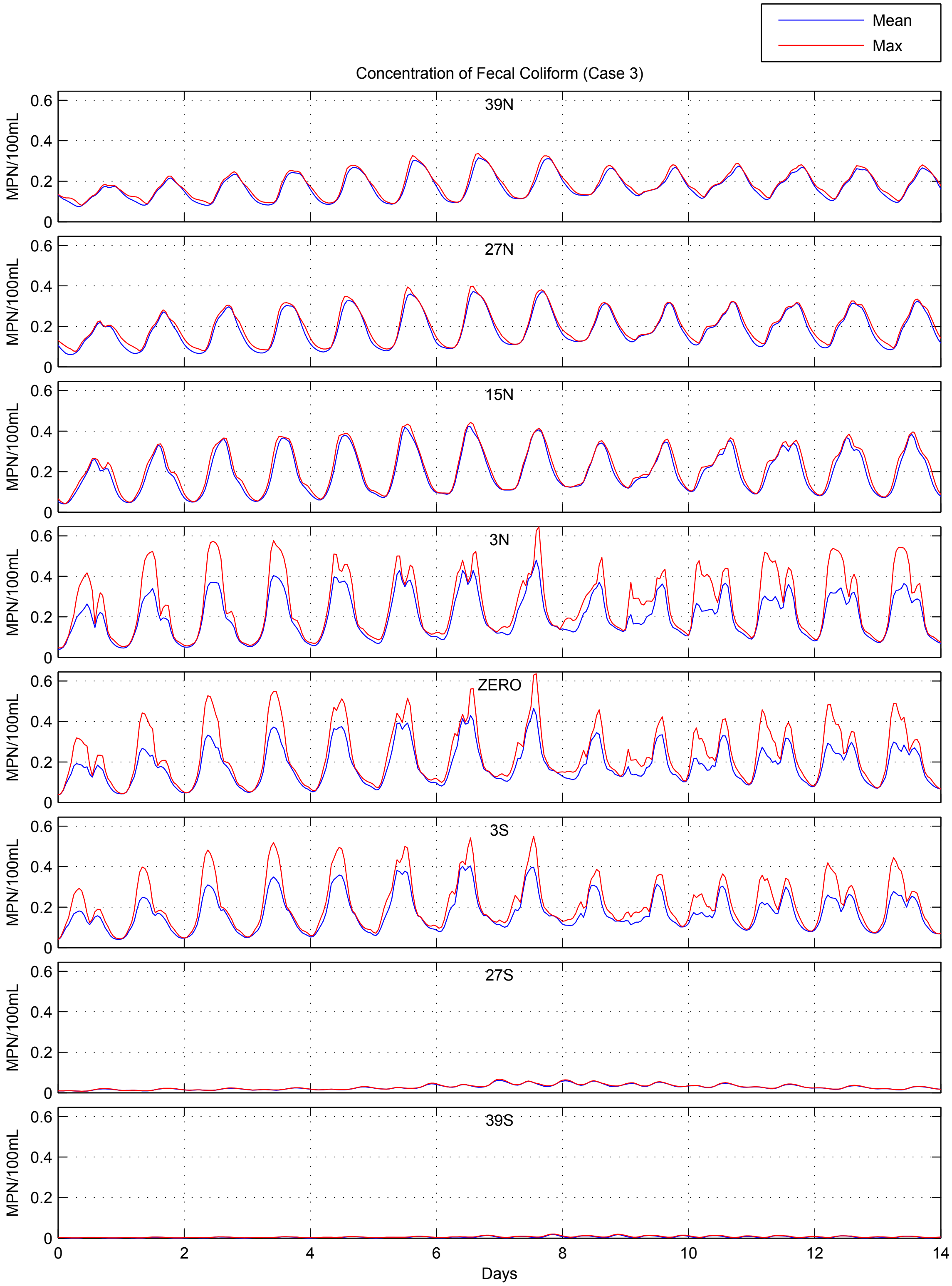

Figure B-87: Concentration of Fecal Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

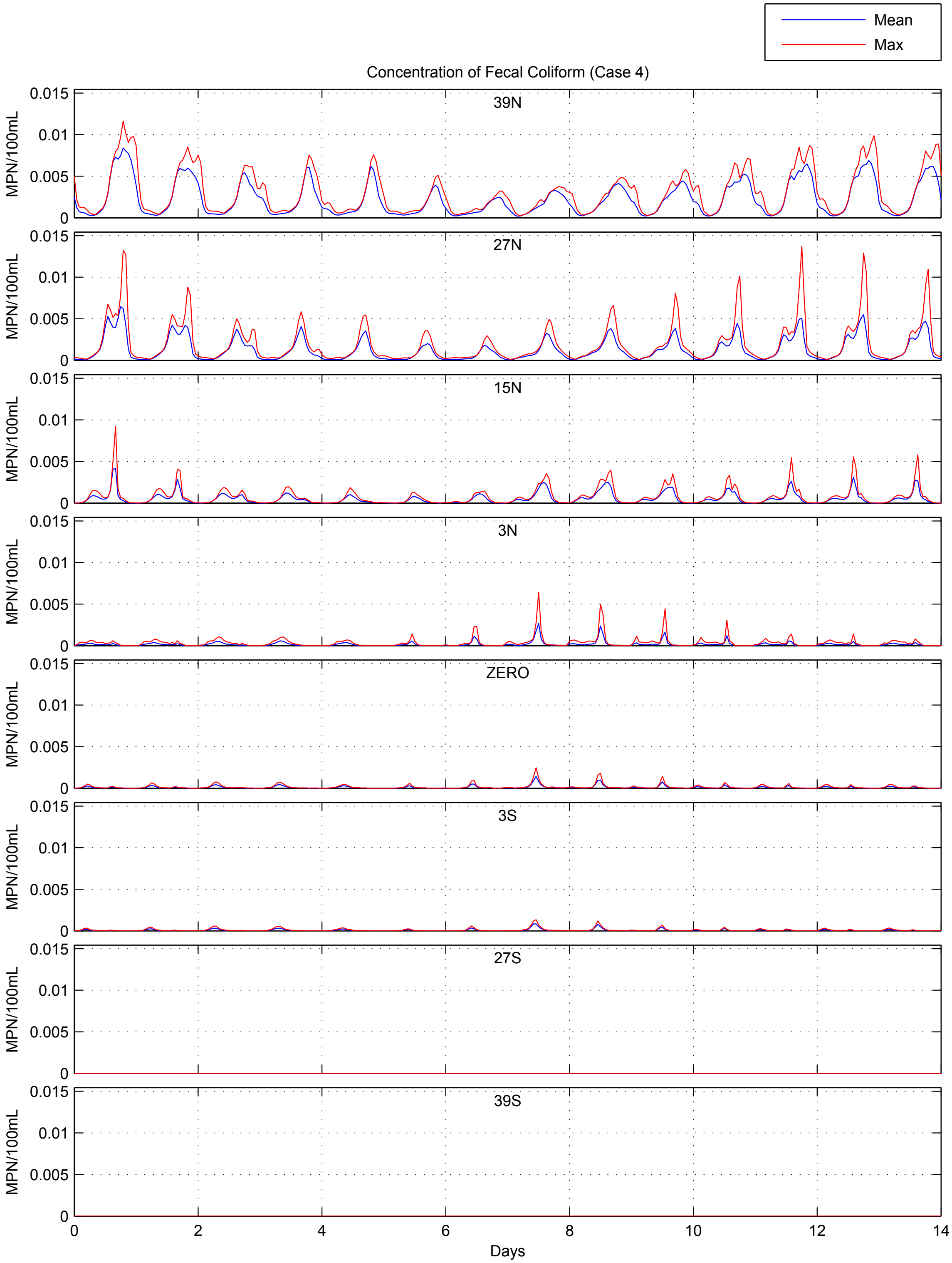

Figure B-88: Concentration of Fecal Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

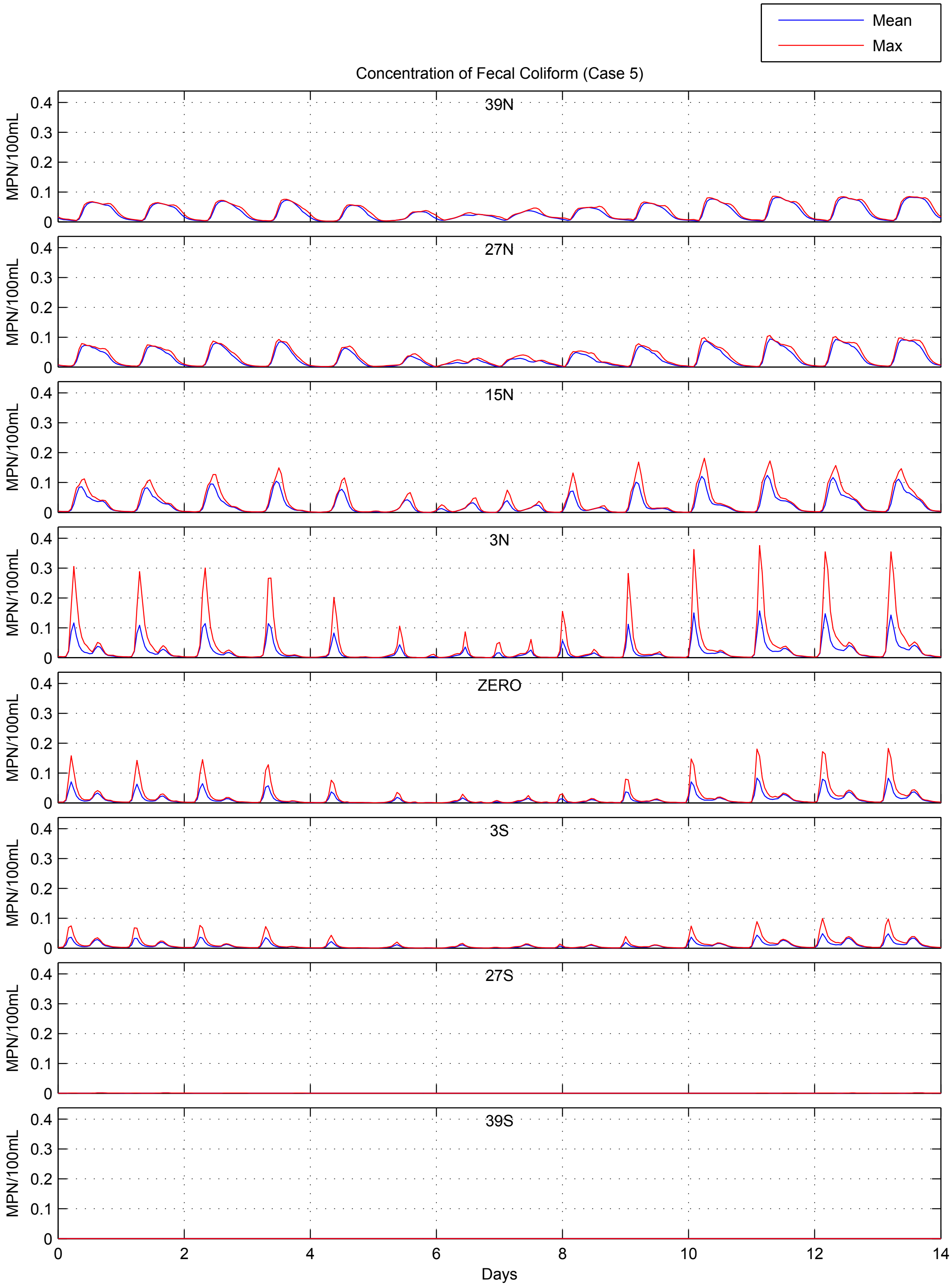

Figure B-89: Concentration of Fecal Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

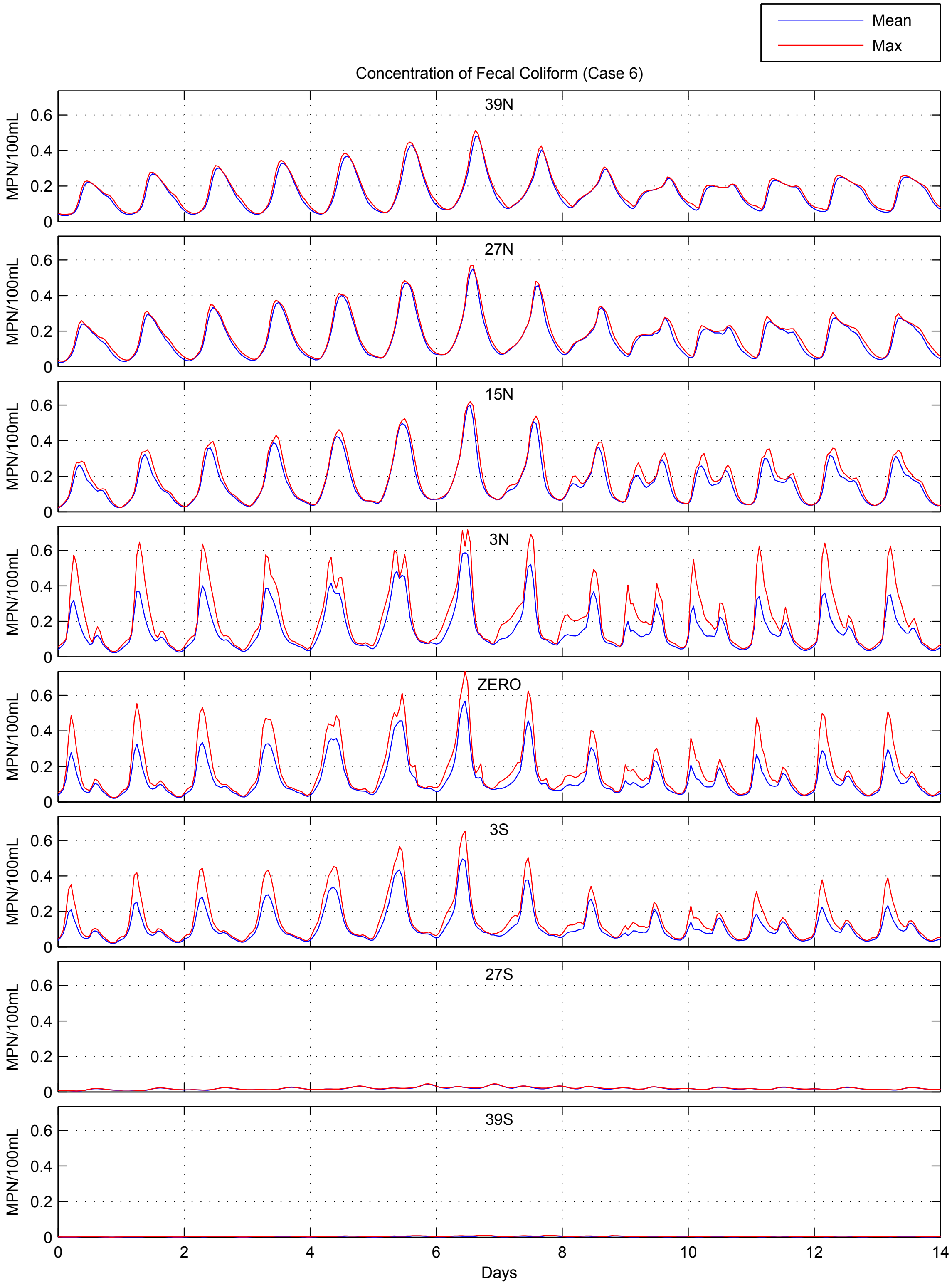

Figure B-90: Concentration of Fecal Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

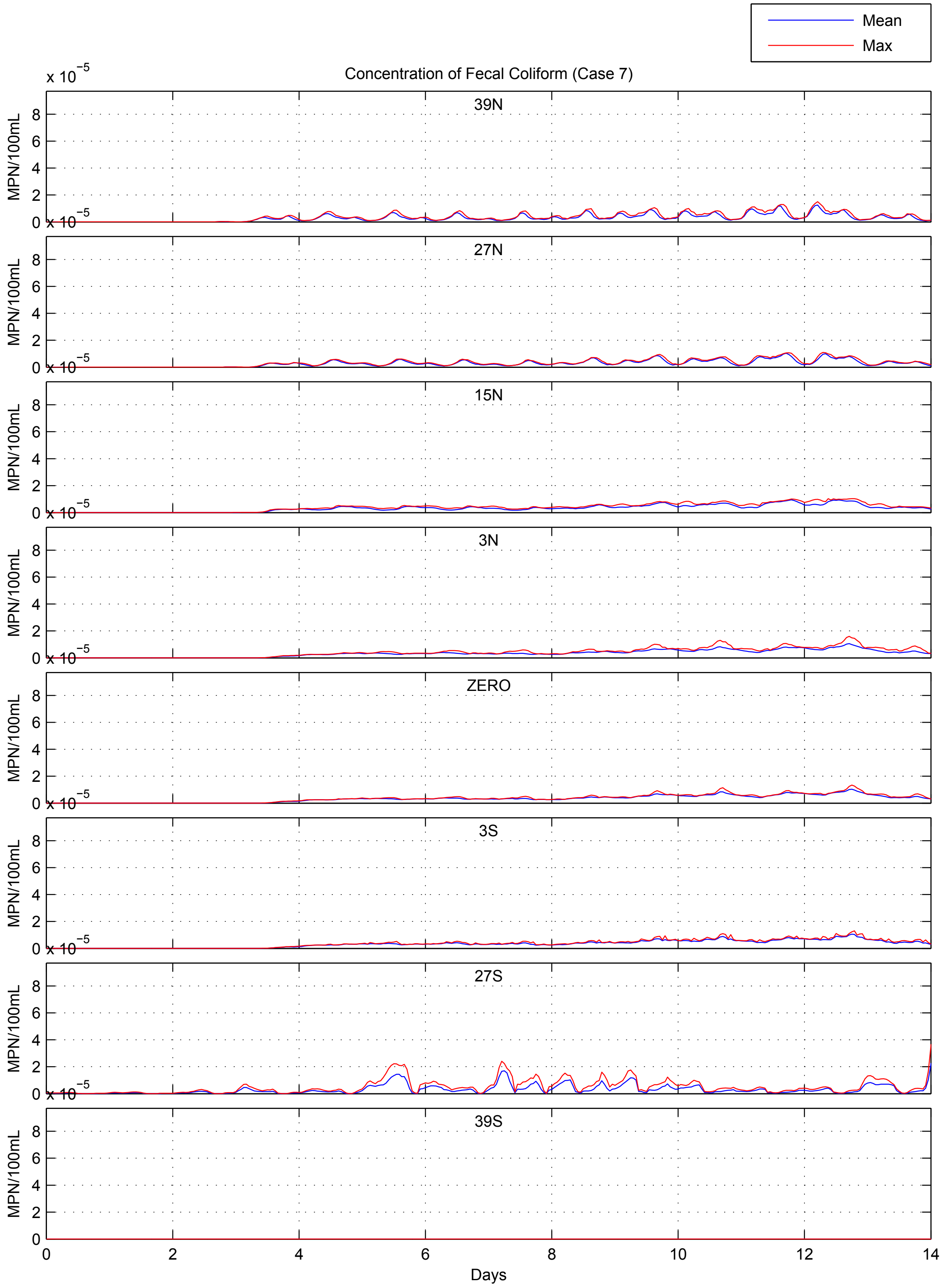

Figure B-91: Concentration of Fecal Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

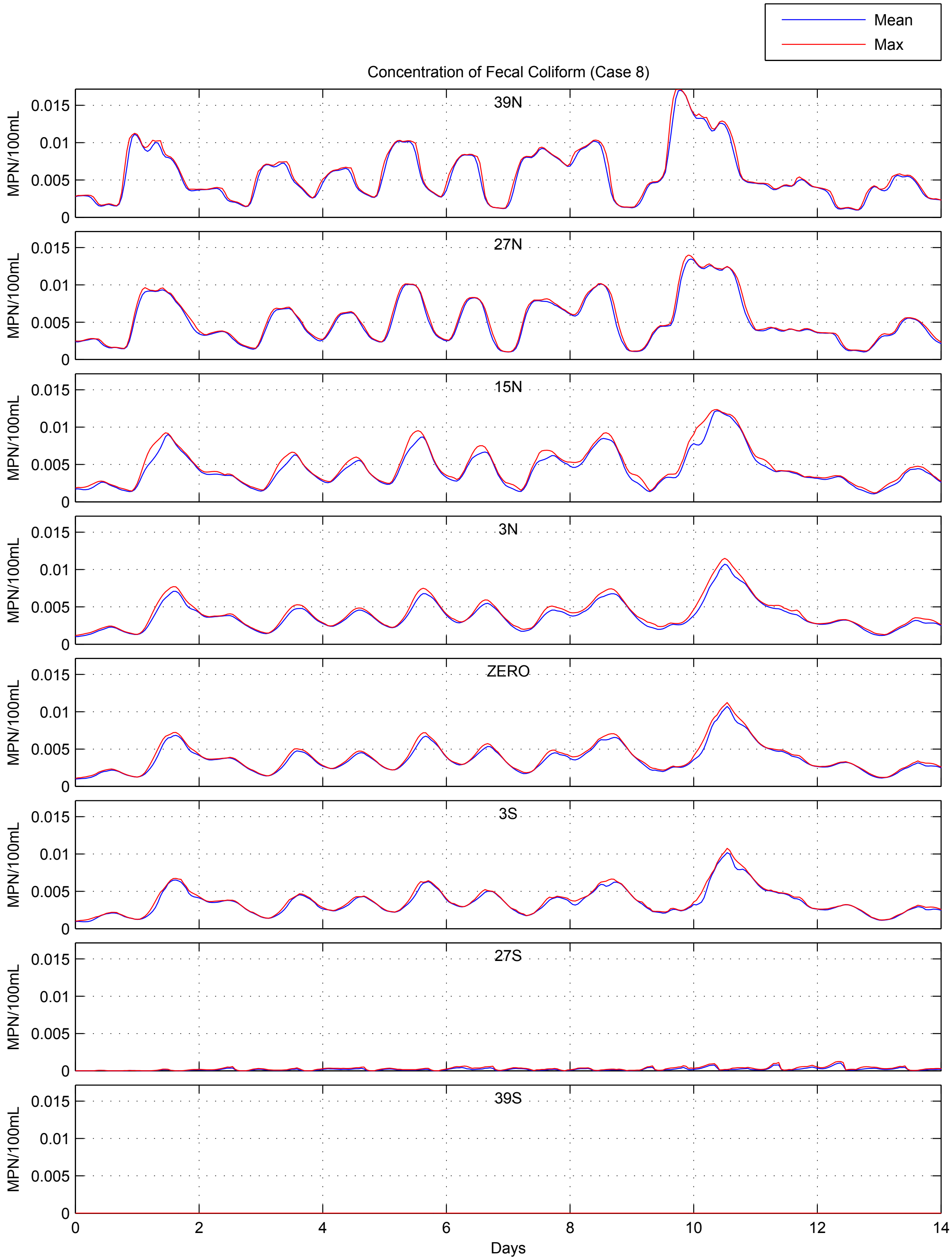

Figure B-92: Concentration of Fecal Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

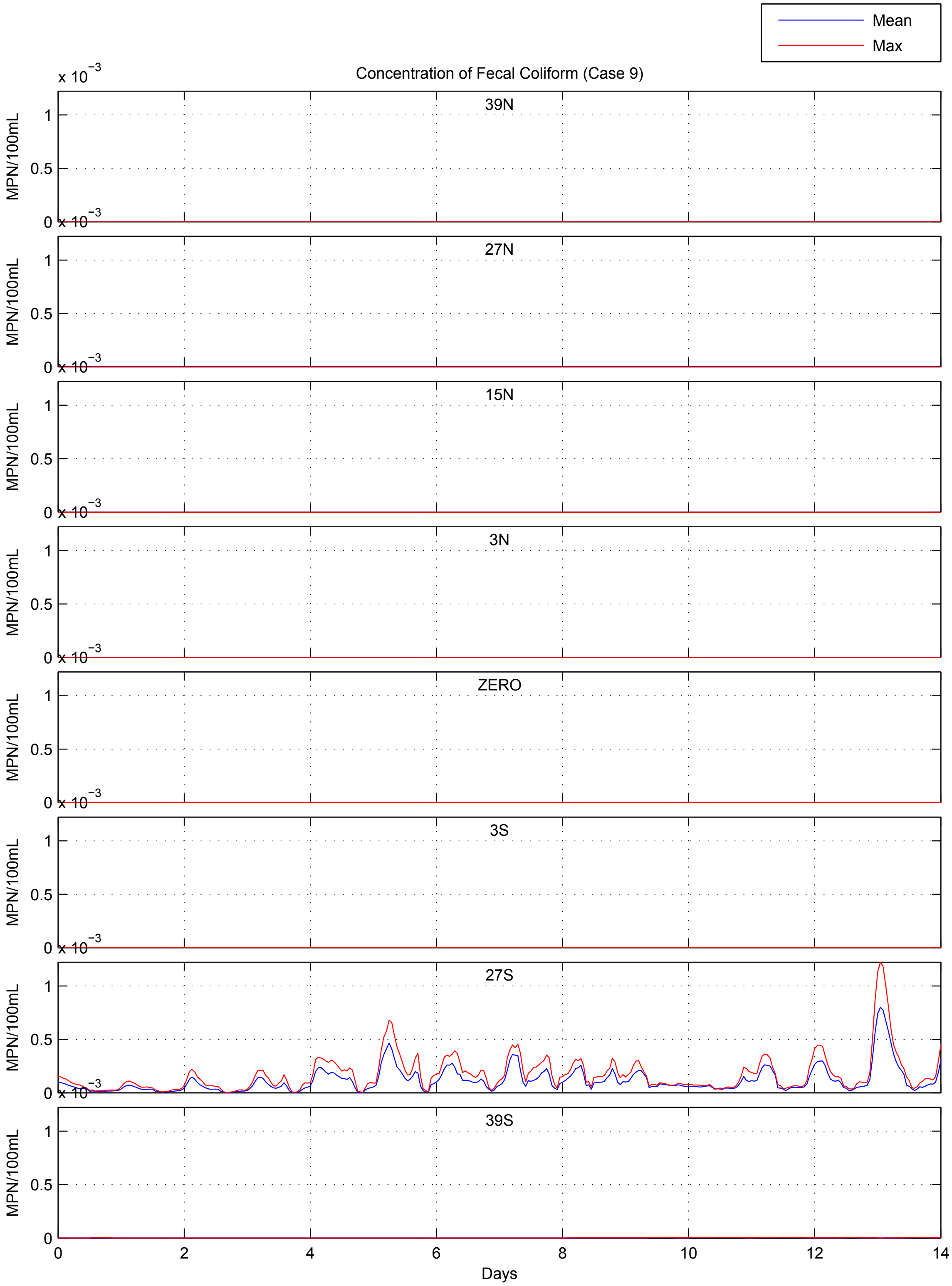

Figure B-93: Concentration of Fecal Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

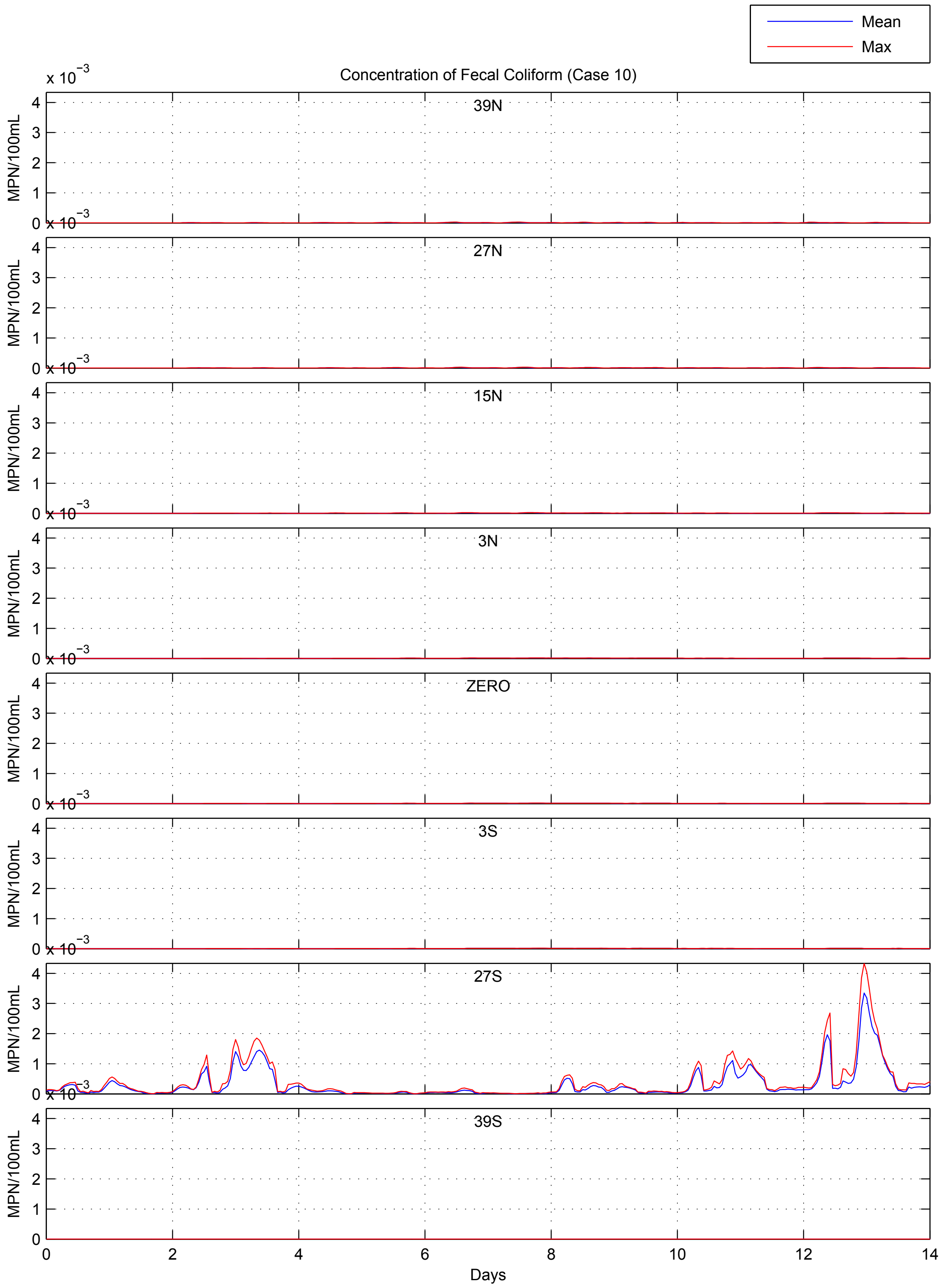

Figure B-94: Concentration of Fecal Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

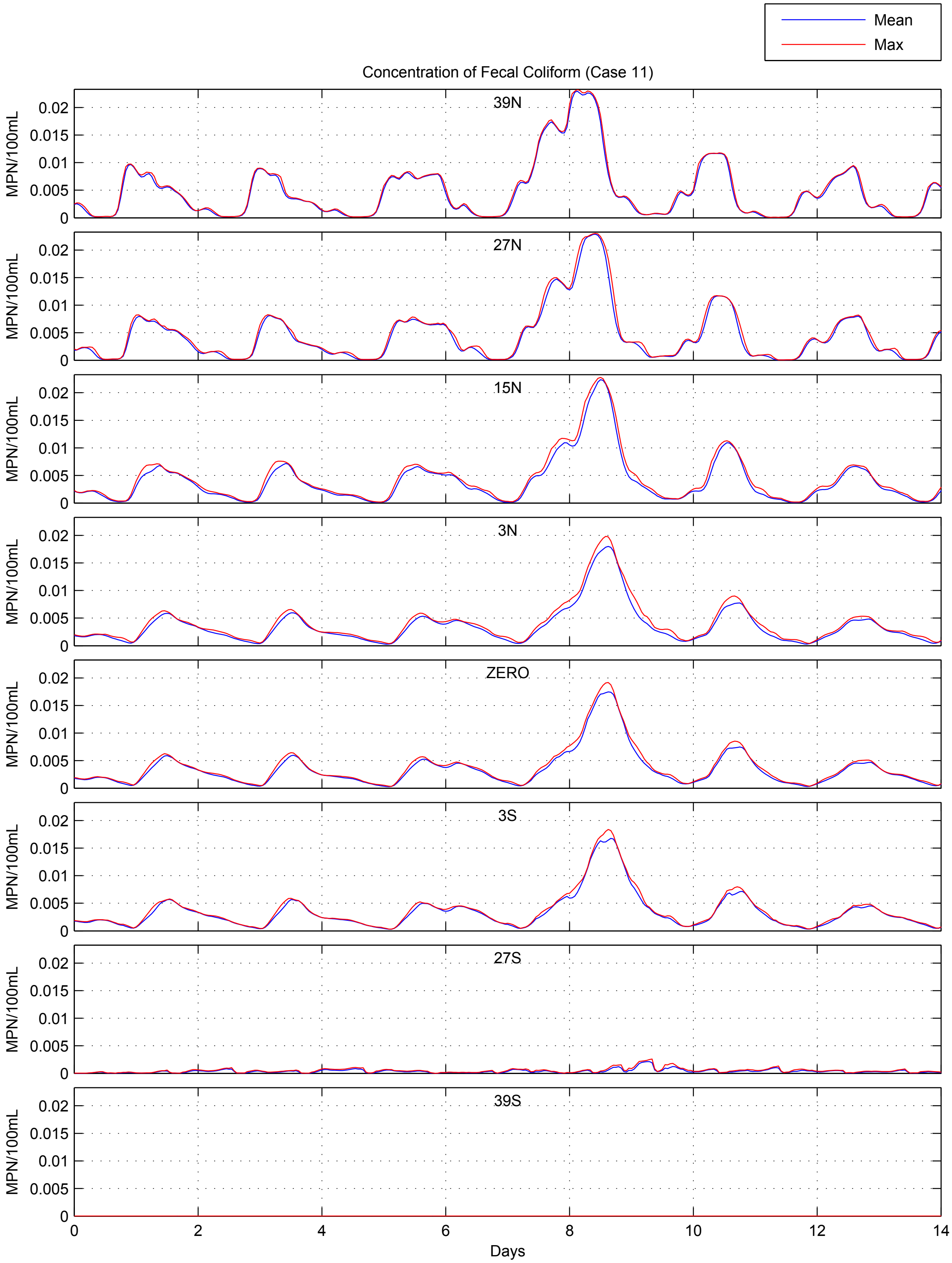

Figure B-95: Concentration of Fecal Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

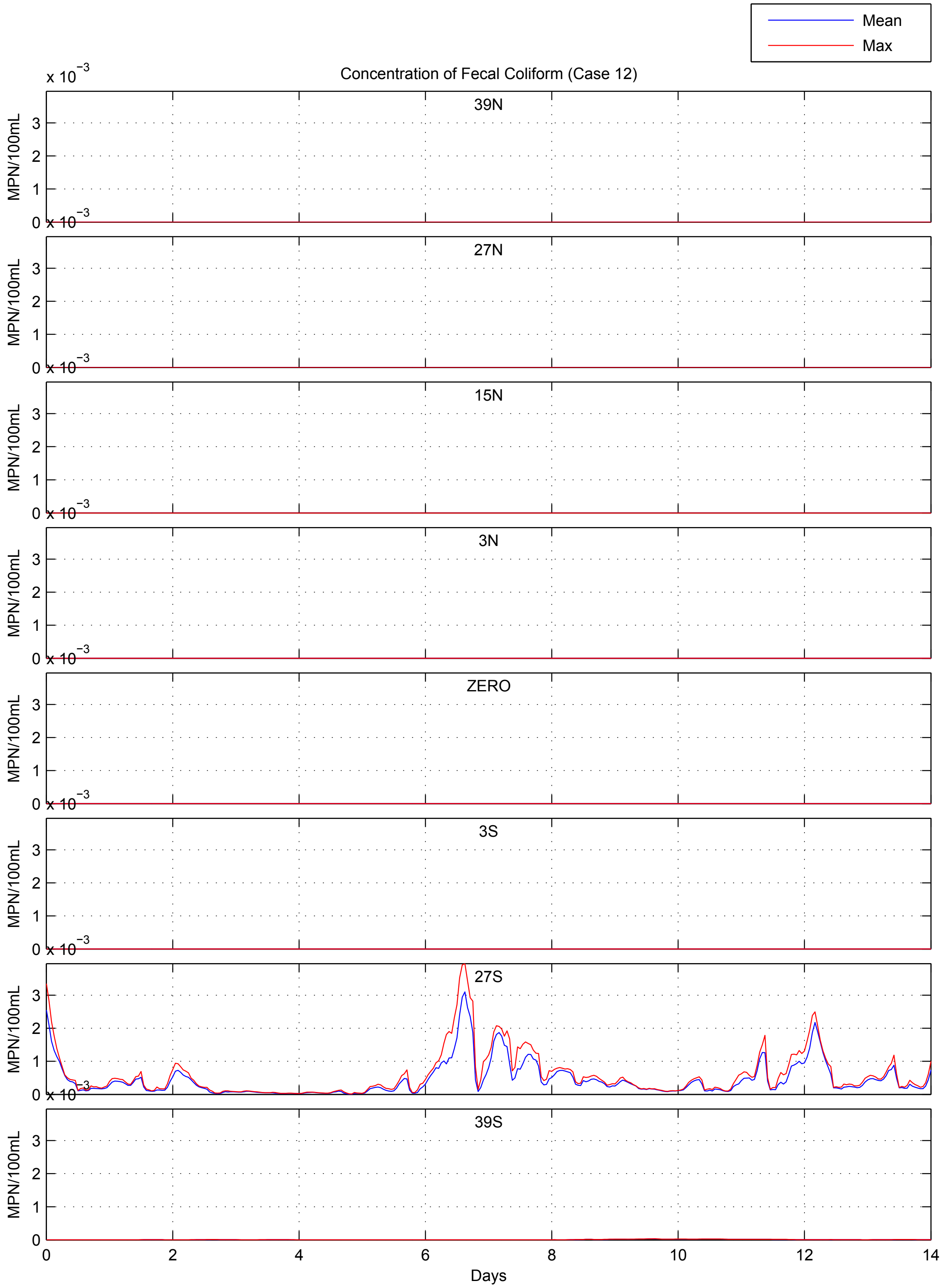

Figure B-96: Concentration of Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

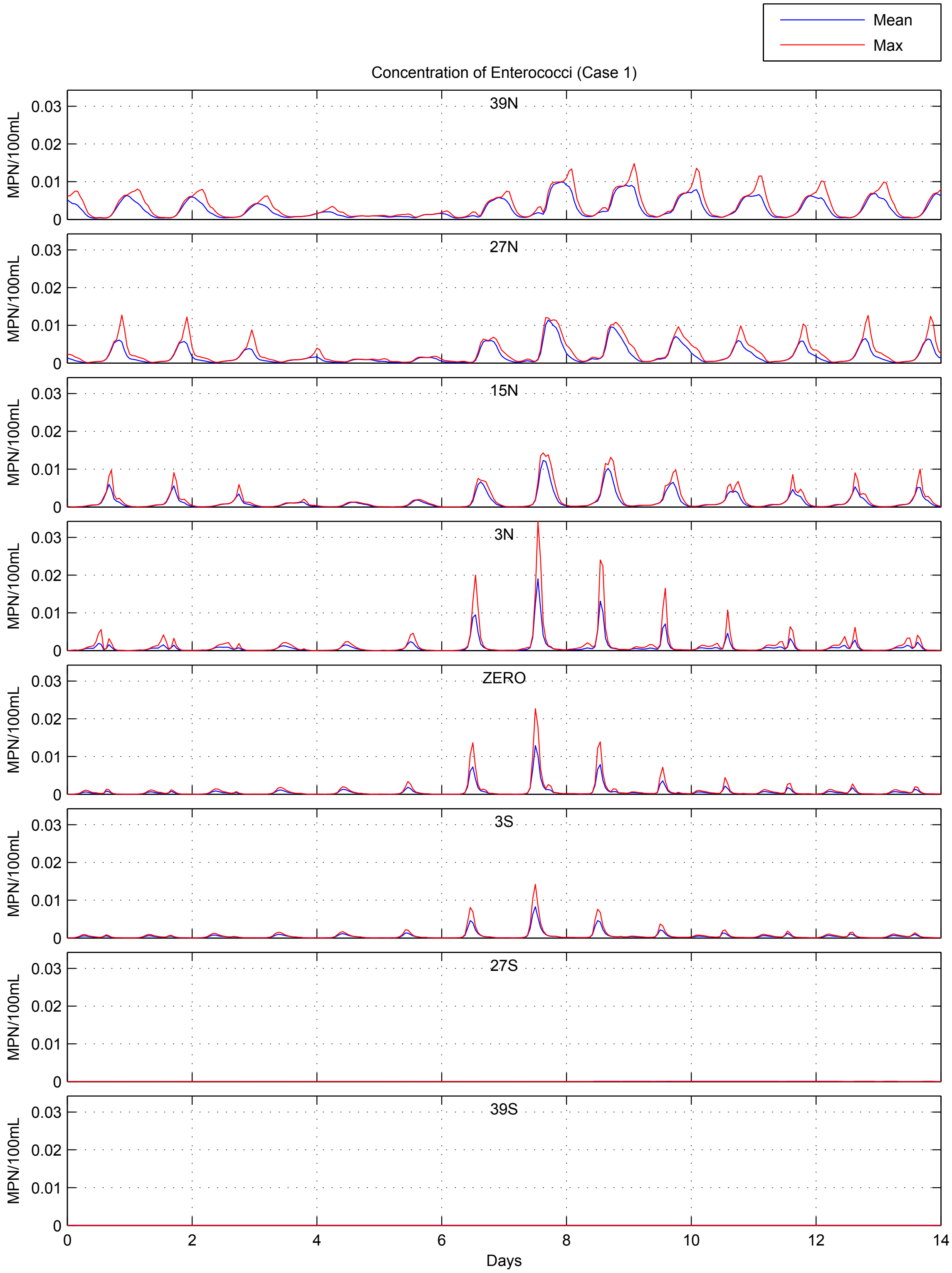

Figure B-97: Concentration of Enterococci for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

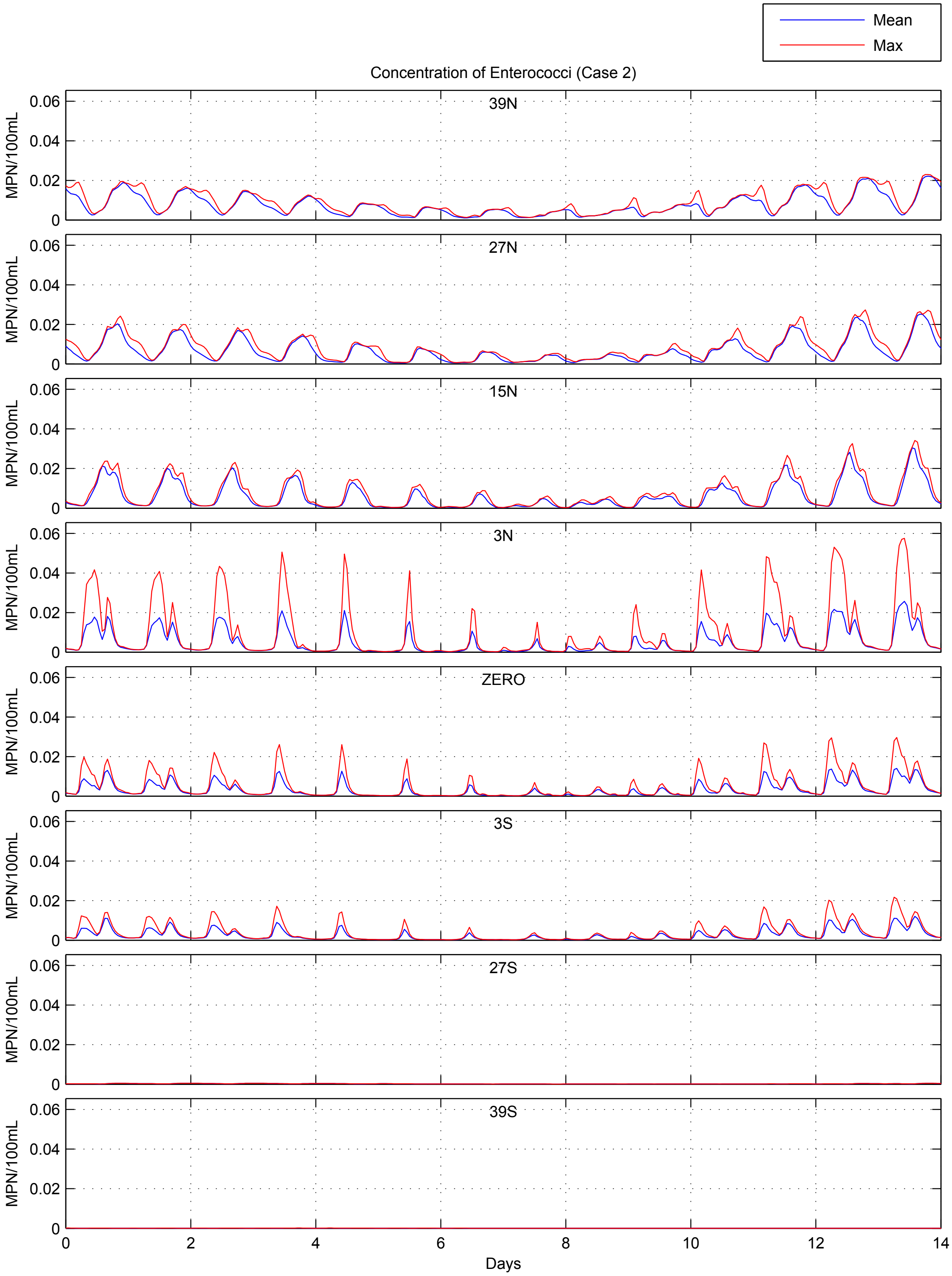

Figure B-98: Concentration of Enterococci for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

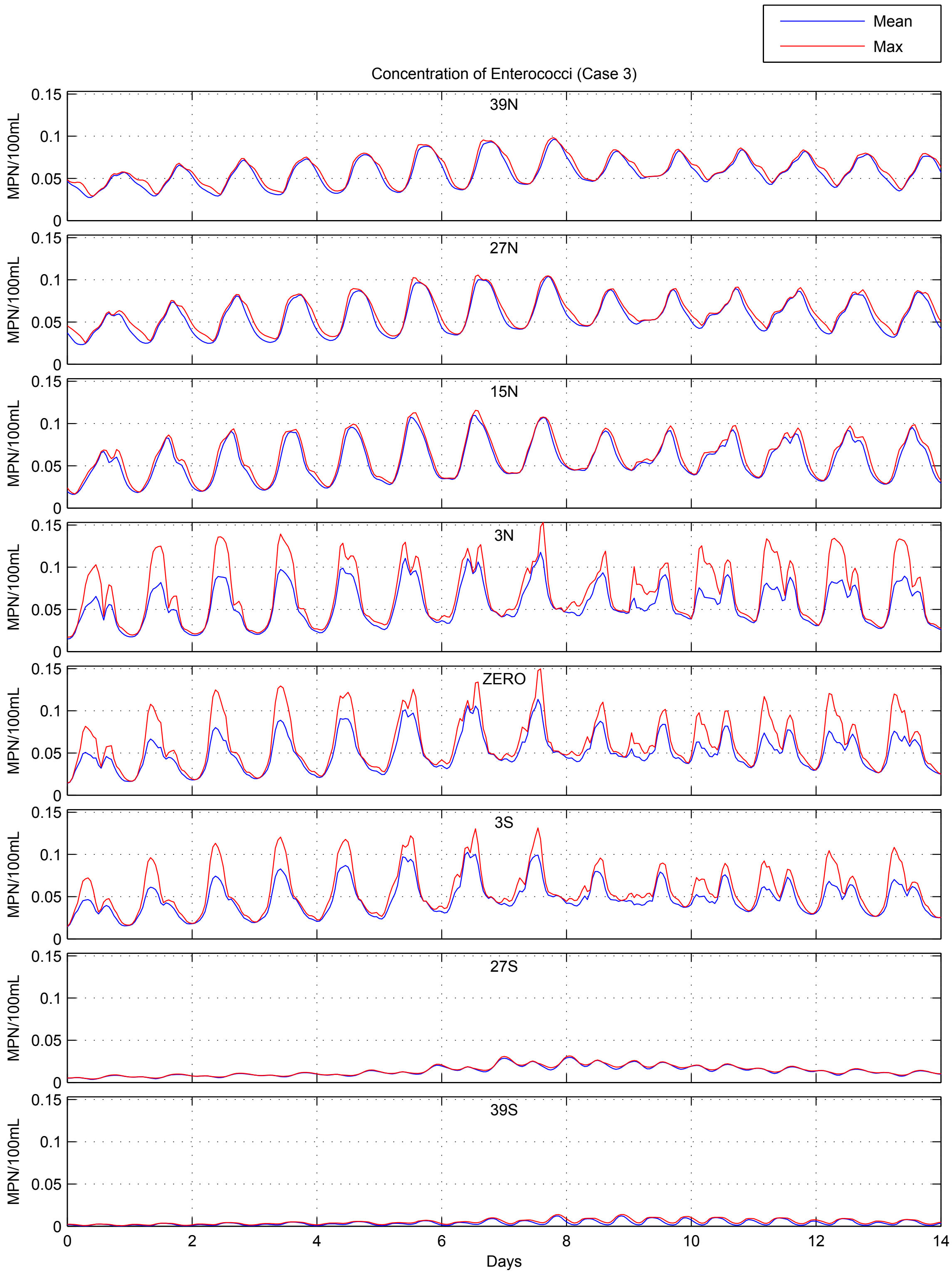

Figure B-99: Concentration of Enterococci for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

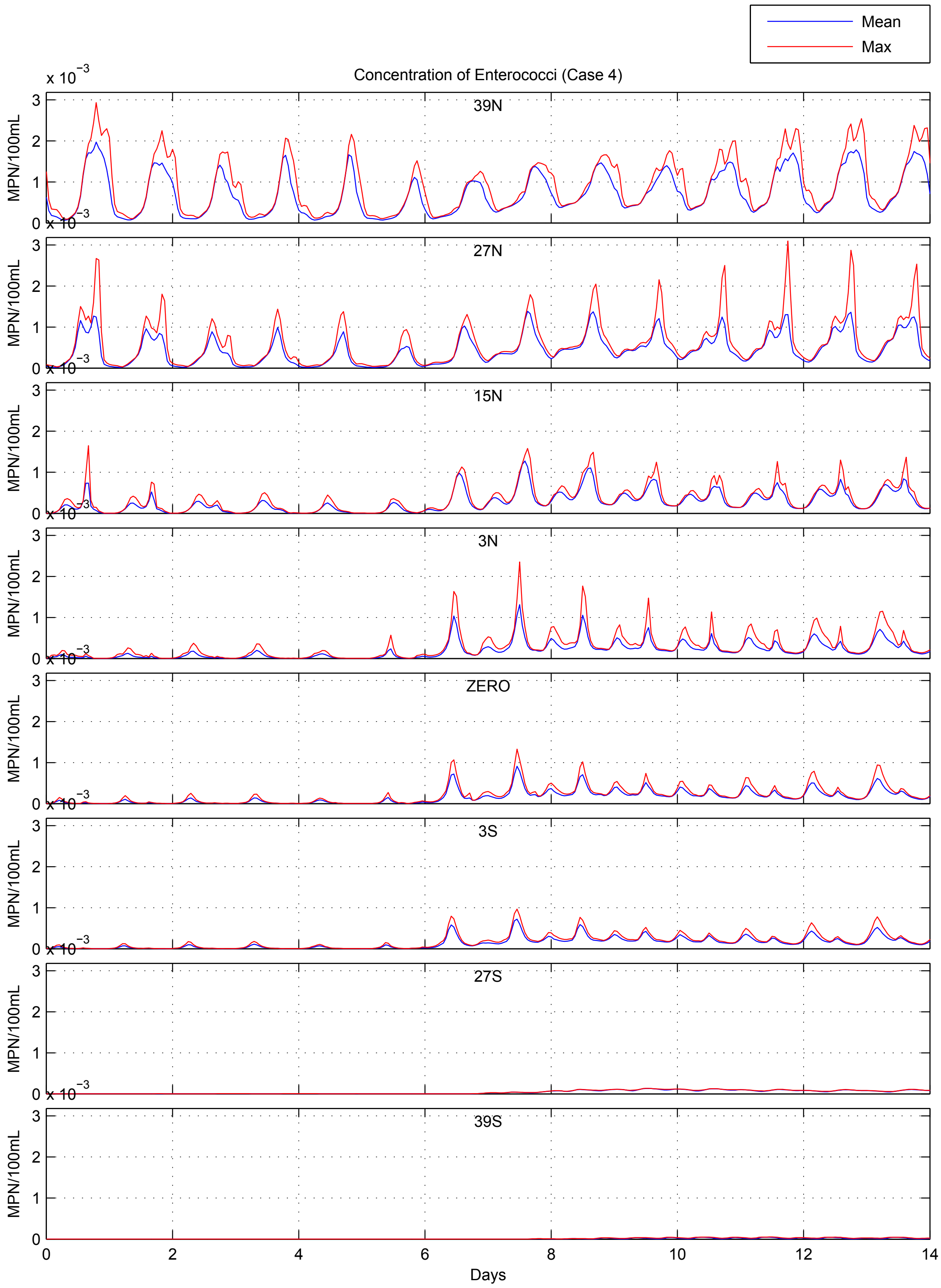

Figure B-100: Concentration of Enterococci for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

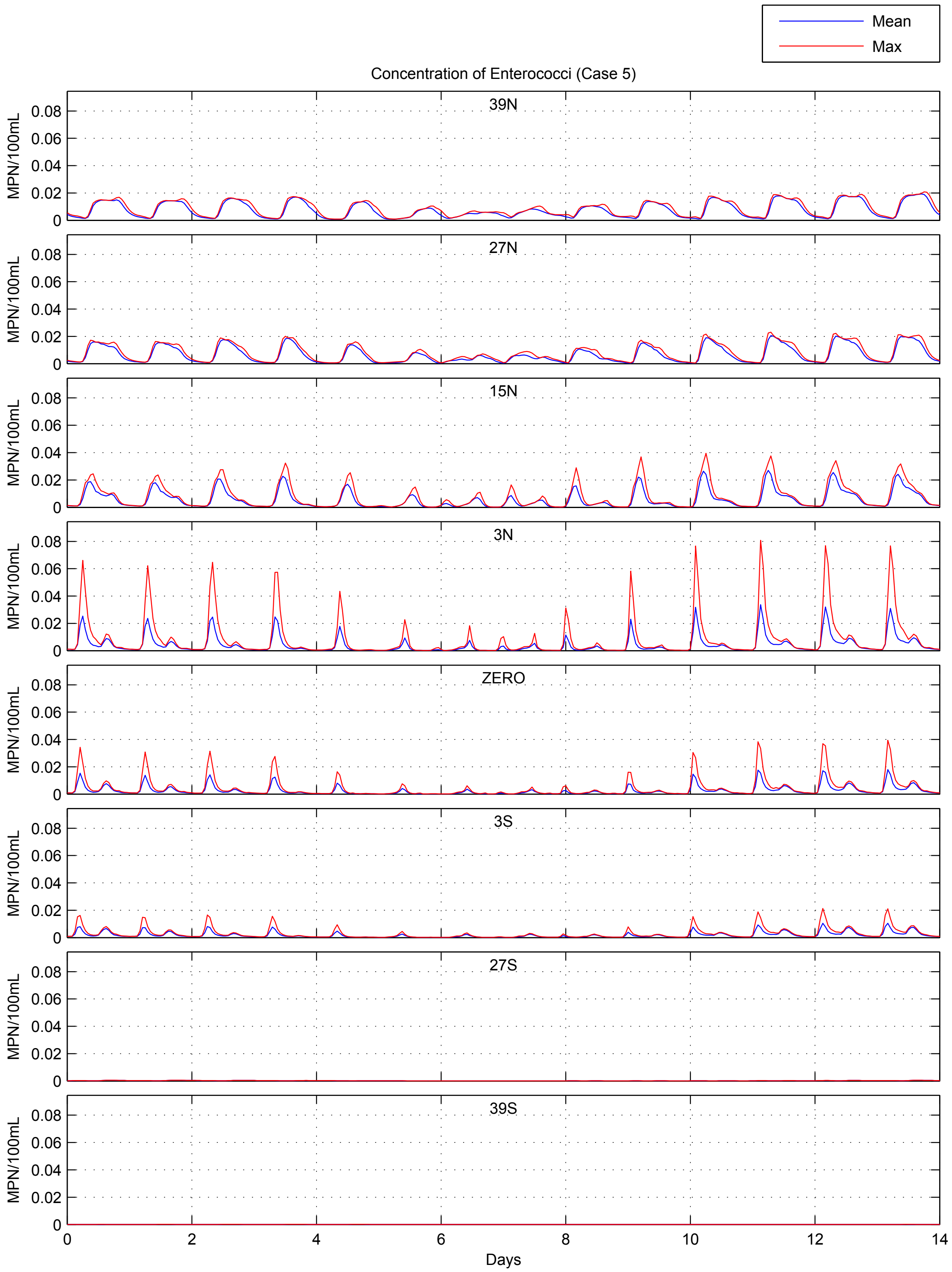

Figure B-101: Concentration of Enterococci for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

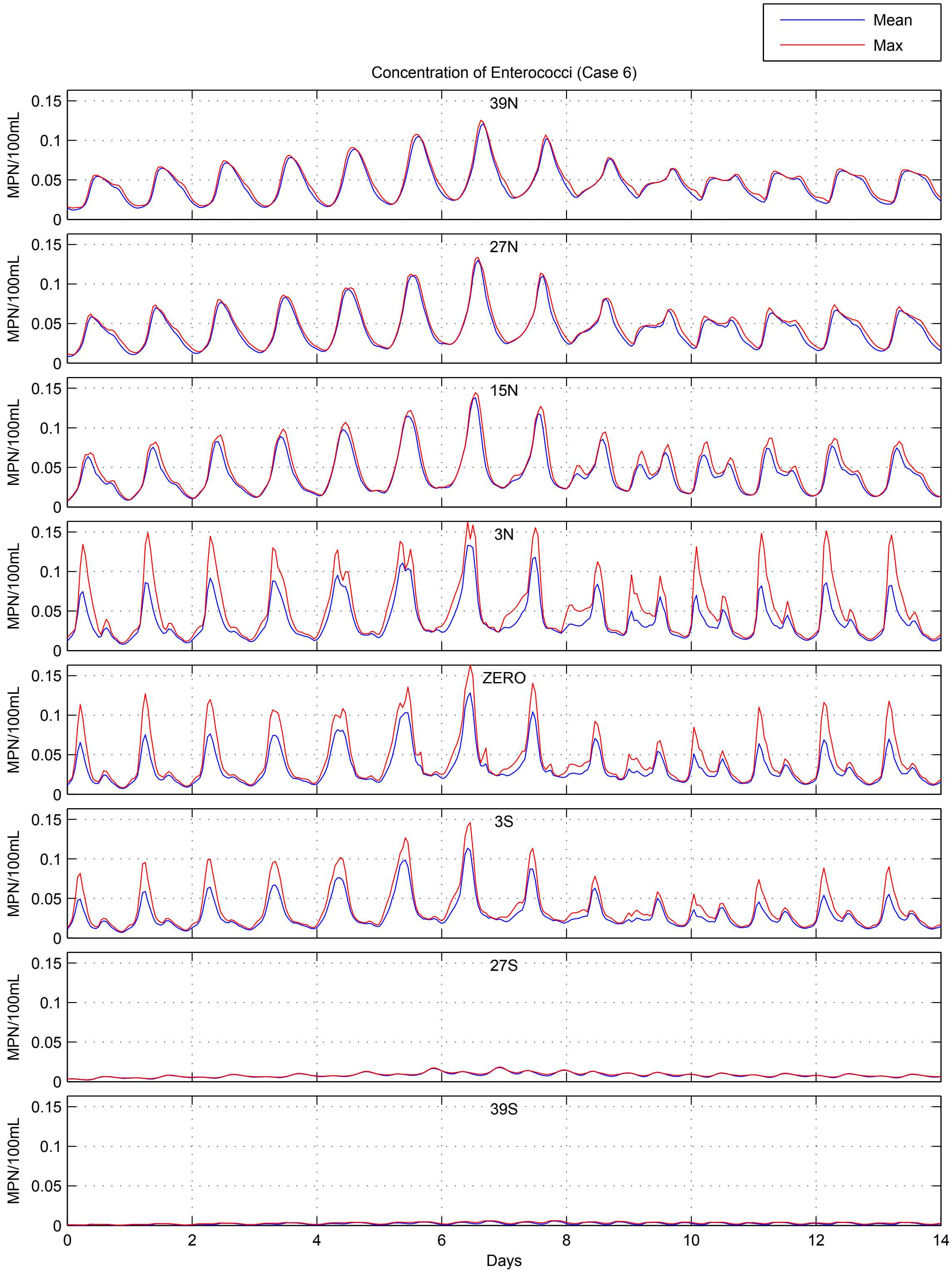

Figure B-102: Concentration of Enterococci for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

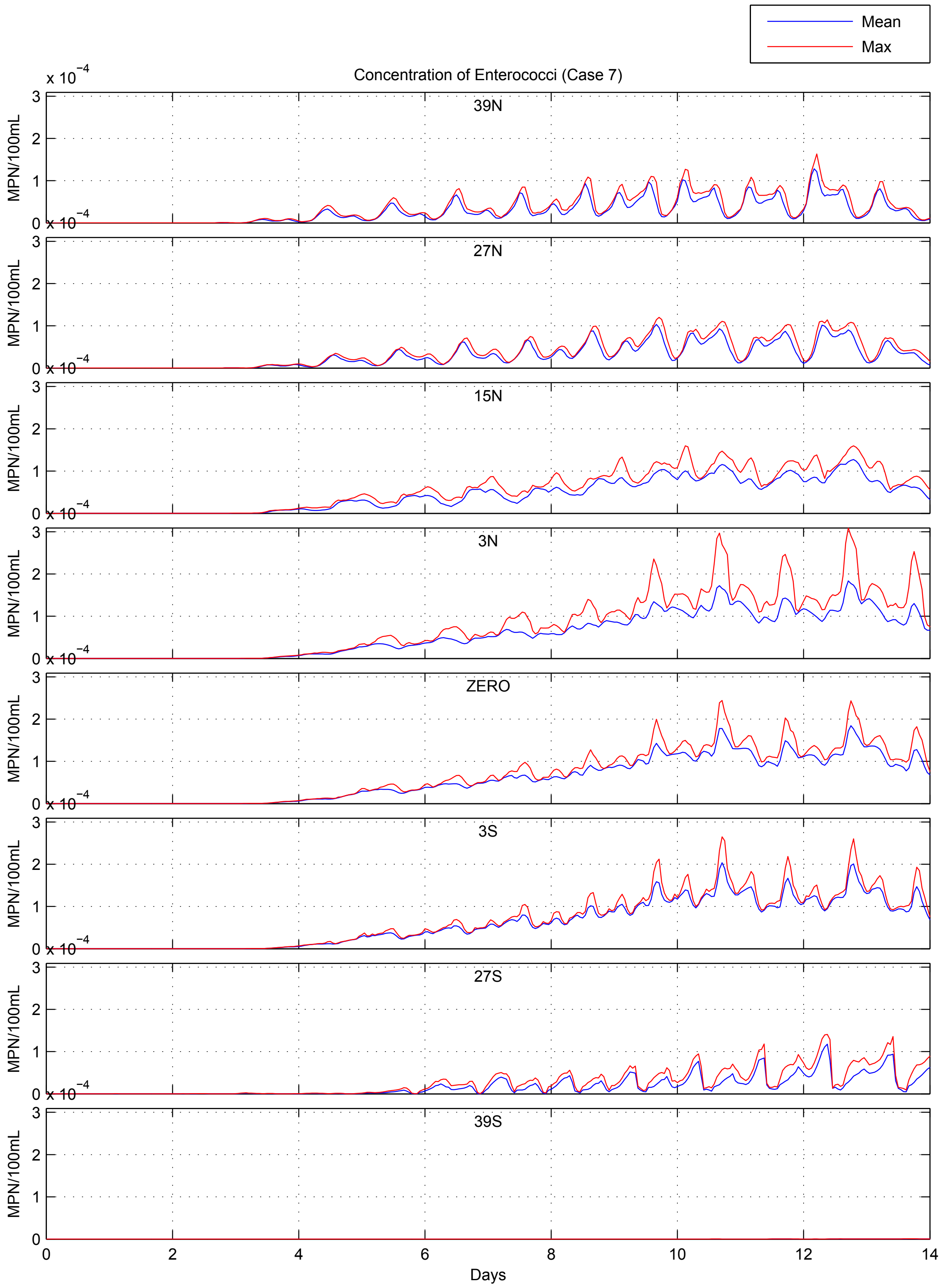

Figure B-103: Concentration of Enterococci for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

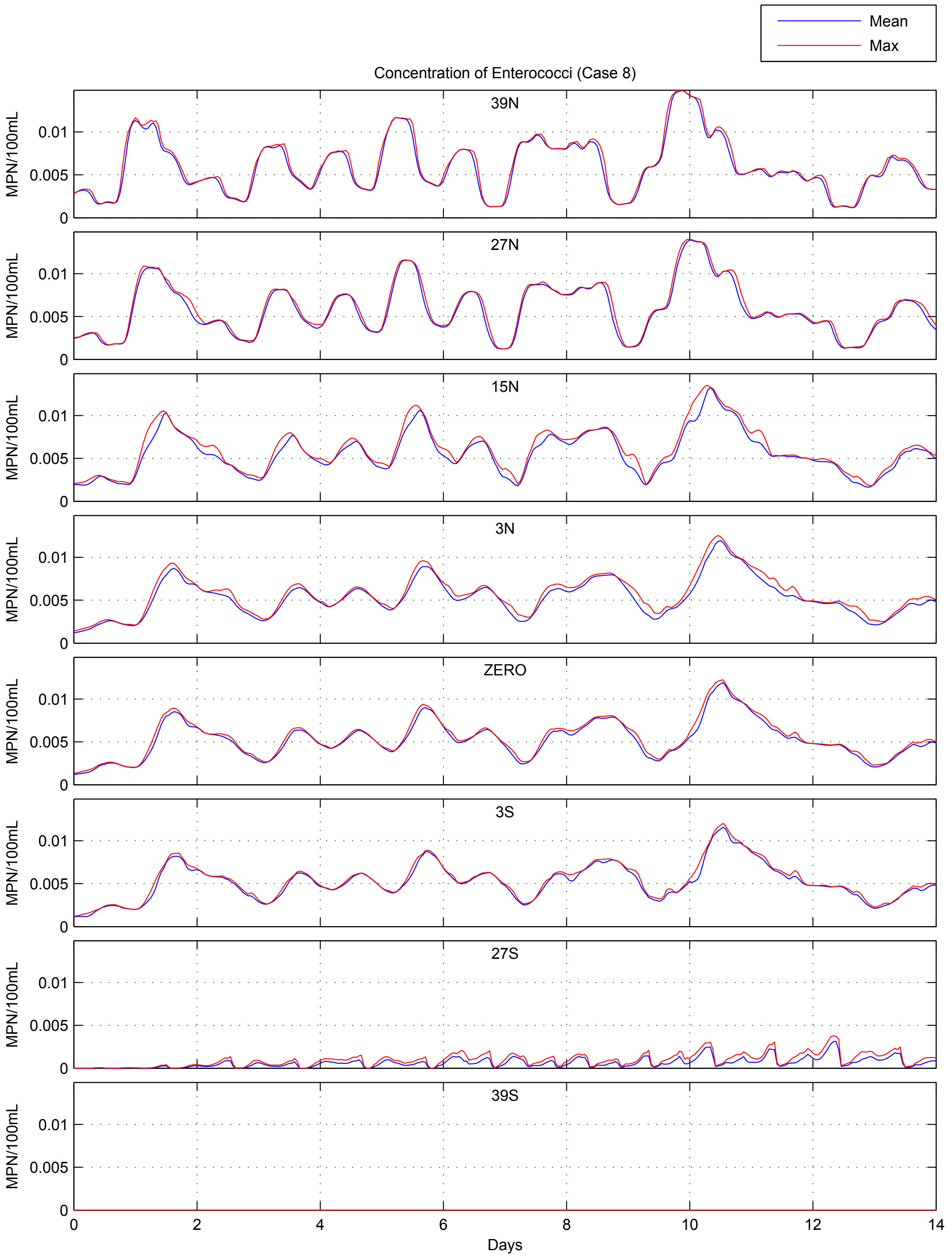

Figure B-104: Concentration of Enterococci for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

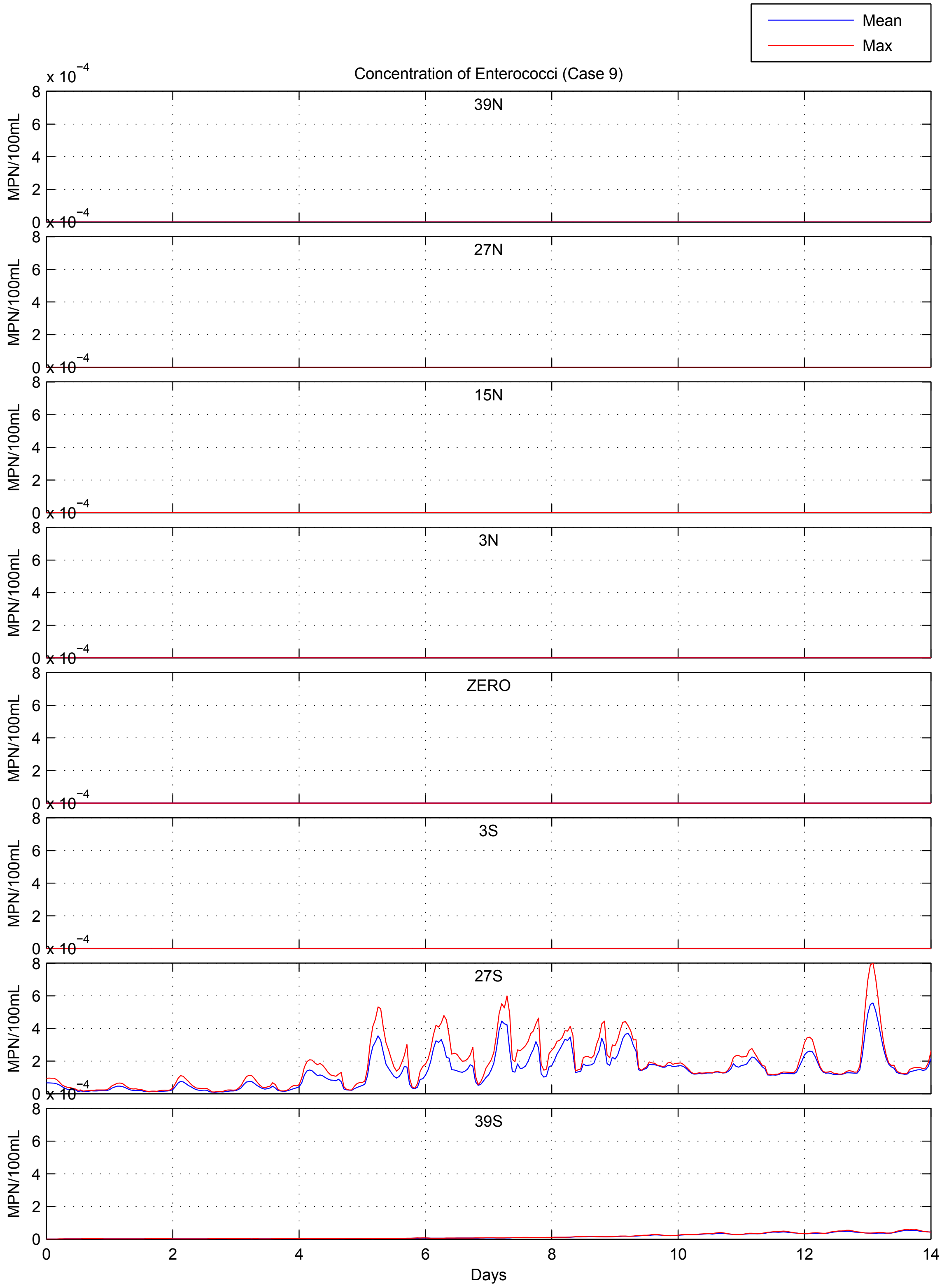

Figure B-105: Concentration of Enterococci for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

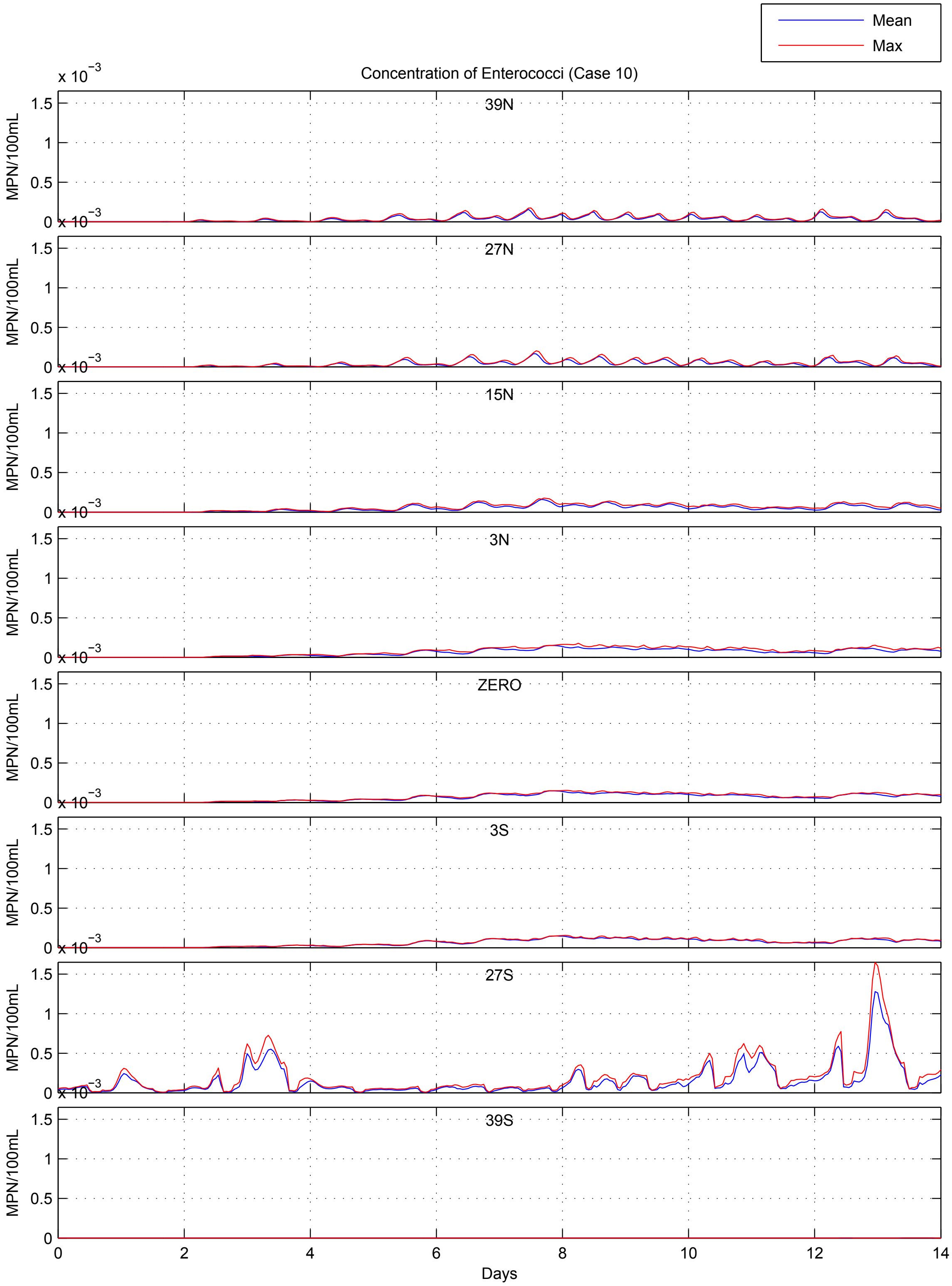

Figure B-106: Concentration of Enterococci for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

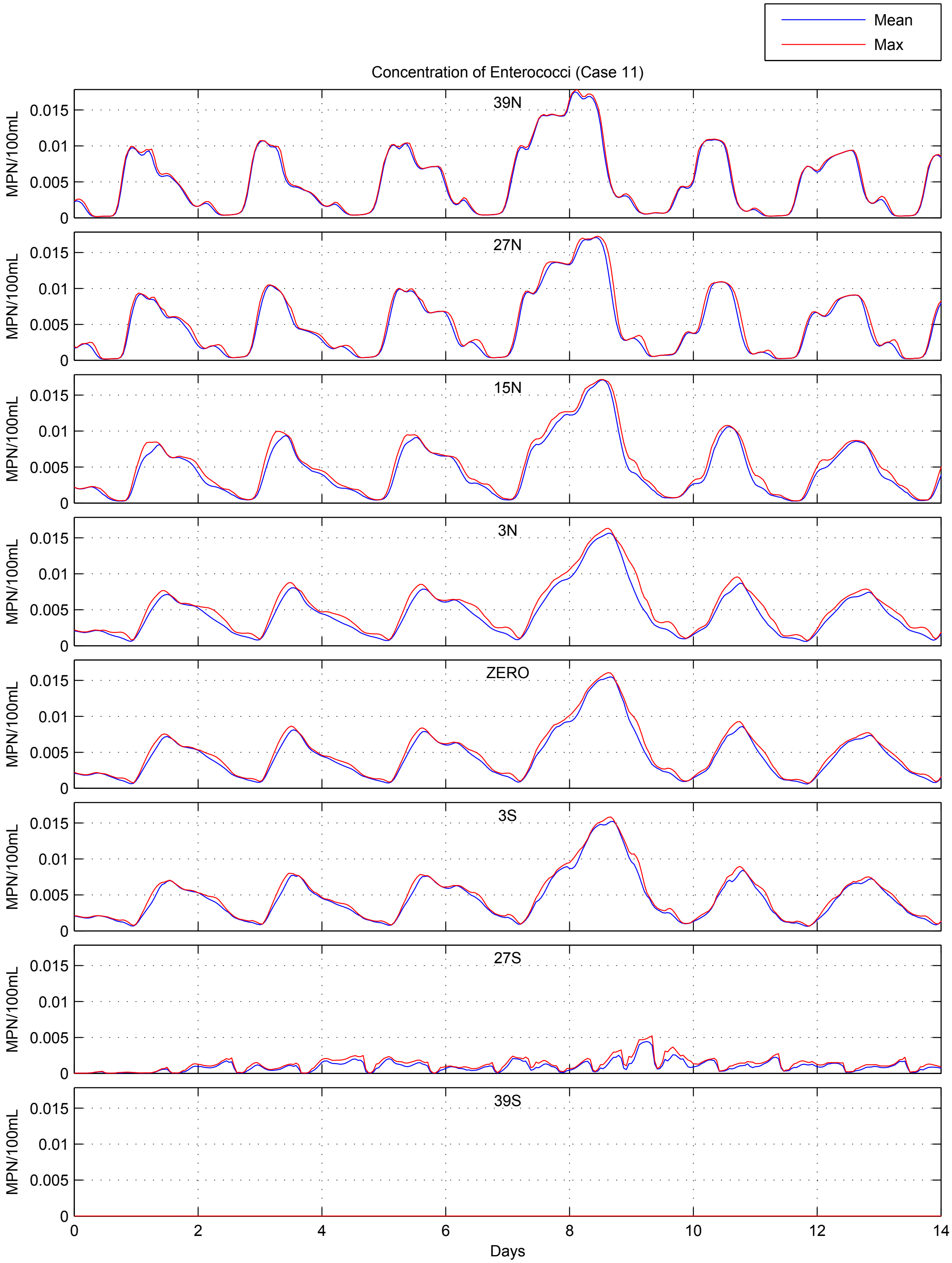

Figure B-107: Concentration of Enterococci for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

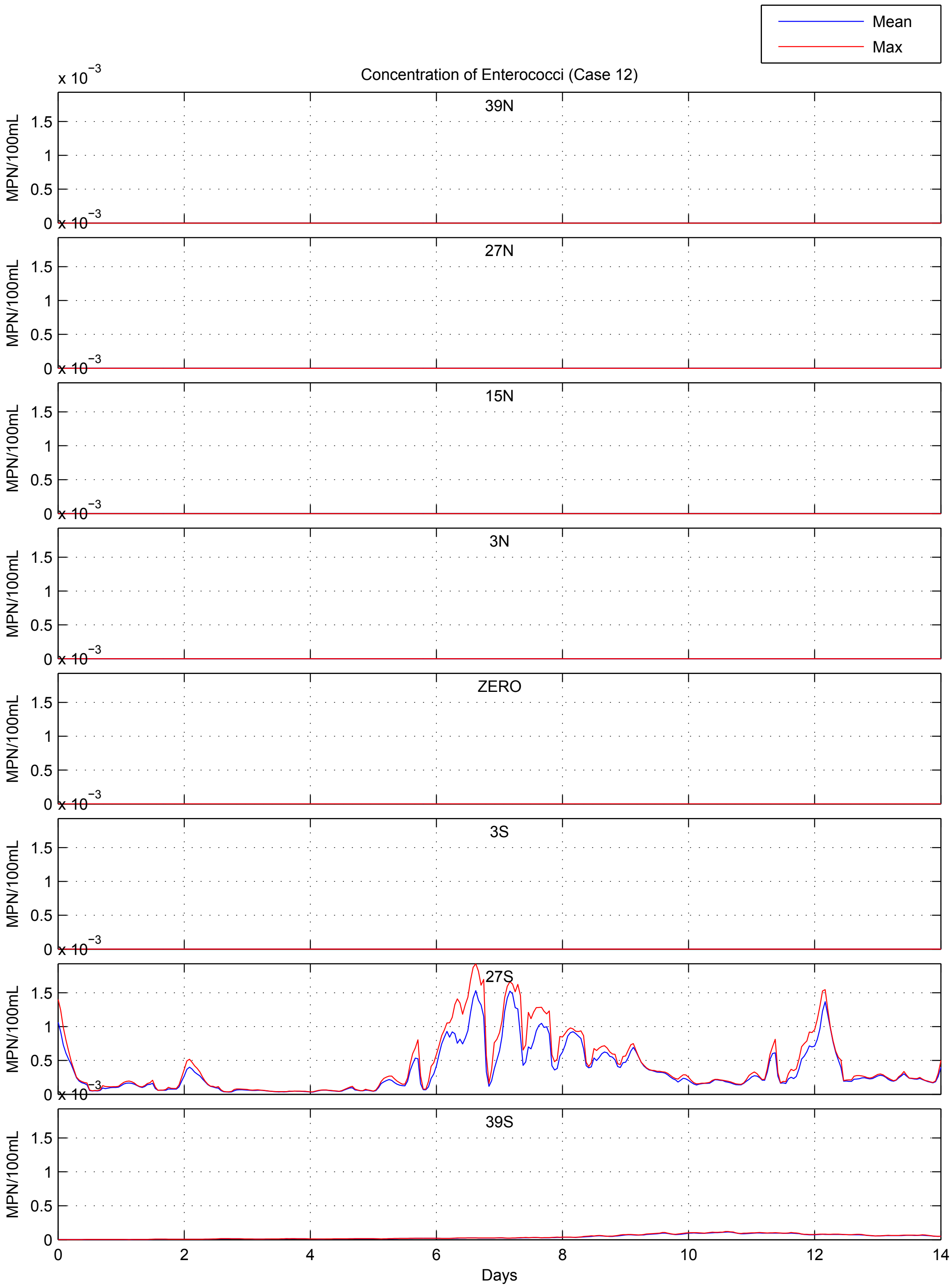

Figure B-108: Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

APPENDIX C

MODELED PLUME DISTRIBUTION MAPS AND TIME SERIES OF CONCENTRATIONS FROM 3D SIMULATIONS

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Figure C-9: Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

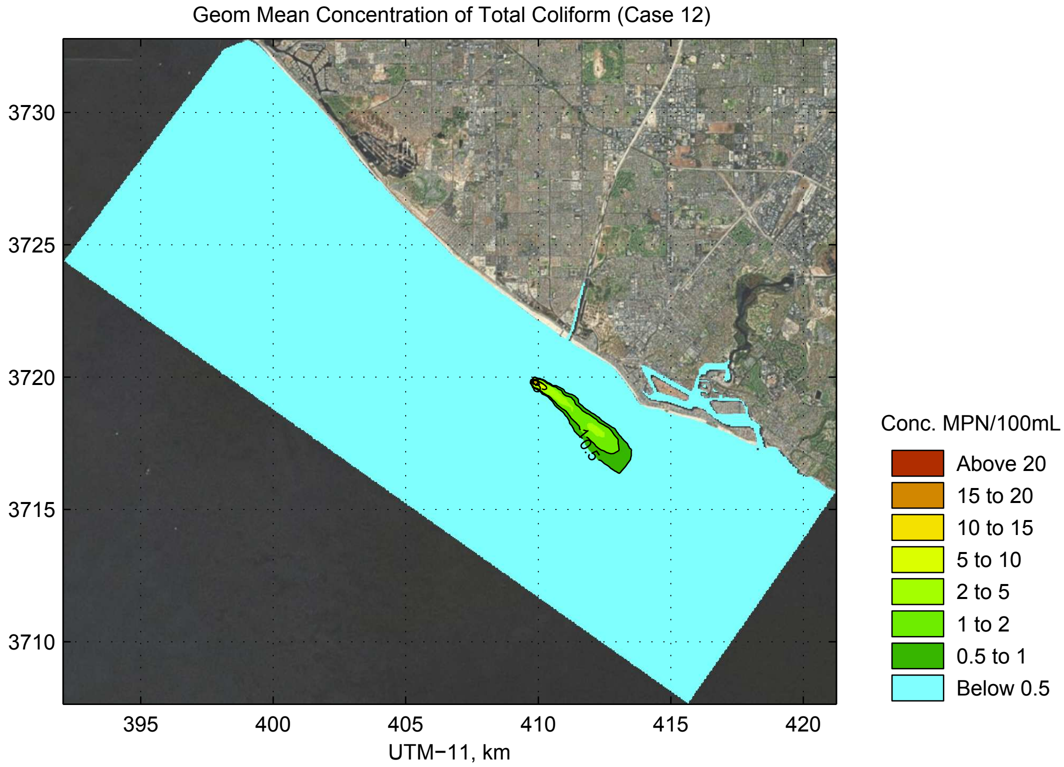

Figure C-1: Geom Mean Concentration of Total Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

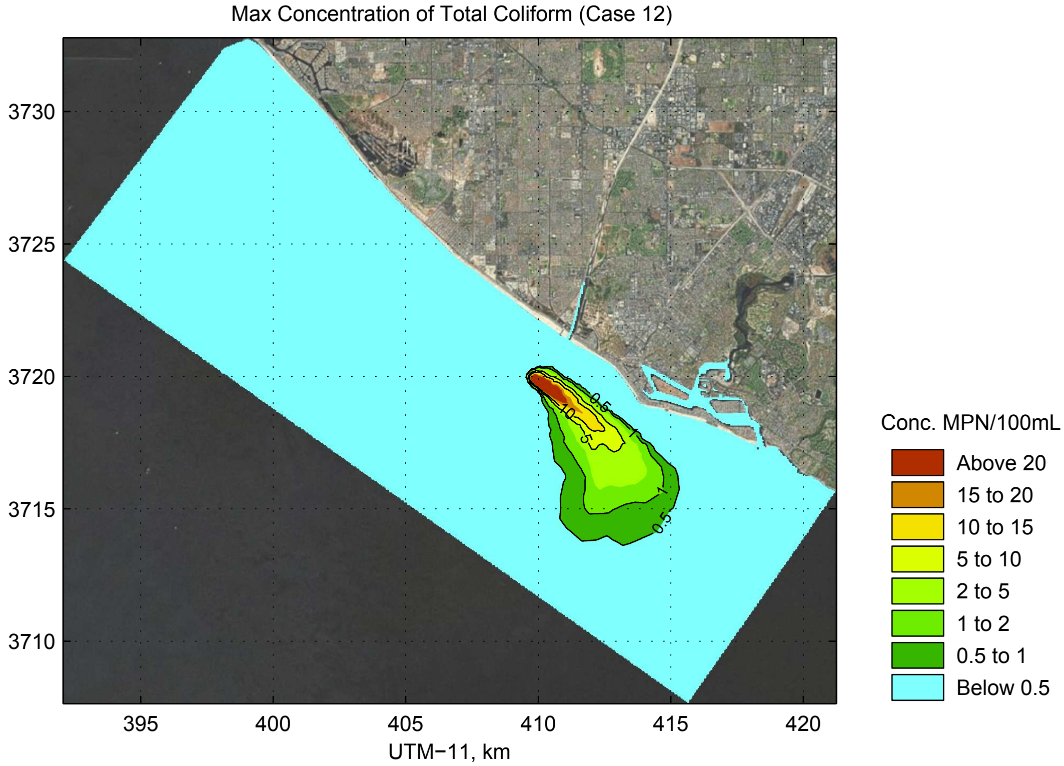

Figure C-2: Max Concentration of Total Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

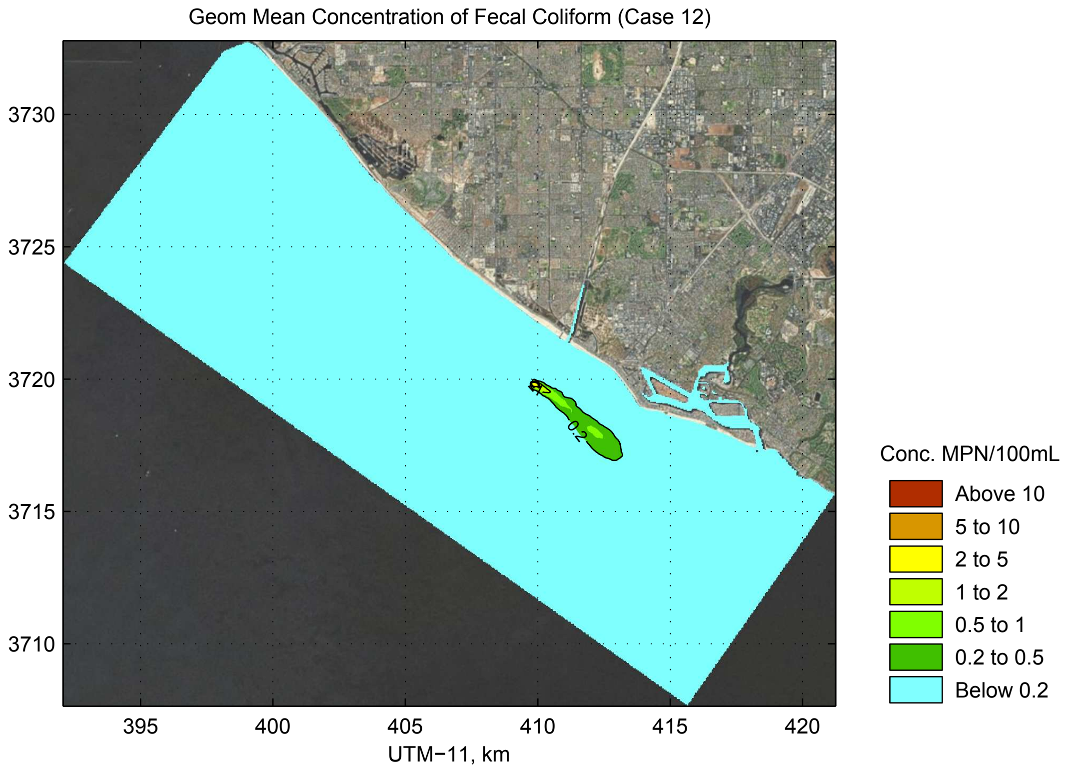

Figure C-3: Geom Mean Concentration of Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

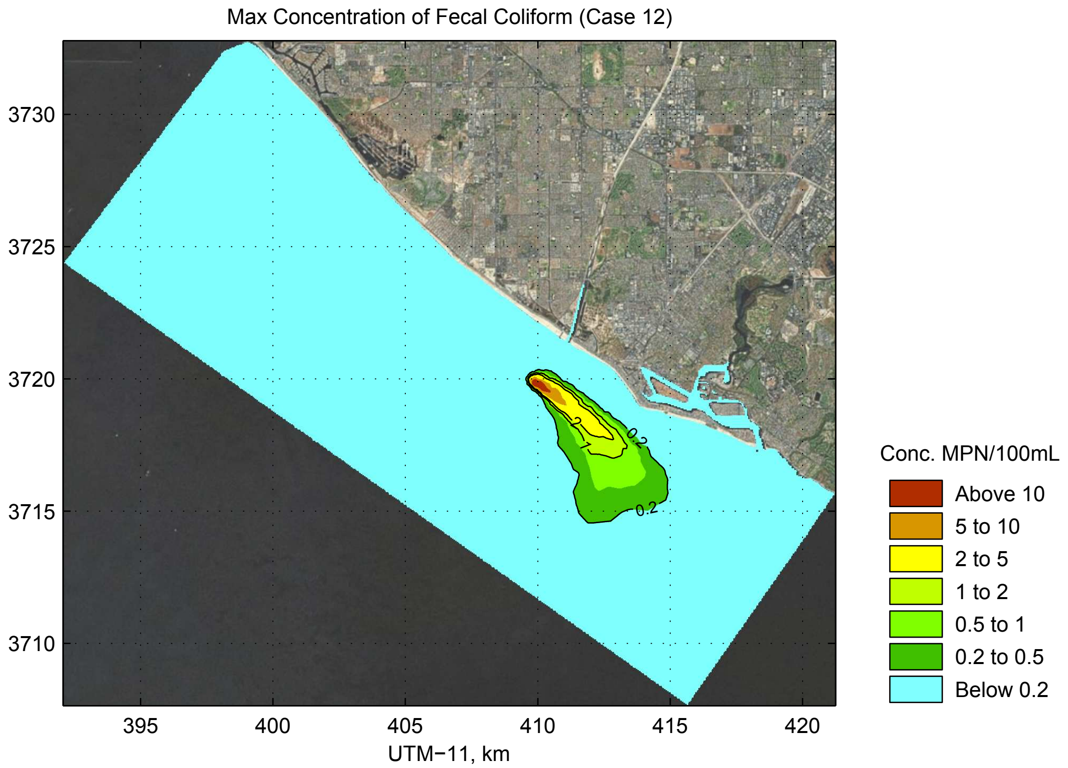

Figure C-4: Max Concentration of Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

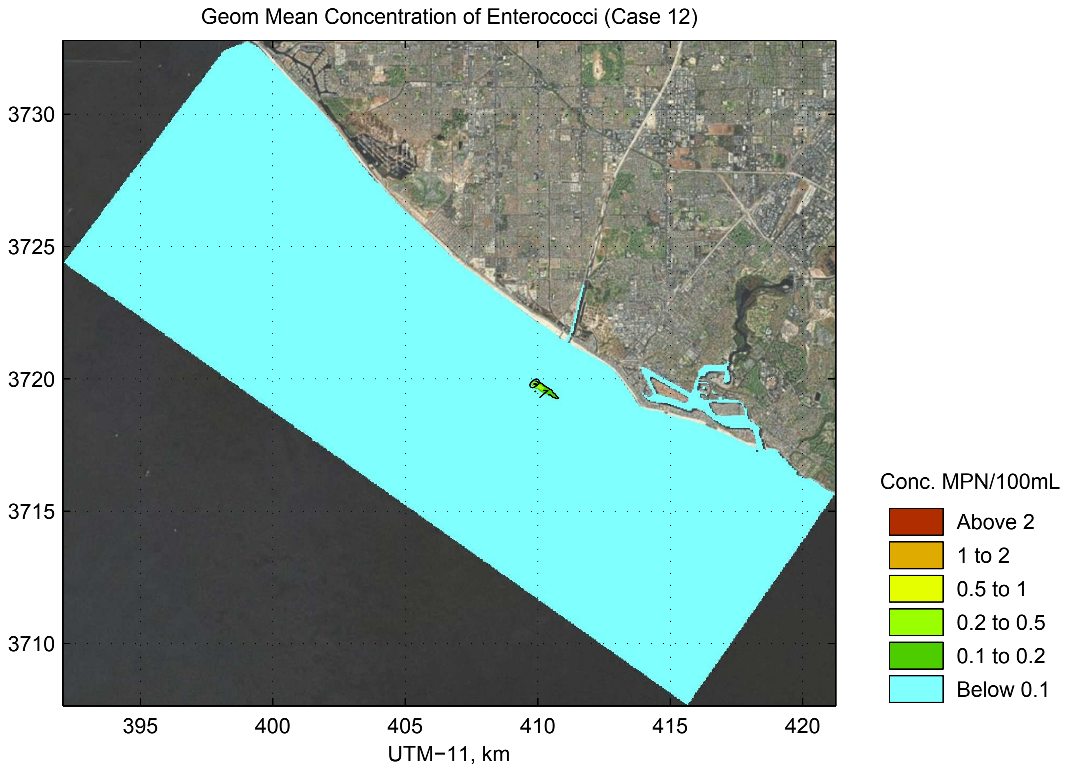
Geom Mean Concentration of Enterococci (Case 12)

Figure C-5: Geom Mean Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

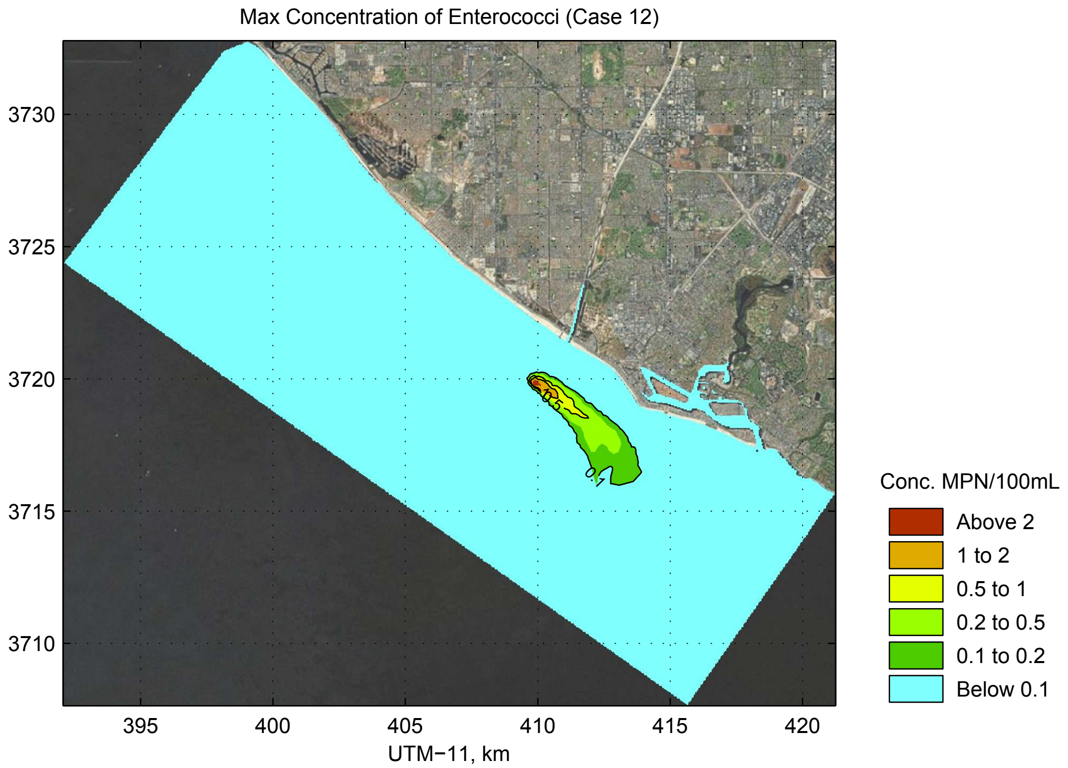
Max Concentration of Enterococci (Case 12)

Figure C-6: Max Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

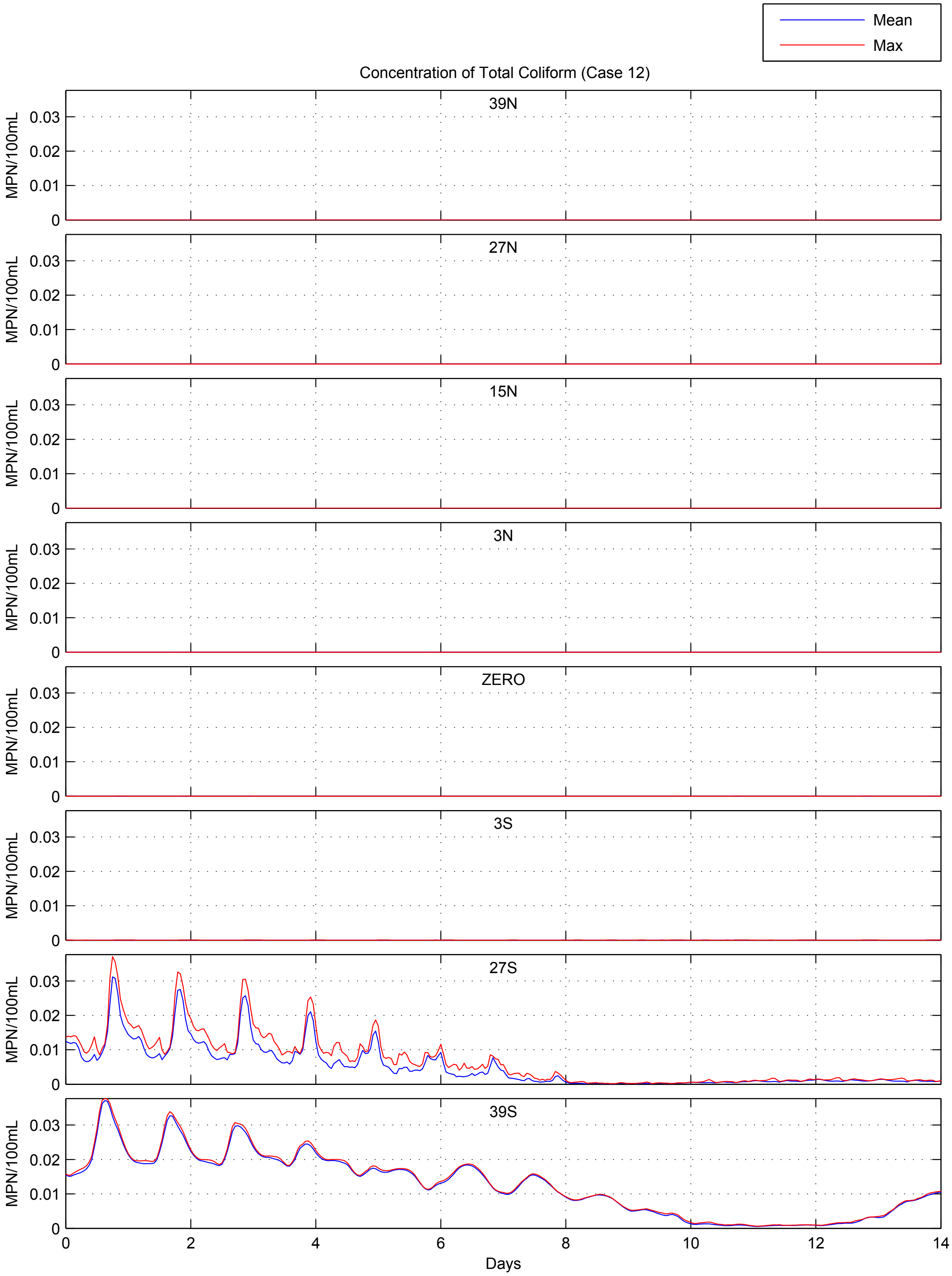

Figure C-7: Concentration of Total Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

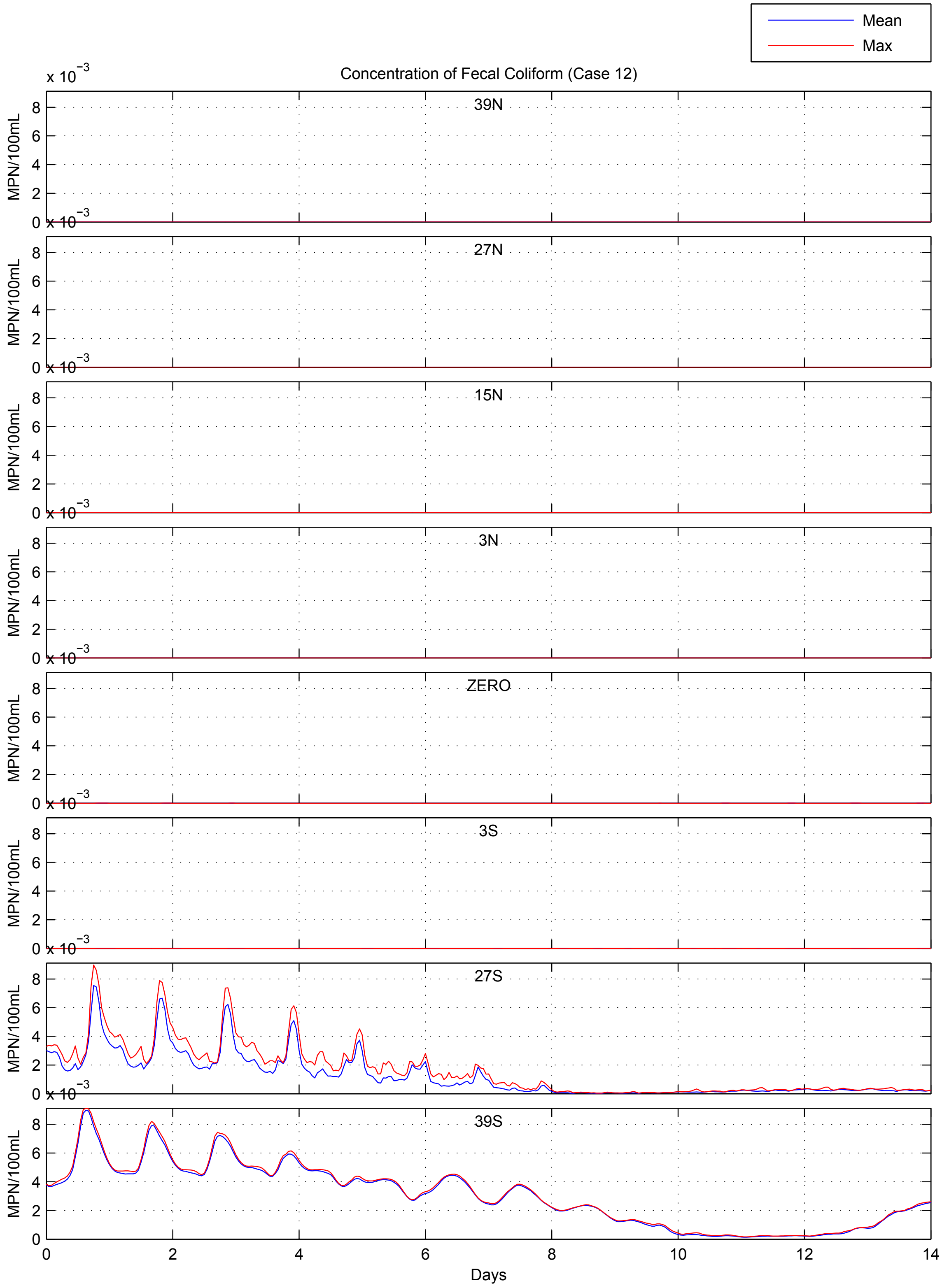

Figure C-8: Concentration of Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

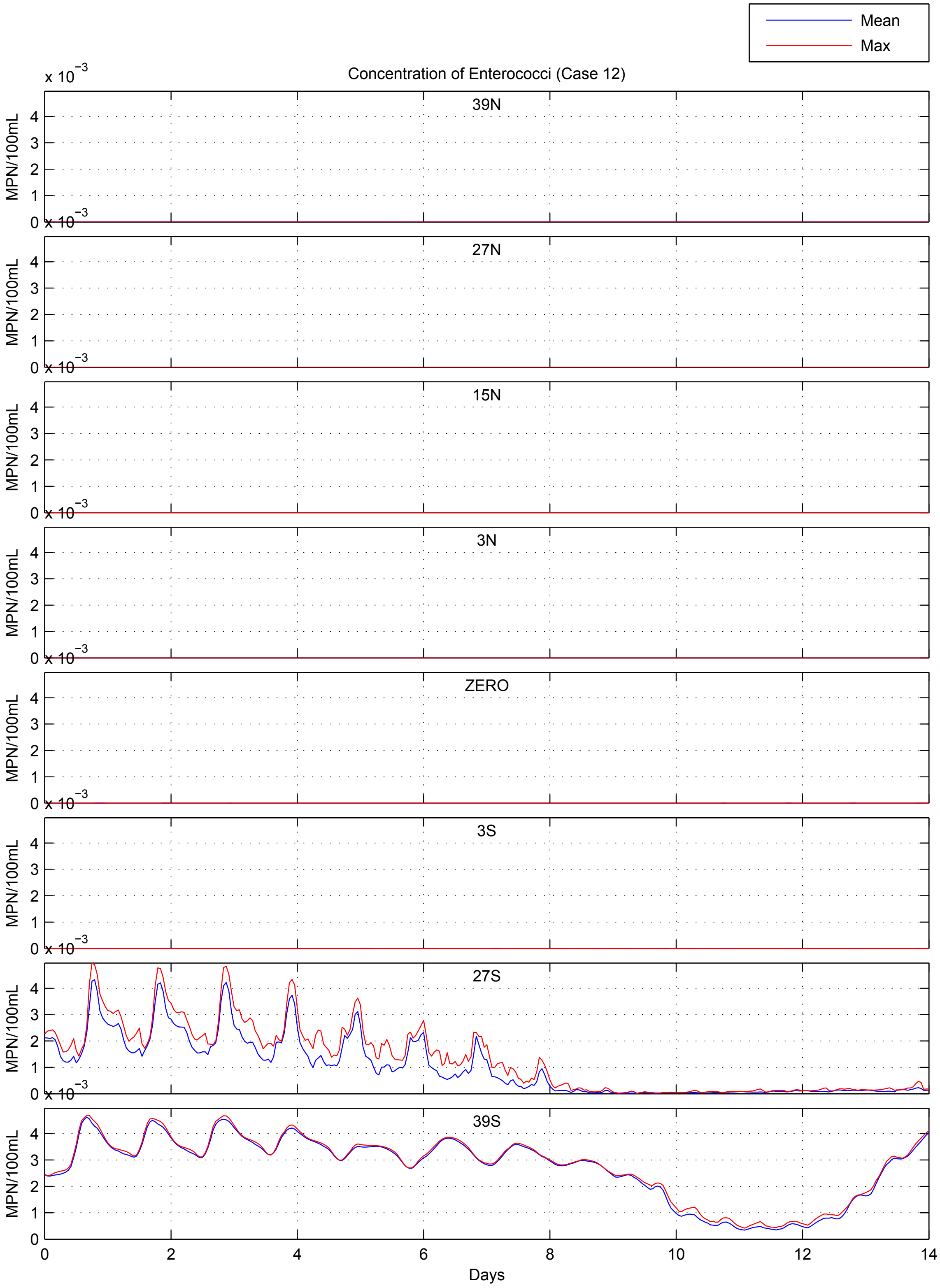

Figure C-9: Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

APPENDIX D

MODELED PLUME DISTRIBUTION MAPS AND TIME SERIES OF RELATIVE CONCENTRATIONS FROM 2D SIMULATIONS

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Figure D-60: Relative Concentration of Total/Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

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Figure D-63: Relative Concentration of Enterococci for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

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Figure D-65: Relative Concentration of Enterococci for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

Figure D-66: Relative Concentration of Enterococci for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

Figure D-67: Relative Concentration of Enterococci for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

Figure D-68: Relative Concentration of Enterococci for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

Figure D-69: Relative Concentration of Enterococci for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

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Figure D-71: Relative Concentration of Enterococci for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

Figure D-72: Relative Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

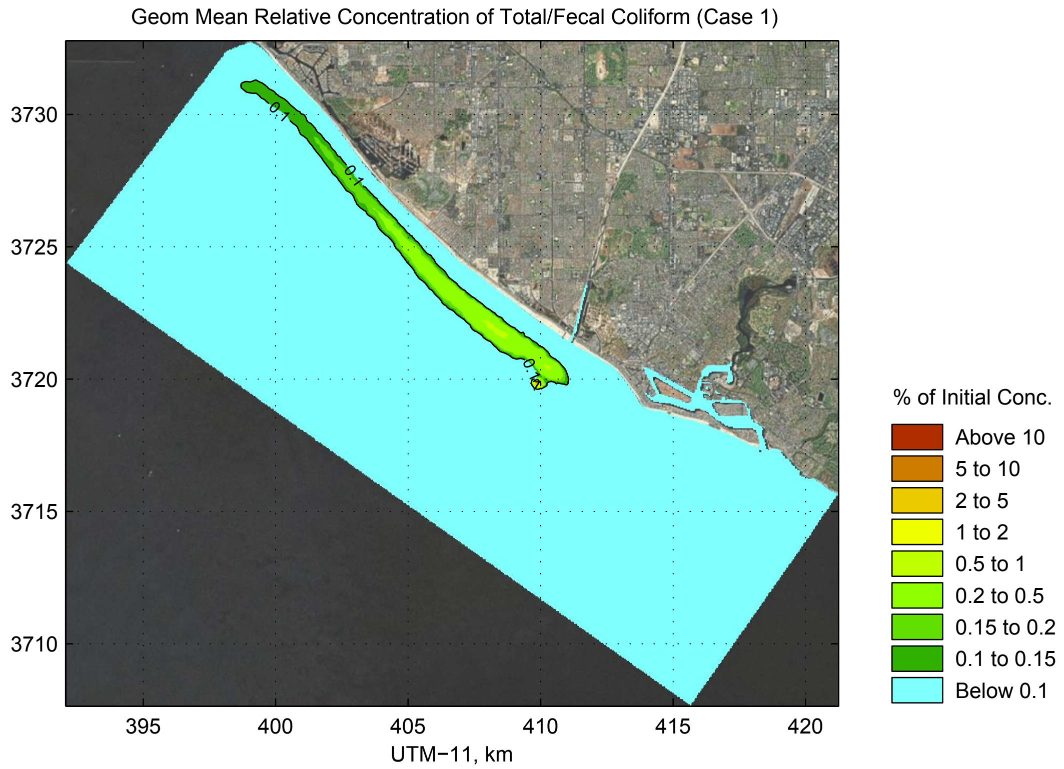


Figure D-1: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

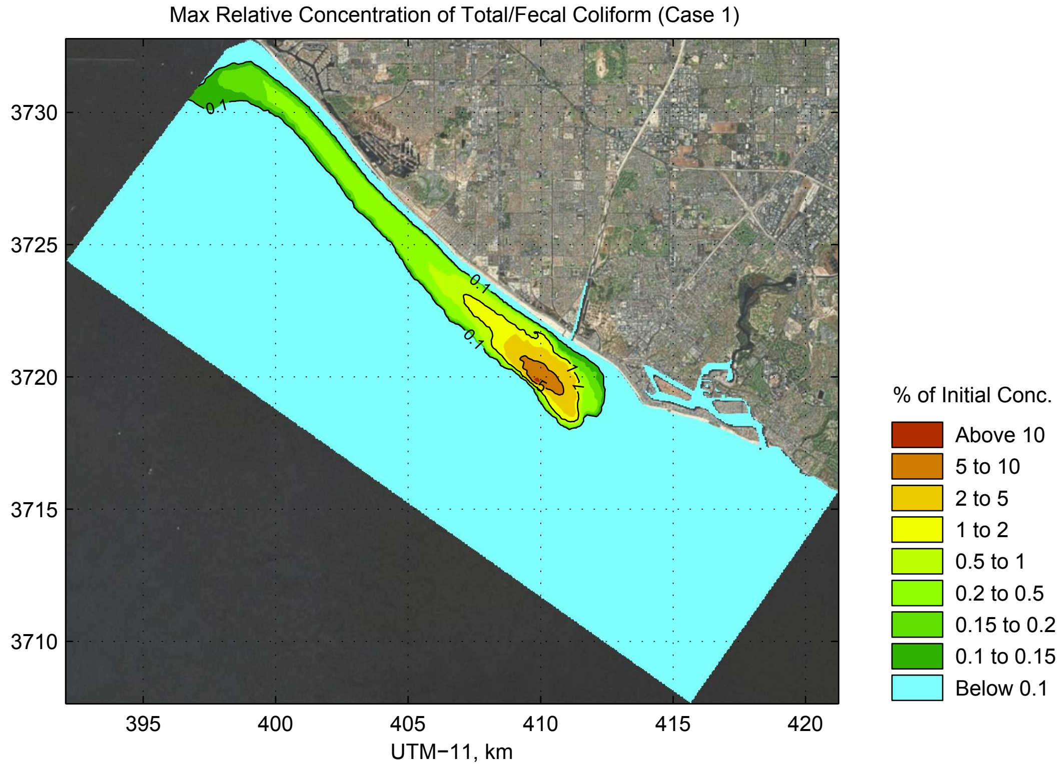


Figure D-2: Max Relative Concentration of Total/Fecal Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

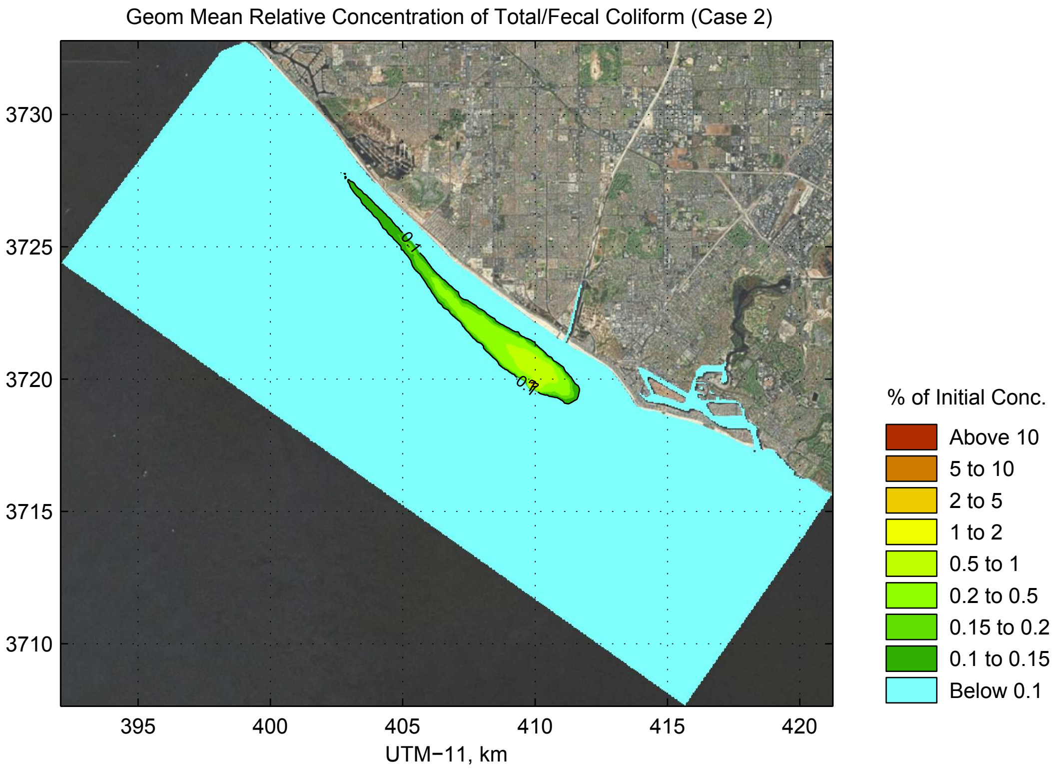

Geom Mean Relative Concentration of Total/Fecal Coliform (Case 2)

Figure D-3: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

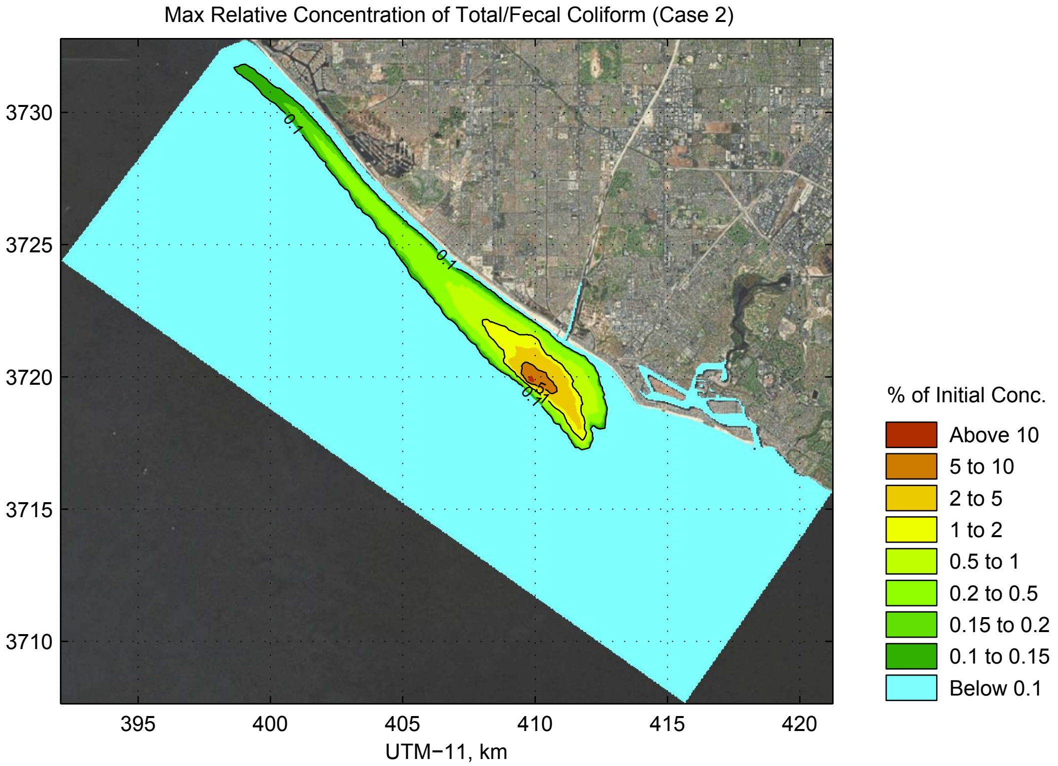

Max Relative Concentration of Total/Fecal Coliform (Case 2)

Figure D-4: Max Relative Concentration of Total/Fecal Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

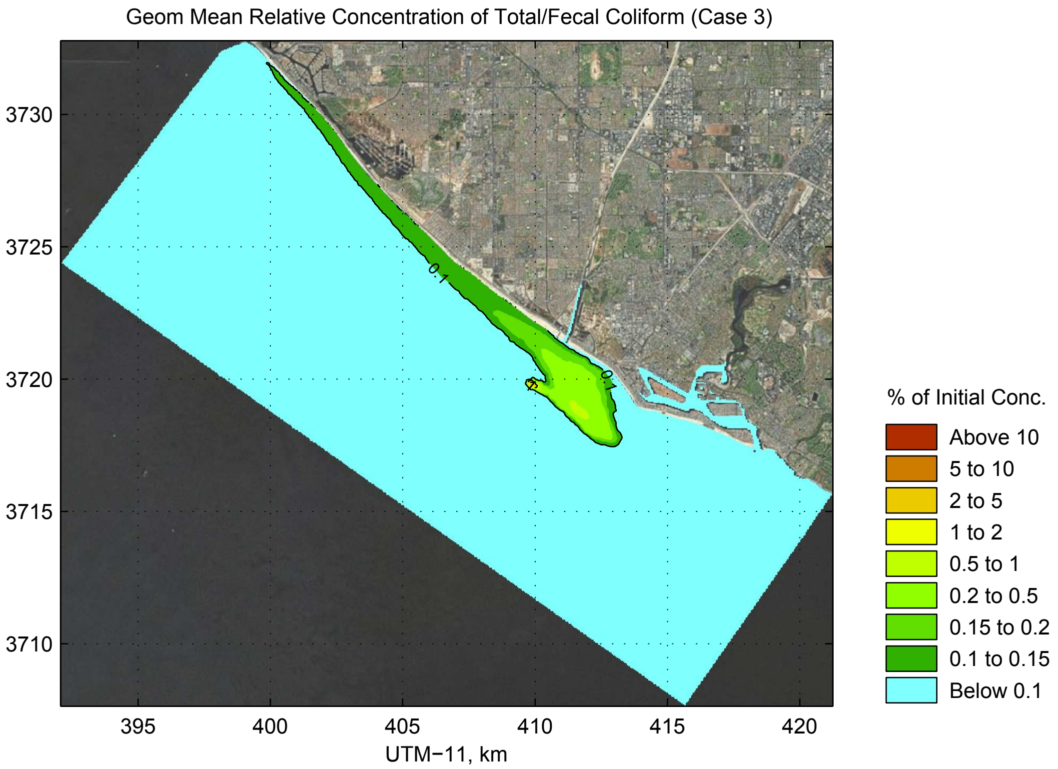


Figure D-5: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

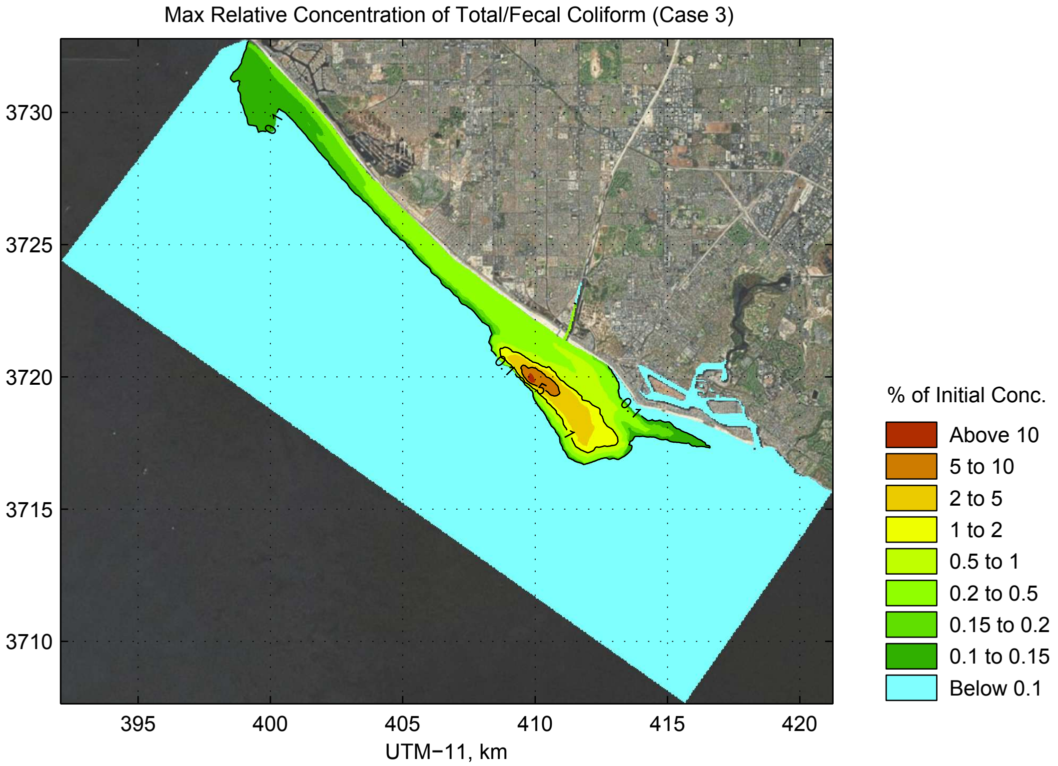


Figure D-6: Max Relative Concentration of Total/Fecal Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

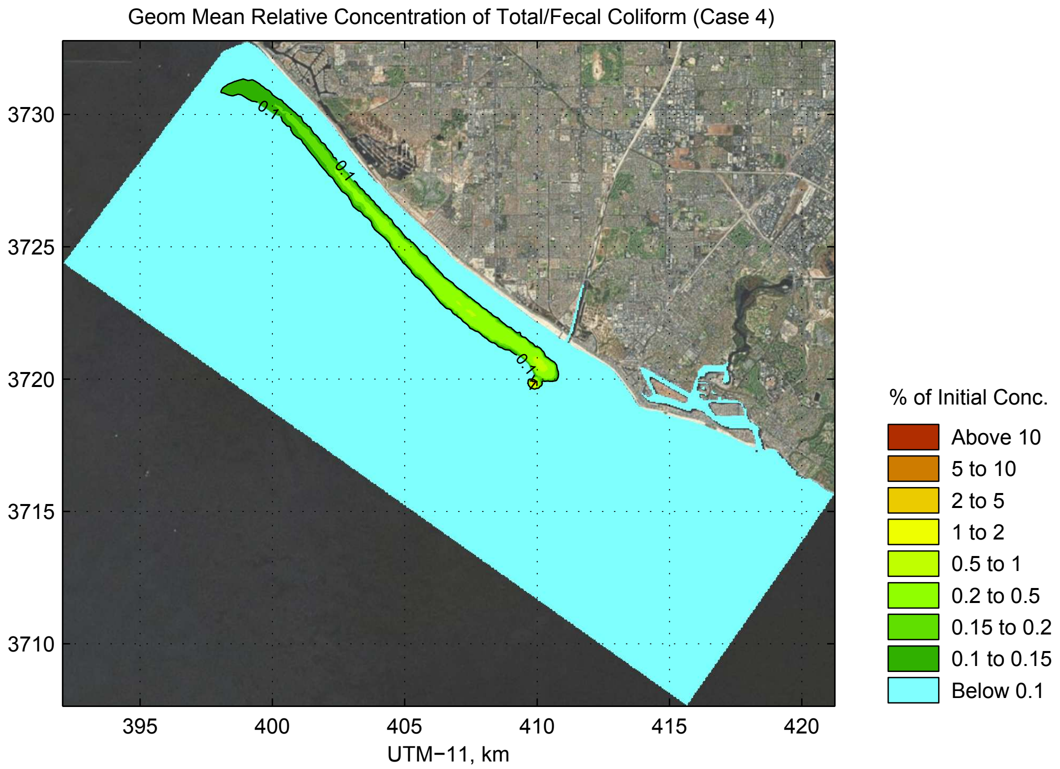


Figure D-7: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

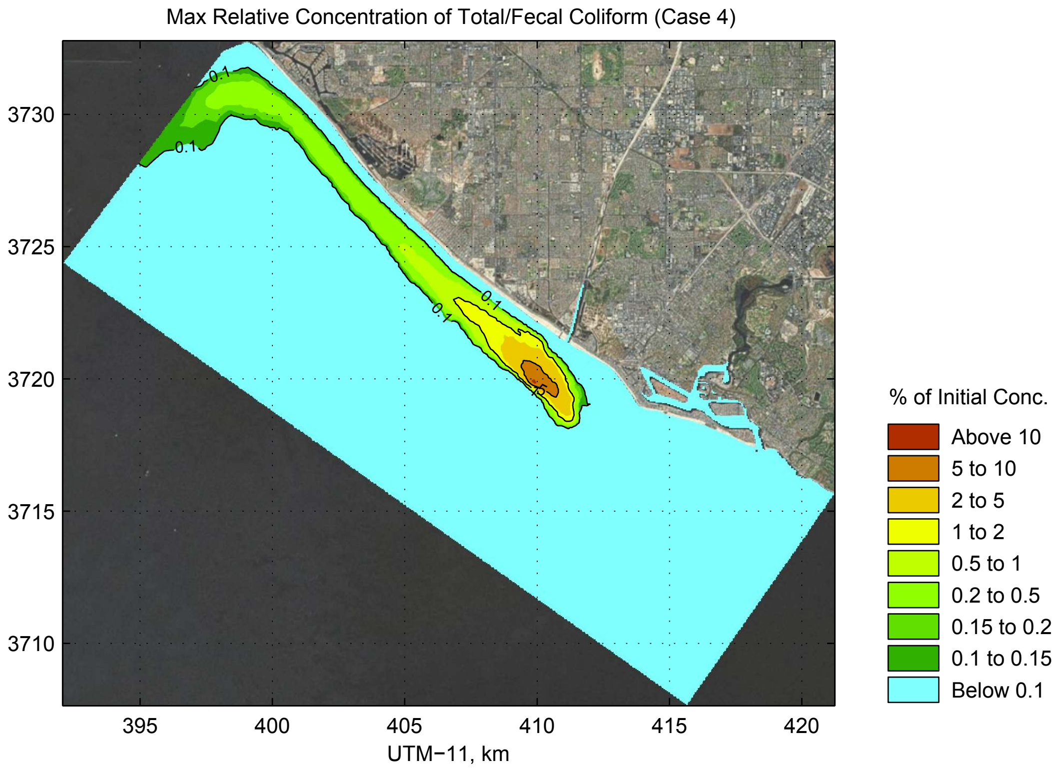


Figure D-8: Max Relative Concentration of Total/Fecal Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

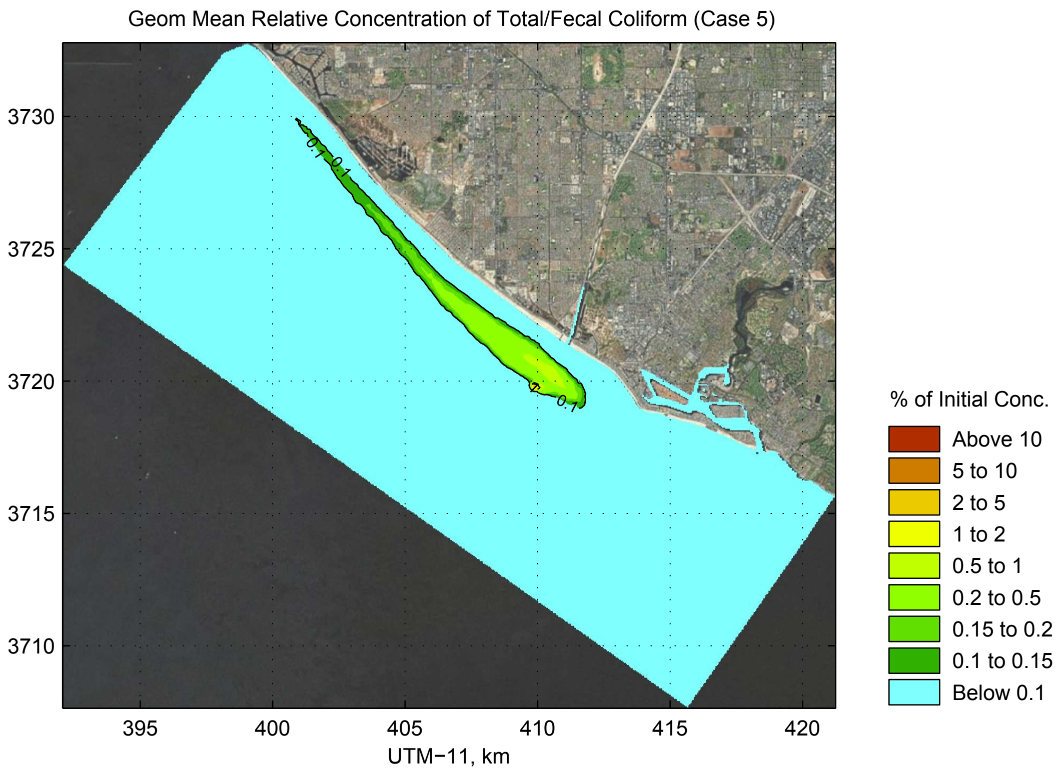


Figure D-9: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

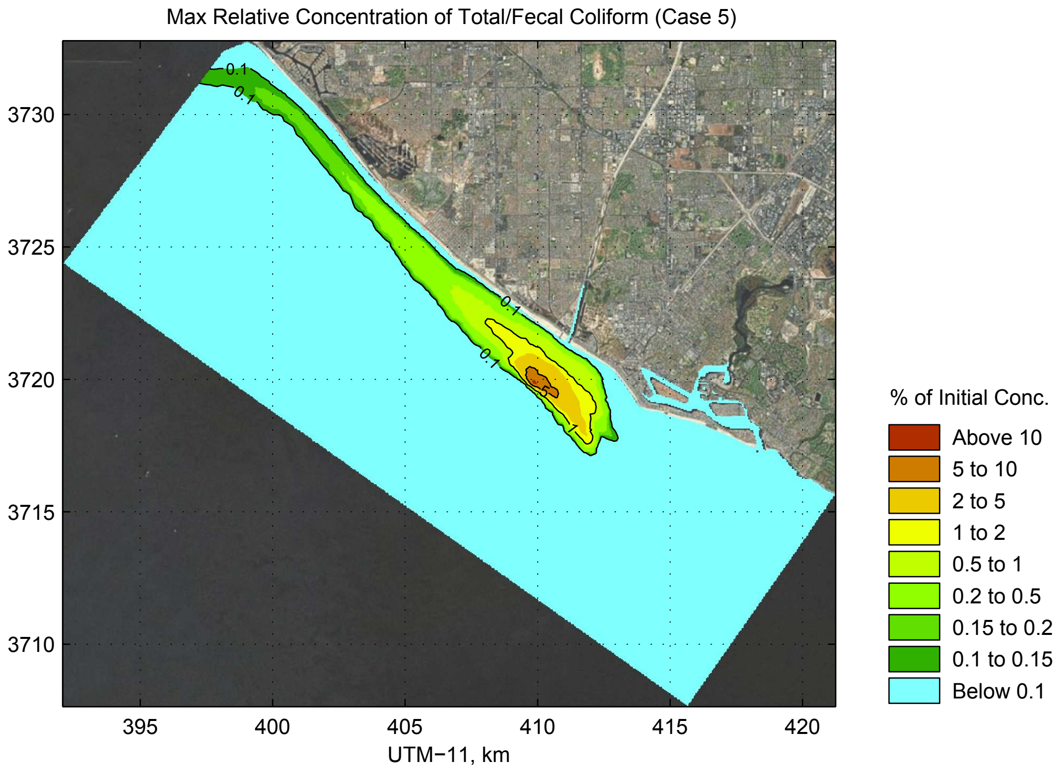


Figure D-10: Max Relative Concentration of Total/Fecal Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

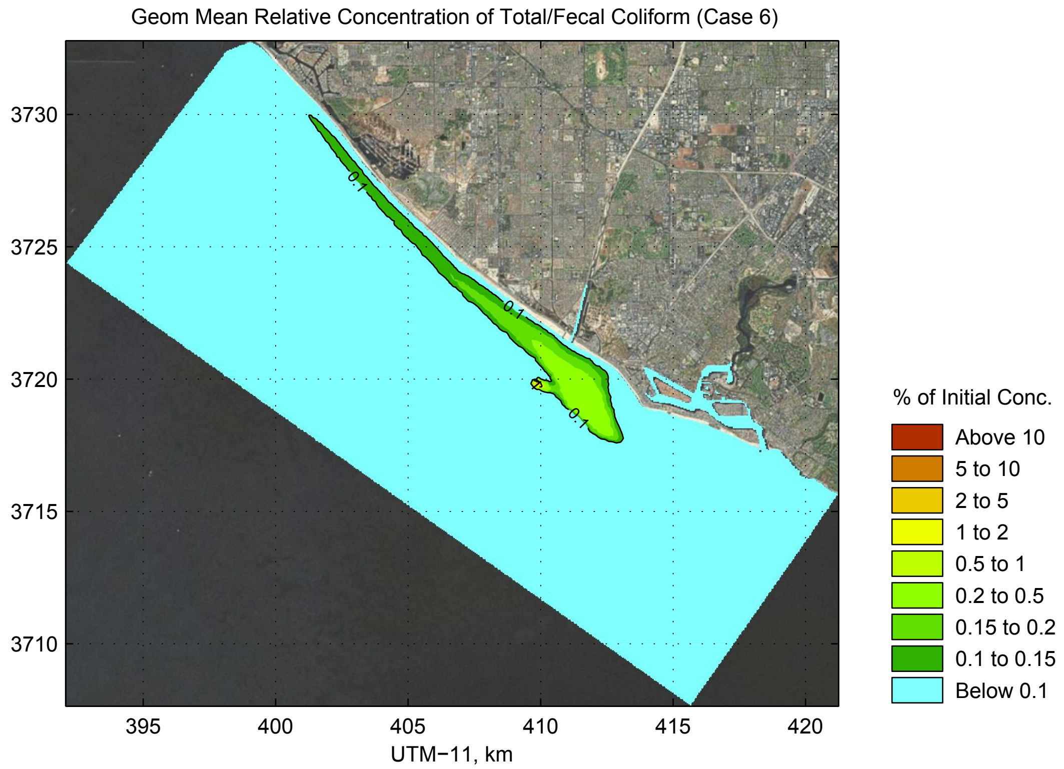


Figure D-11: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

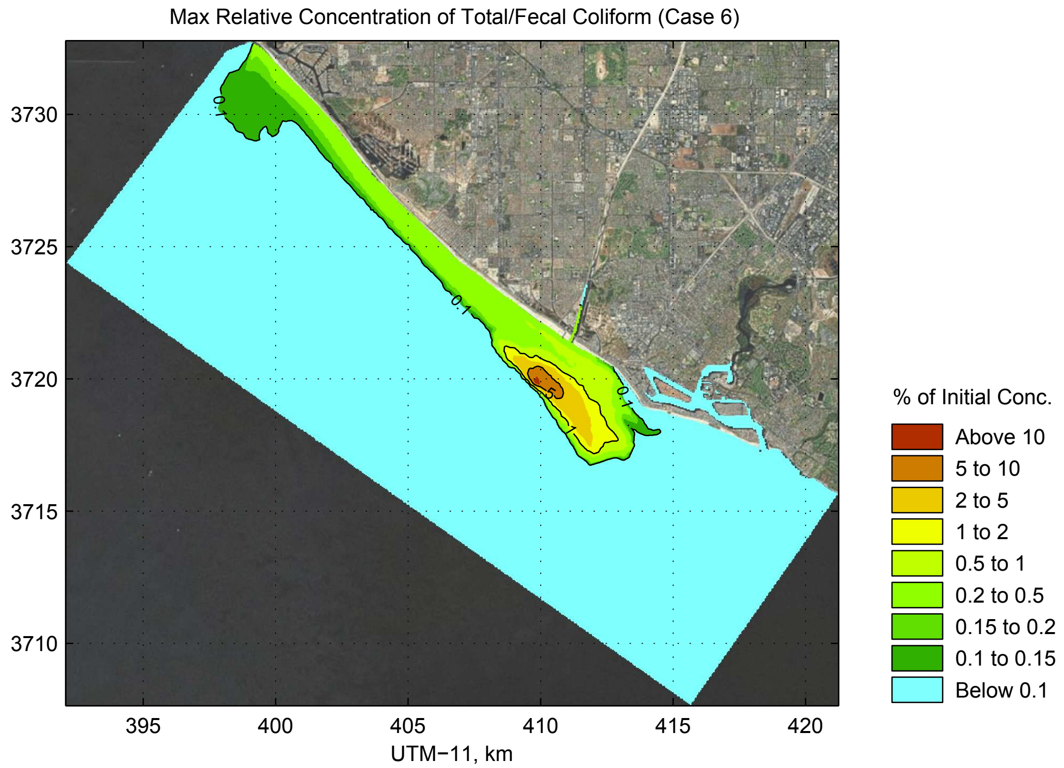


Figure D-12: Max Relative Concentration of Total/Fecal Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

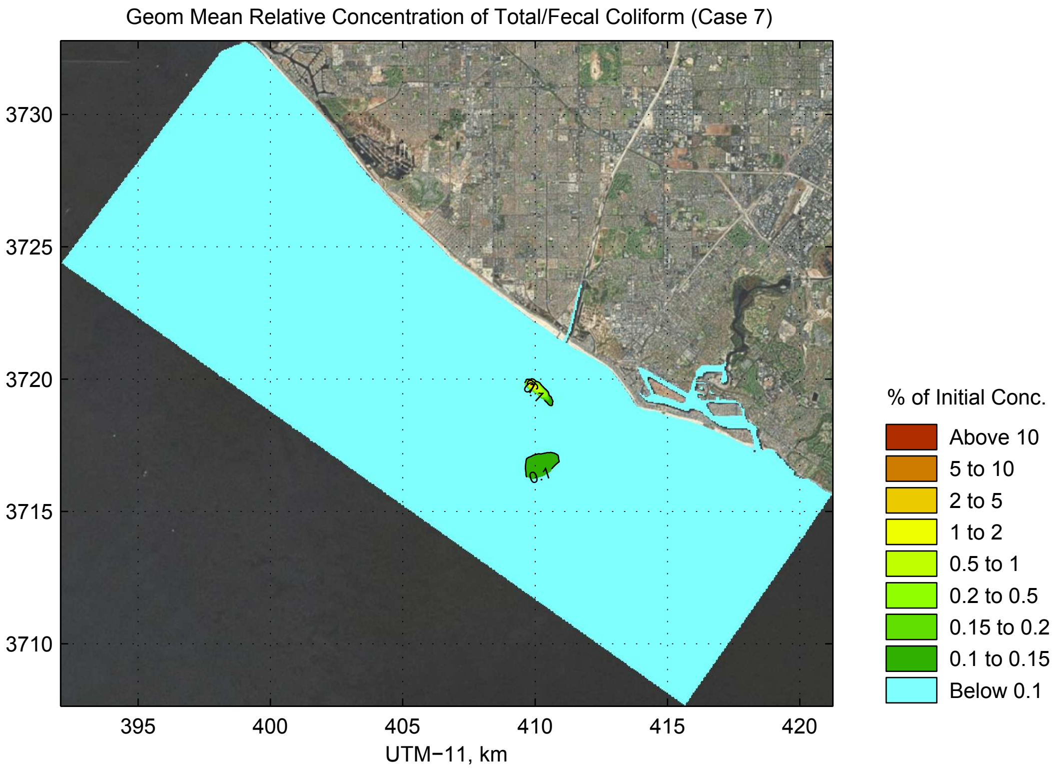


Figure D-13: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

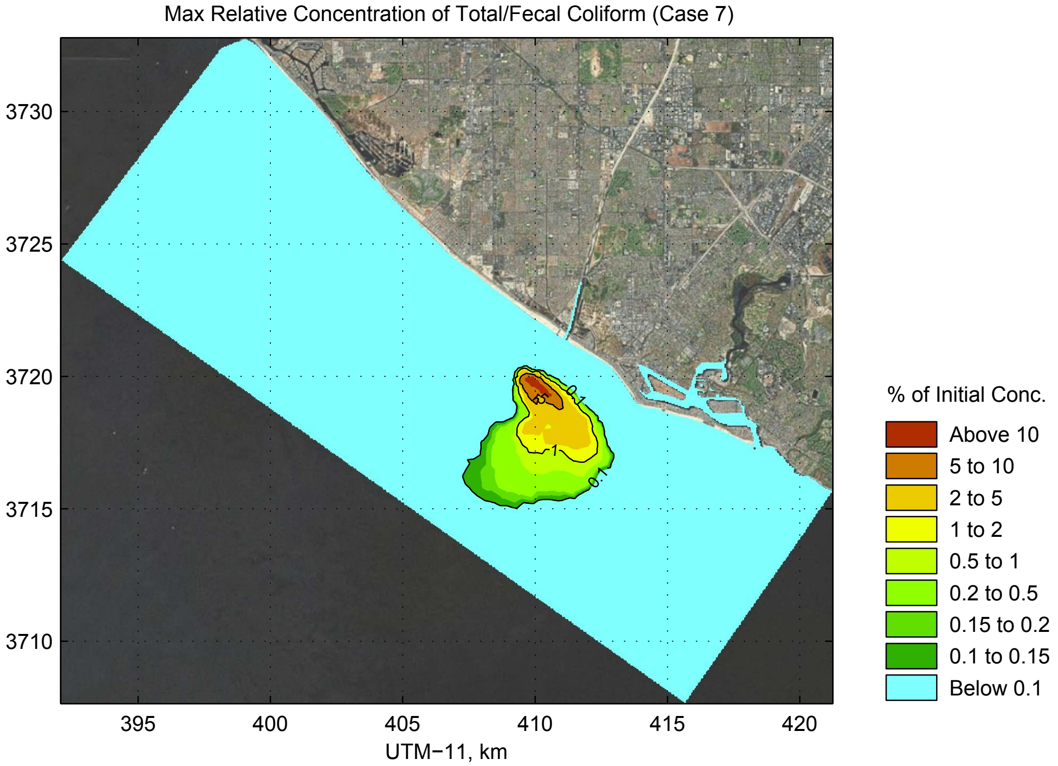


Figure D-14: Max Relative Concentration of Total/Fecal Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

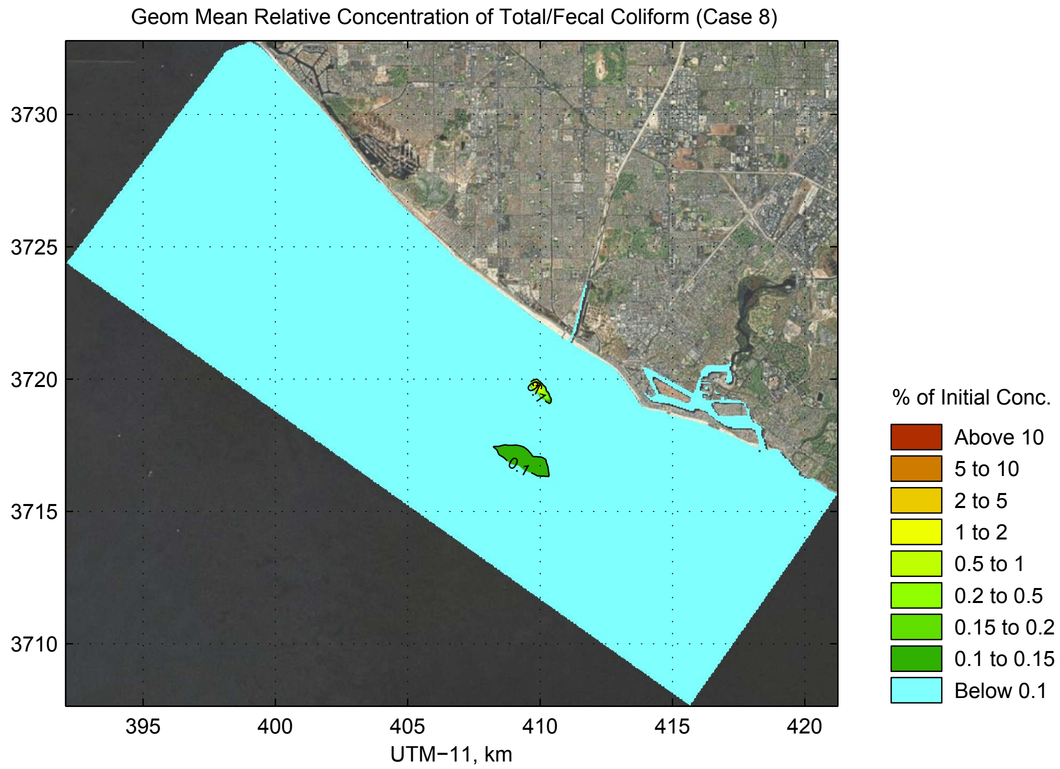


Figure D-15: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

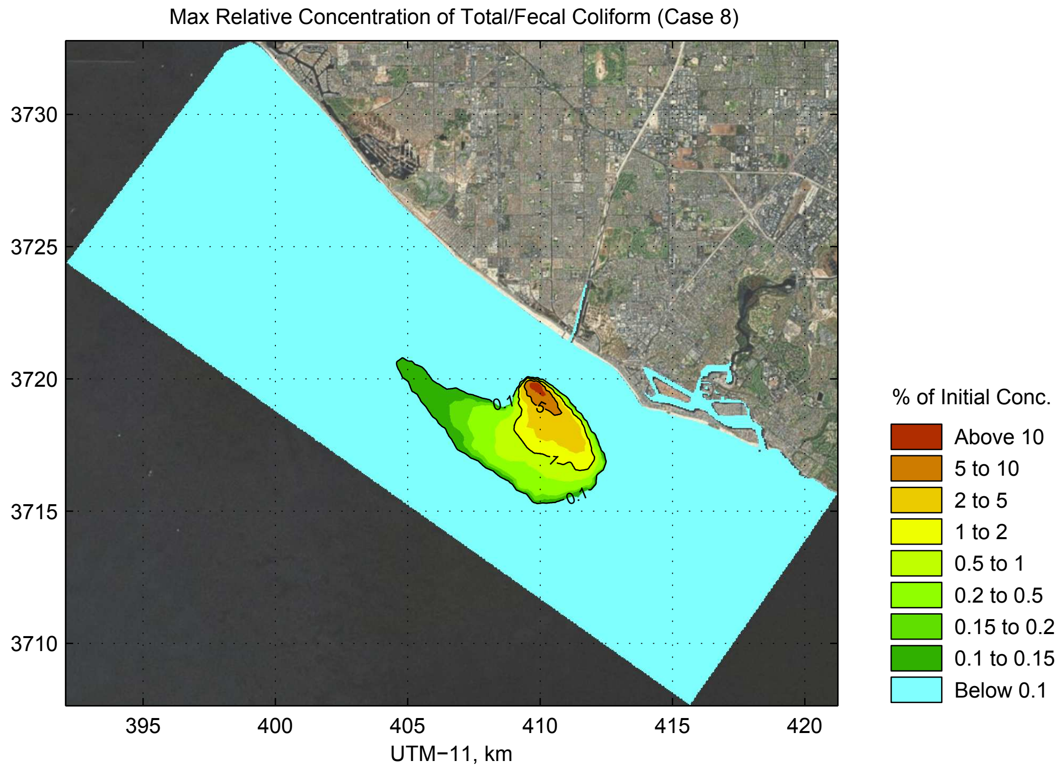


Figure D-16: Max Relative Concentration of Total/Fecal Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

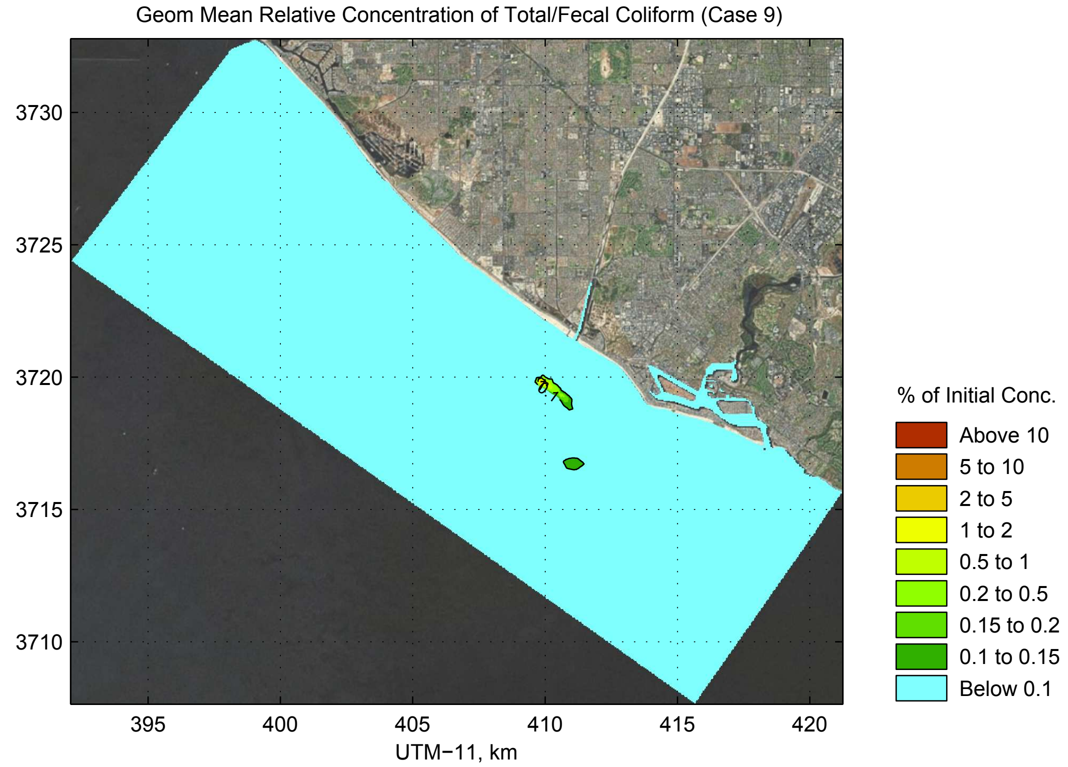


Figure D-17: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

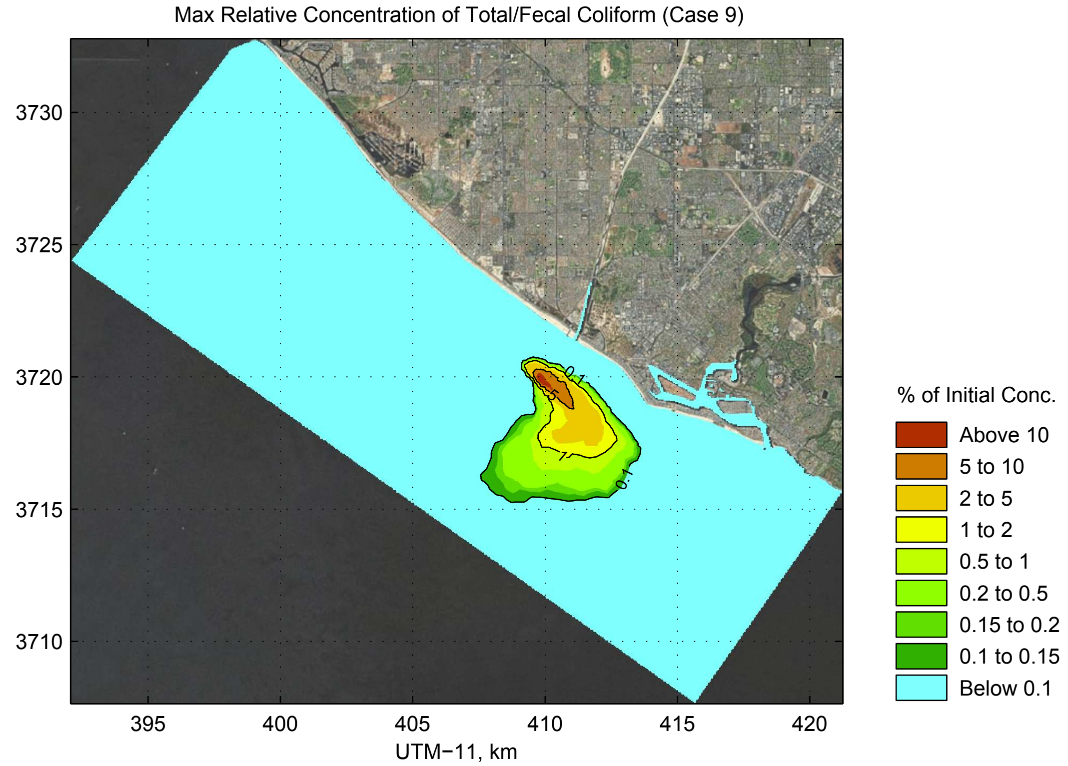


Figure D-18: Max Relative Concentration of Total/Fecal Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

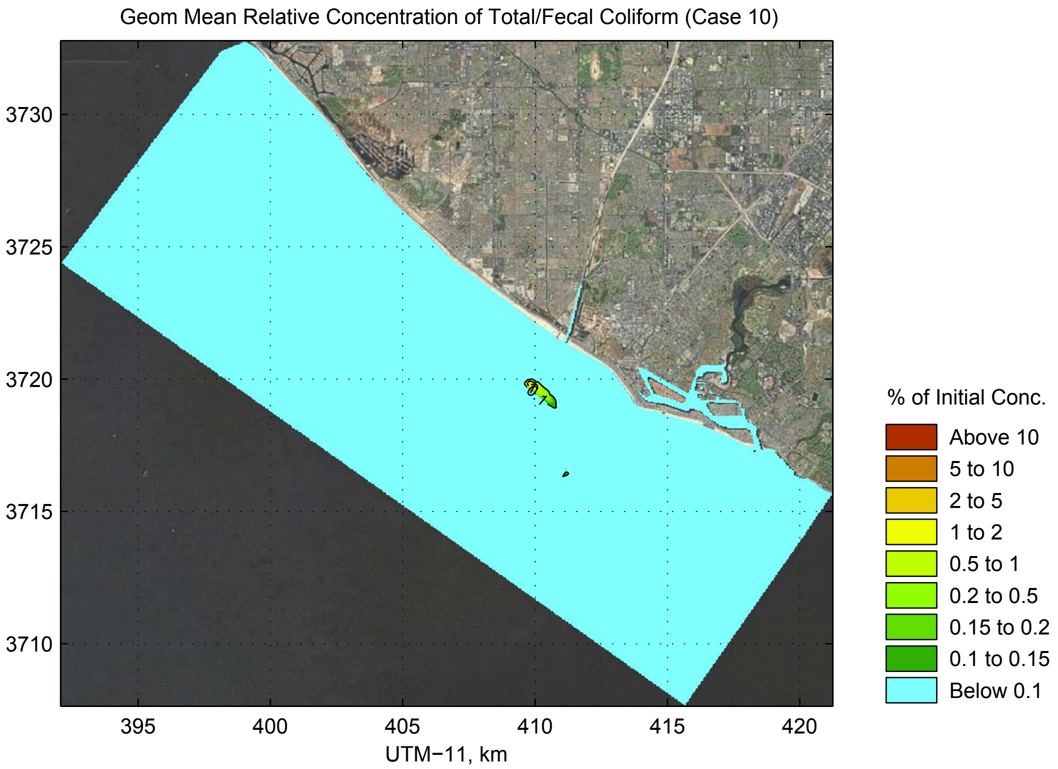


Figure D-19: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

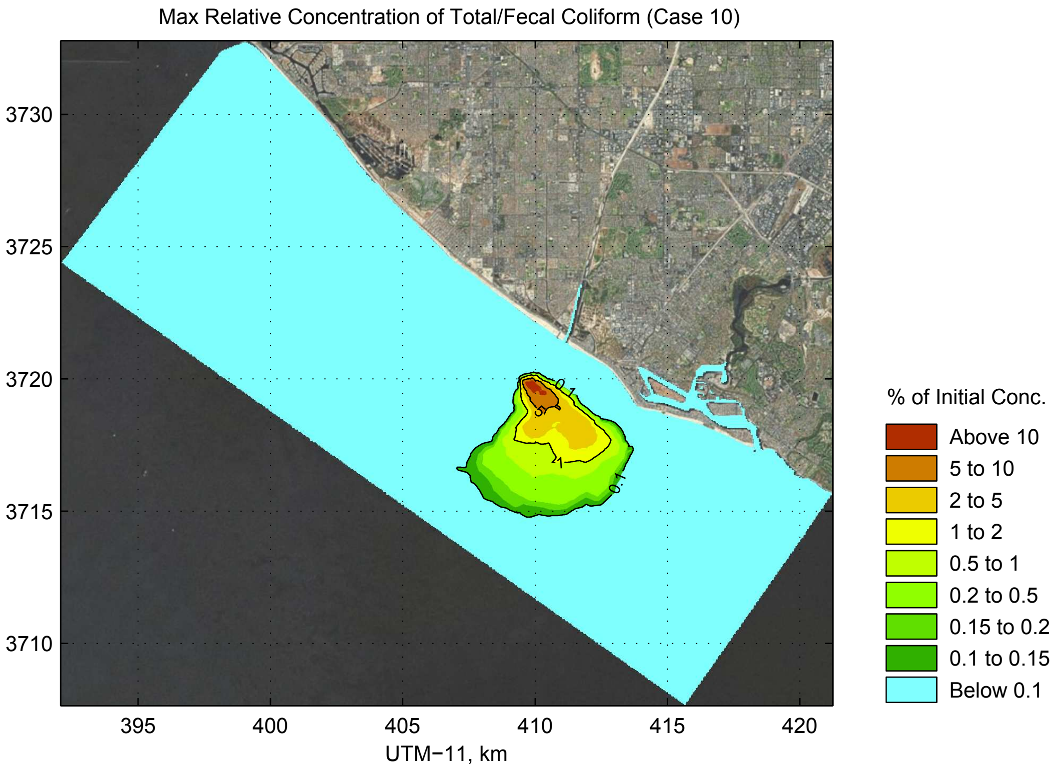
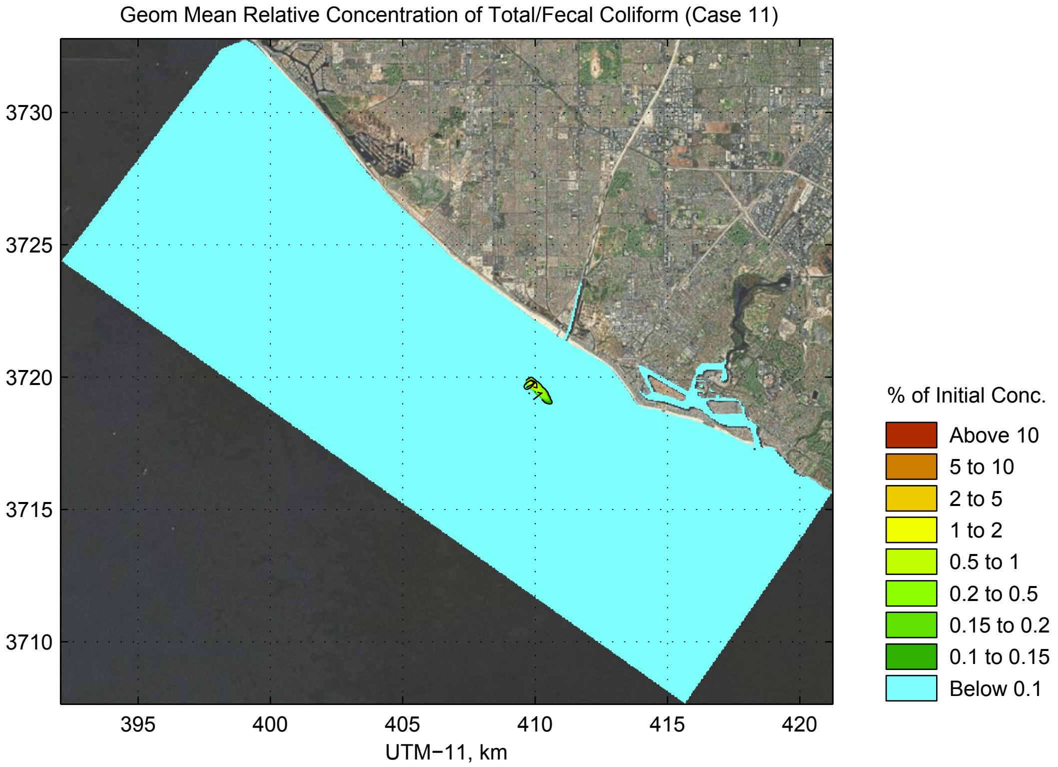
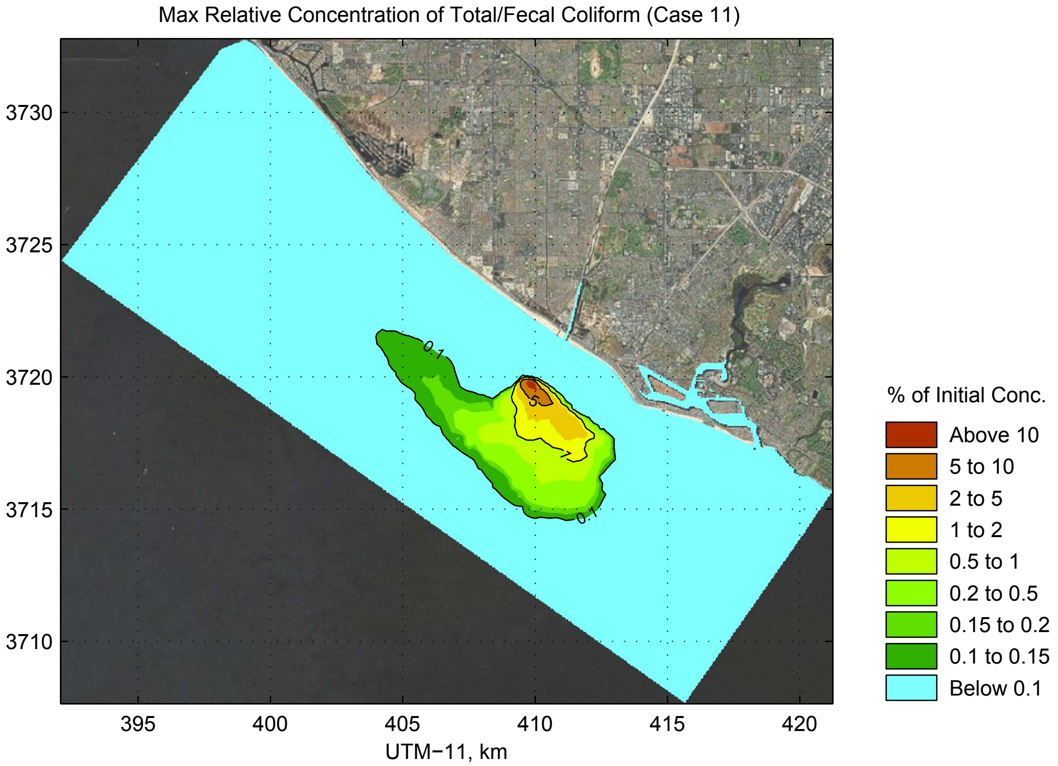


Figure D-20: Max Relative Concentration of Total/Fecal Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)



Geom Mean Relative Concentration of Total/Fecal Coliform (Case 11)

Figure D-21: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270°N)



Max Relative Concentration of Total/Fecal Coliform (Case 11)

Figure D-22: Max Relative Concentration of Total/Fecal Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270°N)

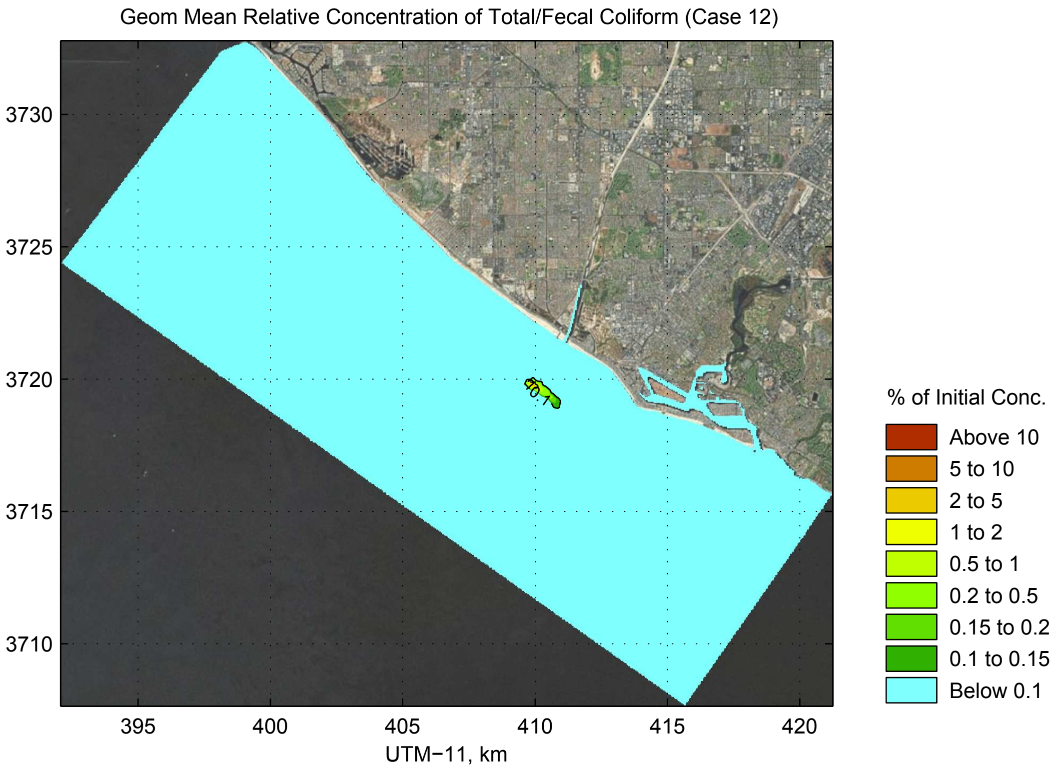


Figure D-23: Geom Mean Relative Concentration of Total/Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270°N)

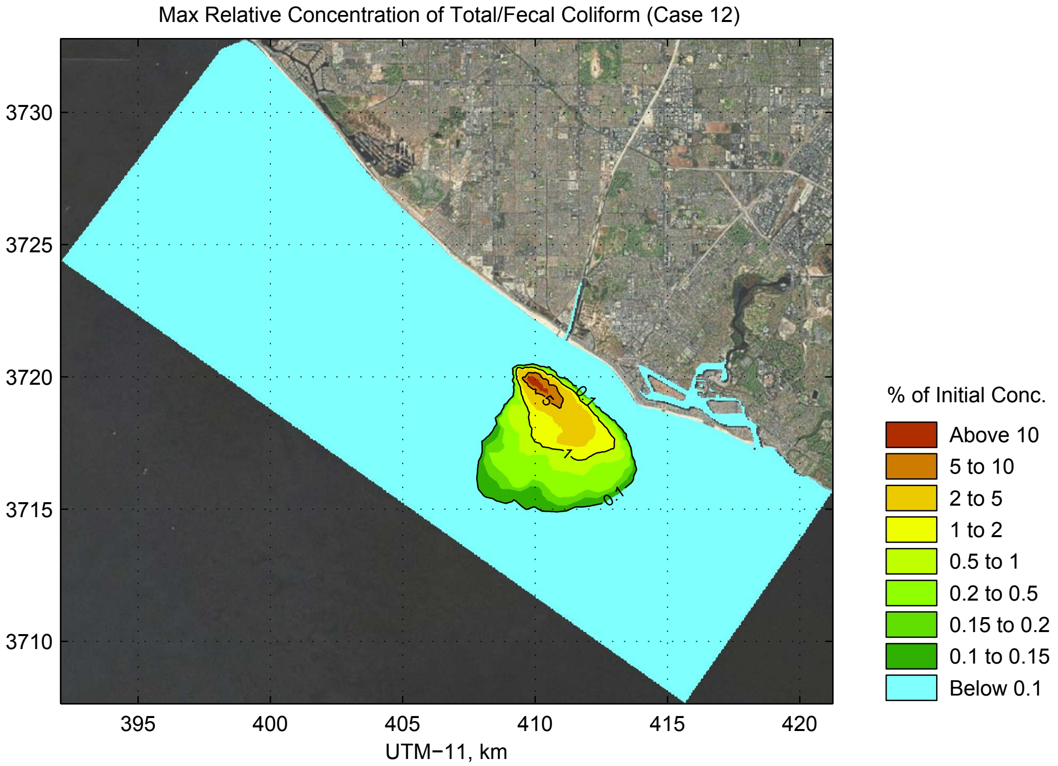


Figure D-24: Max Relative Concentration of Total/Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270°N)

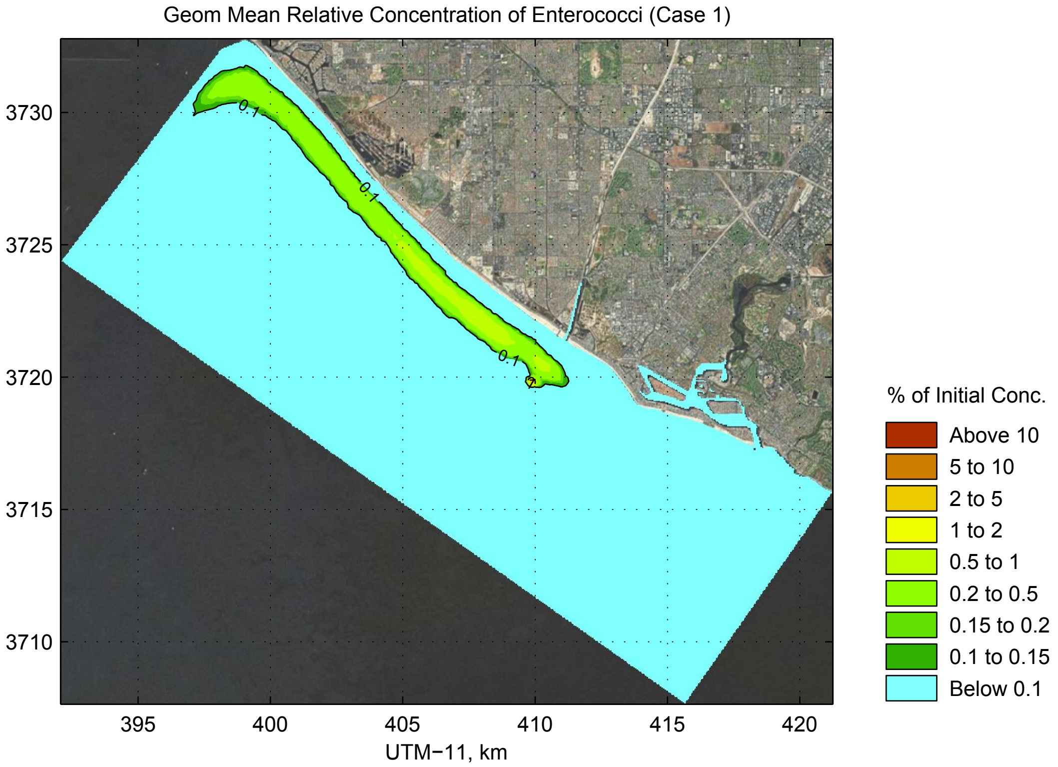


Figure D-25: Geom Mean Relative Concentration of Enterococci for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

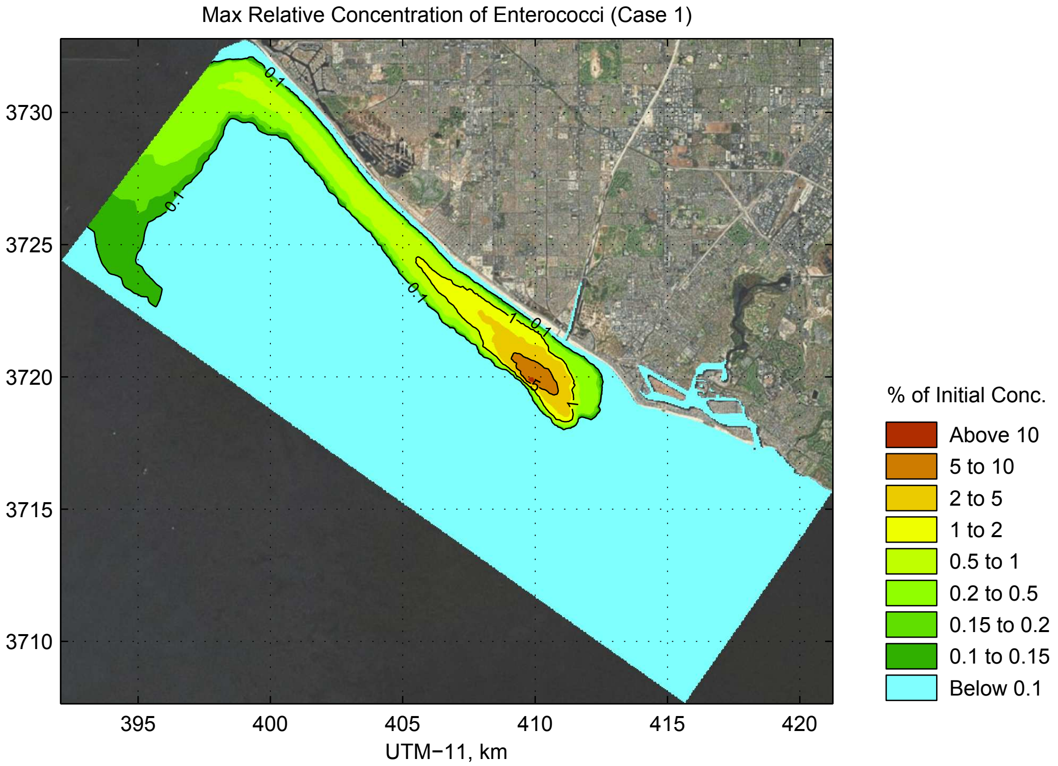
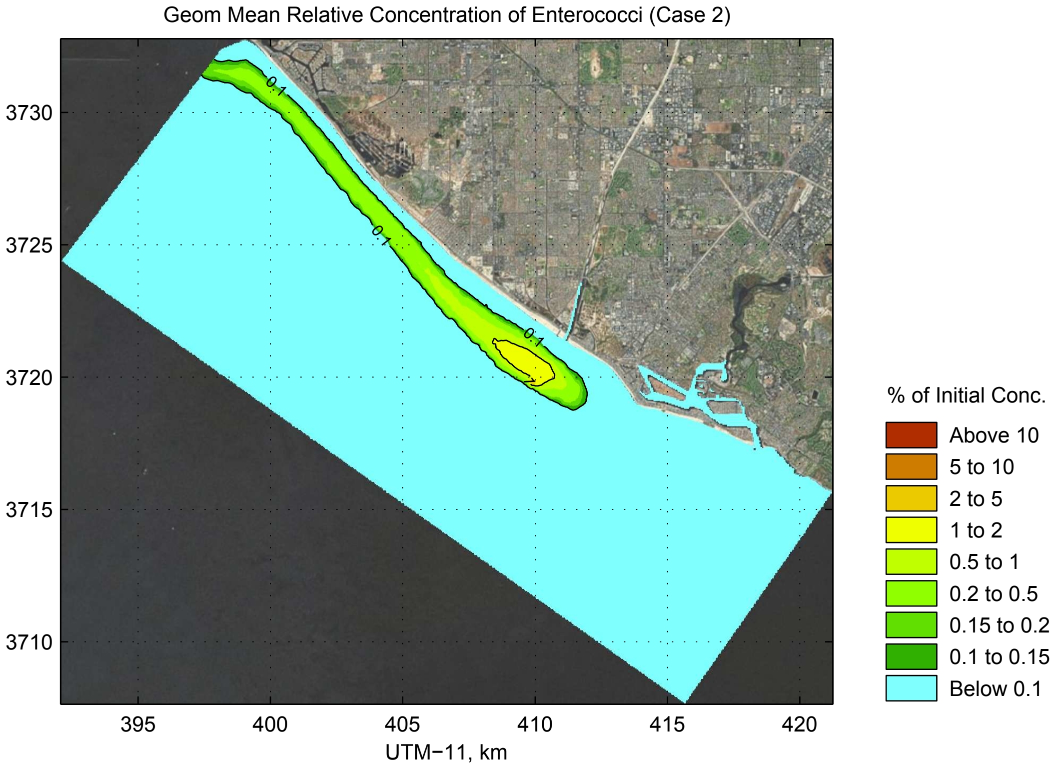
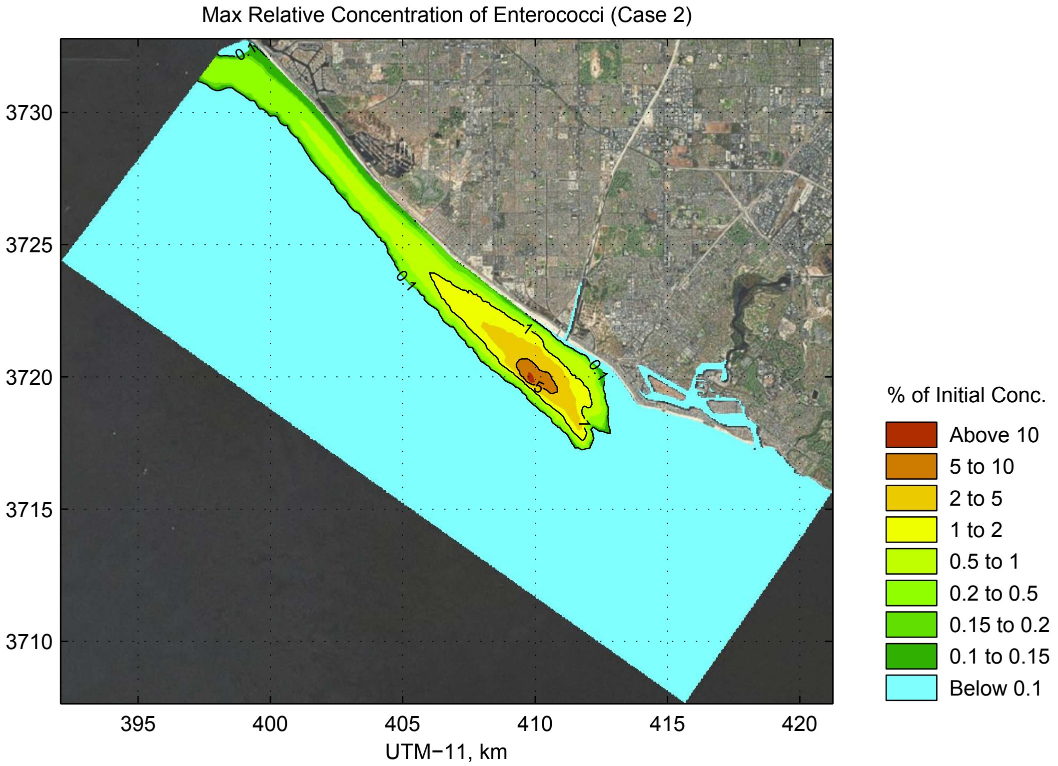


Figure D-26: Max Relative Concentration of Enterococci for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)



Geom Mean Relative Concentration of Enterococci (Case 2)

Figure D-27: Geom Mean Relative Concentration of Enterococci for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)



Max Relative Concentration of Enterococci (Case 2)

Figure D-28: Max Relative Concentration of Enterococci for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

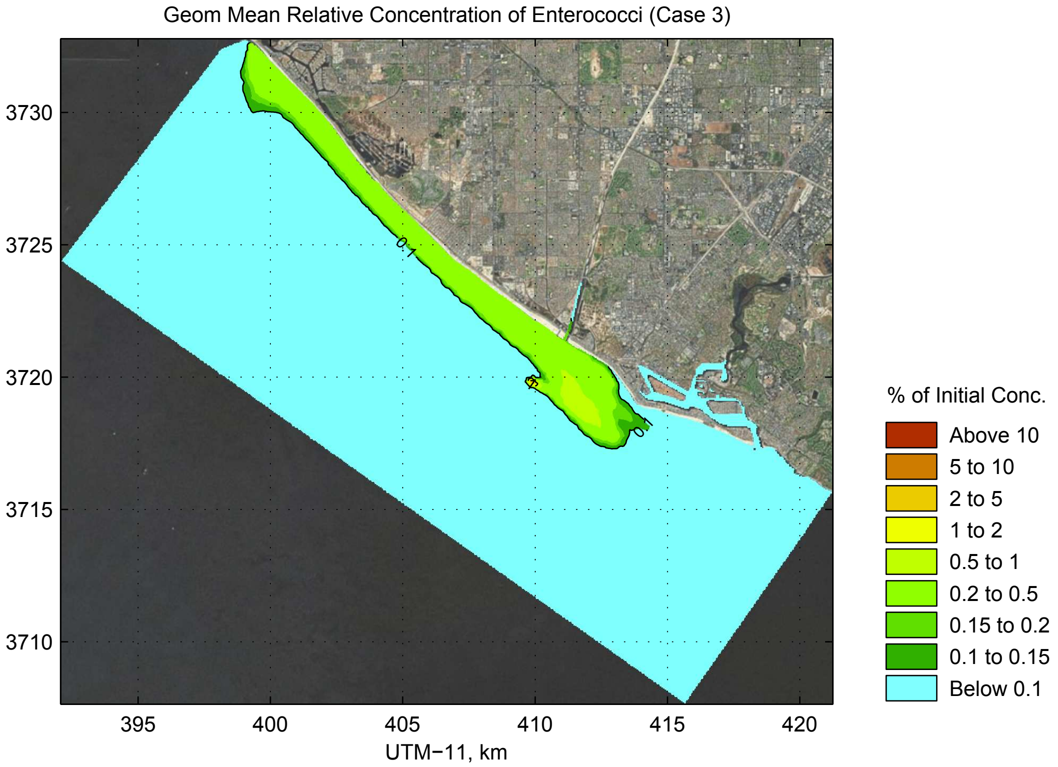


Figure D-29: Geom Mean Relative Concentration of Enterococci for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

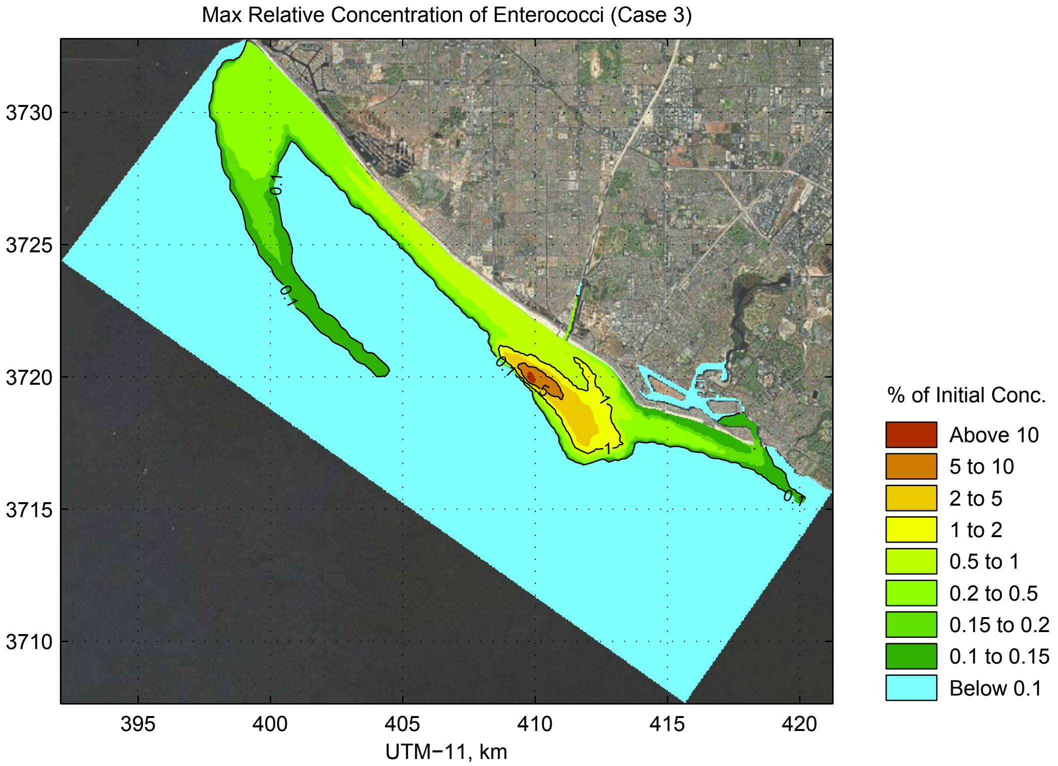


Figure D-30: Max Relative Concentration of Enterococci for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

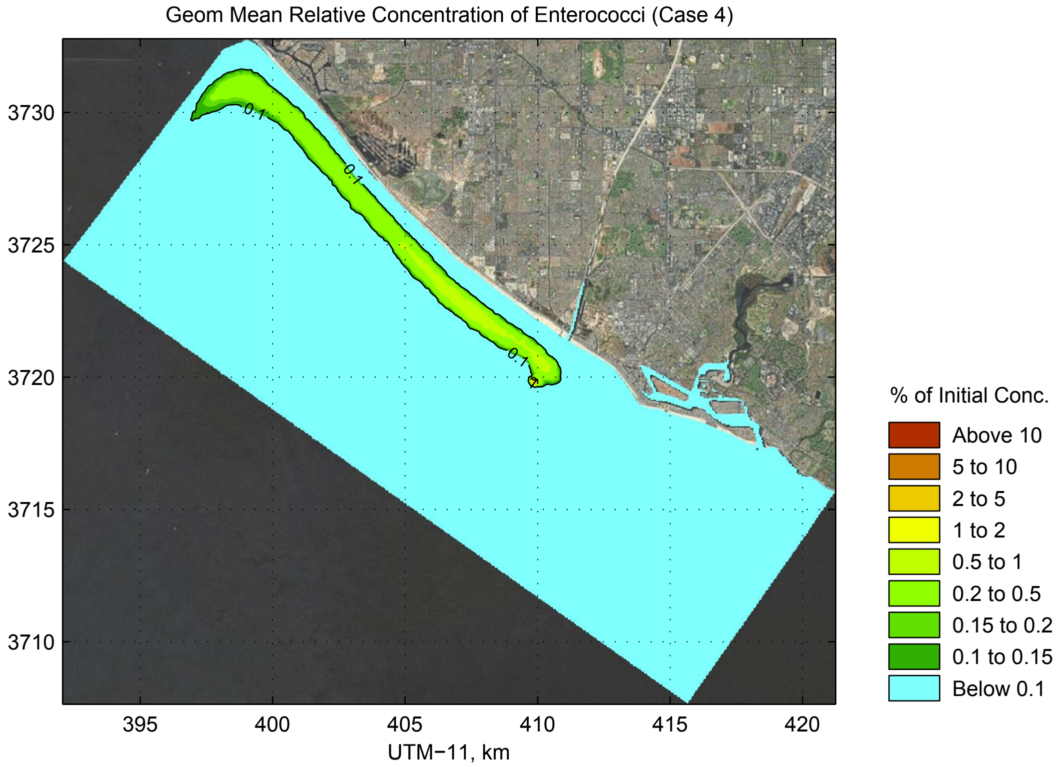


Figure D-31: Geom Mean Relative Concentration of Enterococci for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

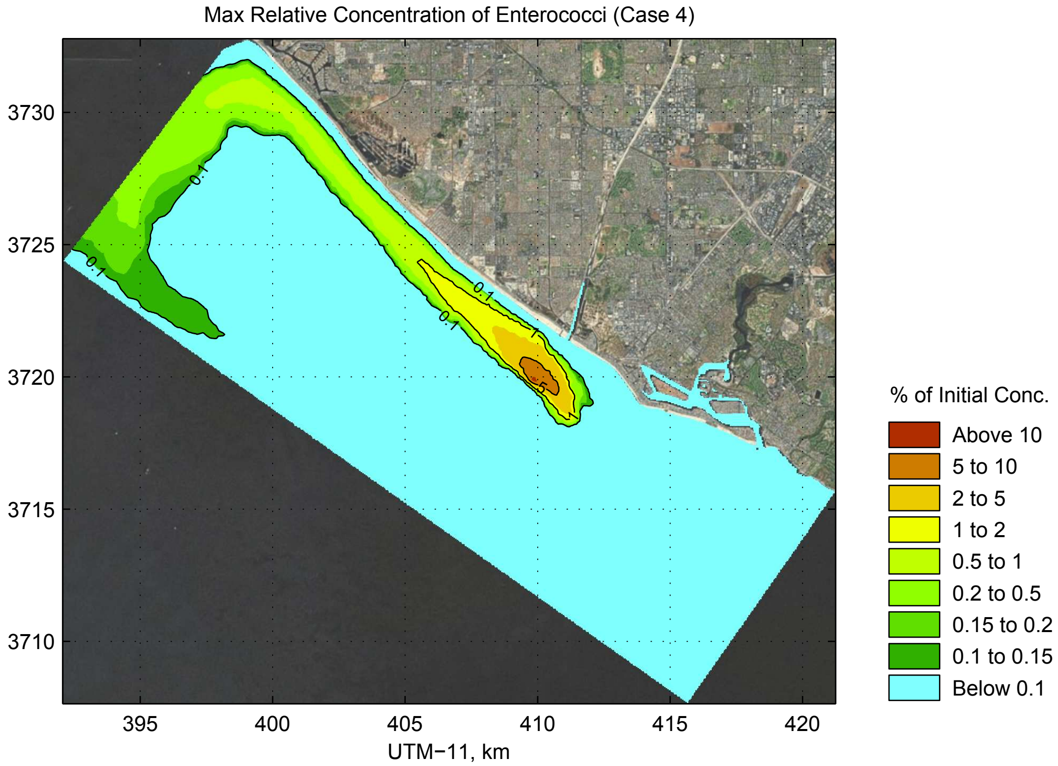


Figure D-32: Max Relative Concentration of Enterococci for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

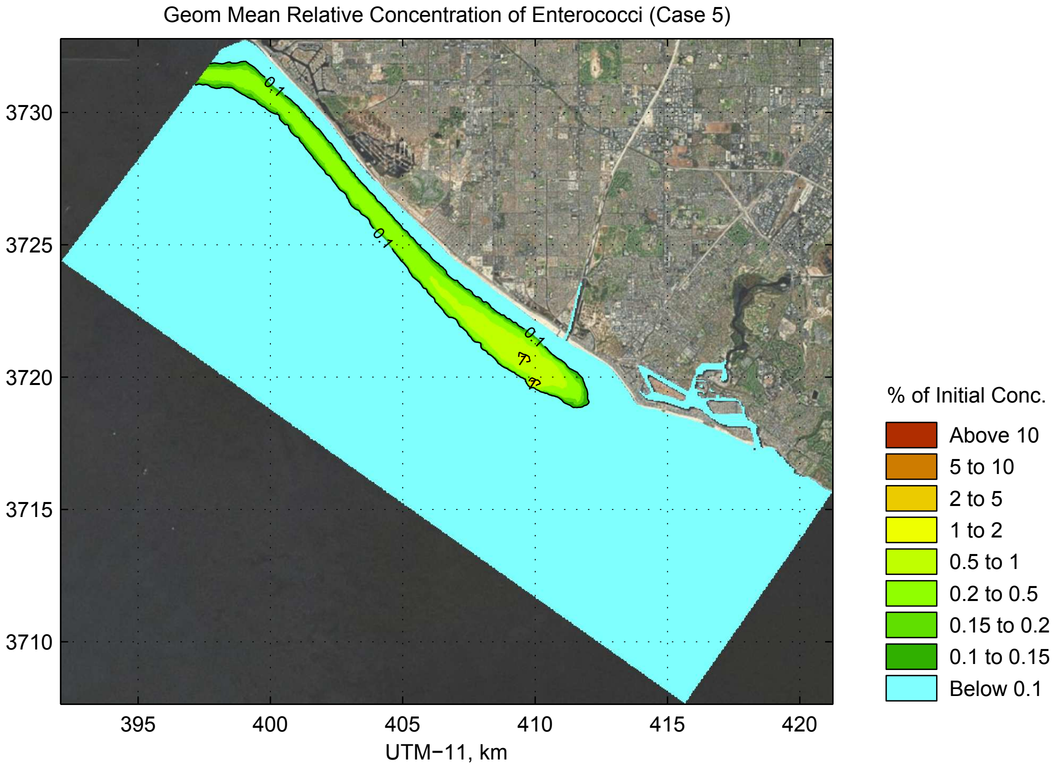


Figure D-33: Geom Mean Relative Concentration of Enterococci for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

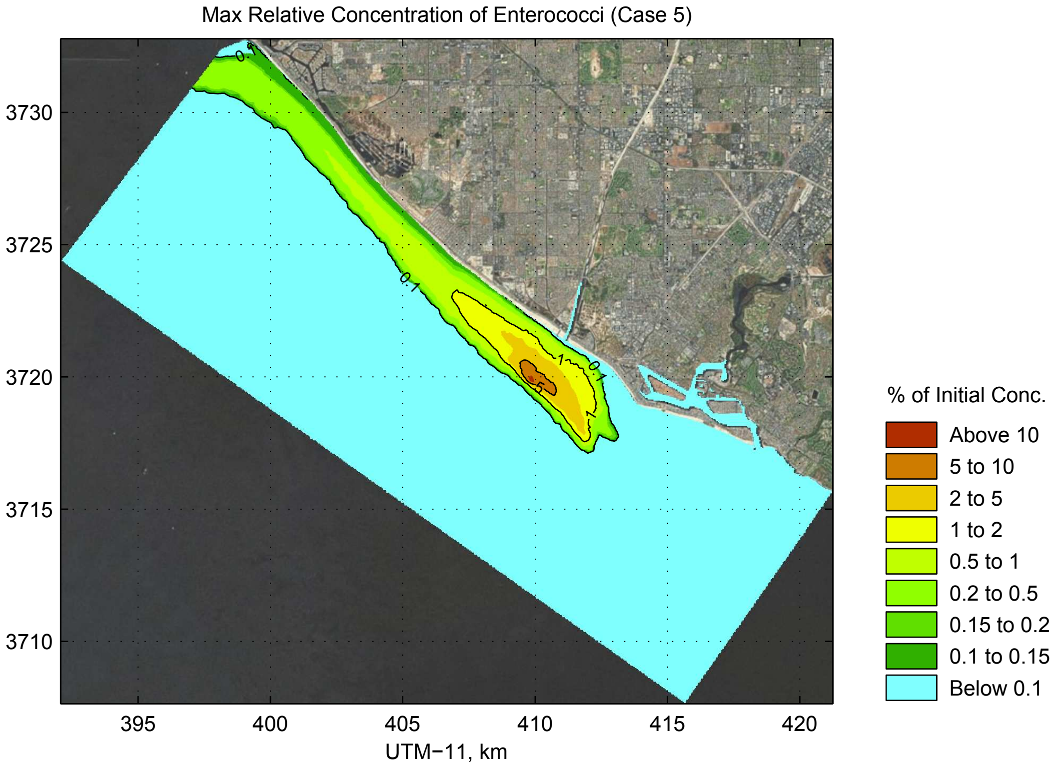


Figure D-34: Max Relative Concentration of Enterococci for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

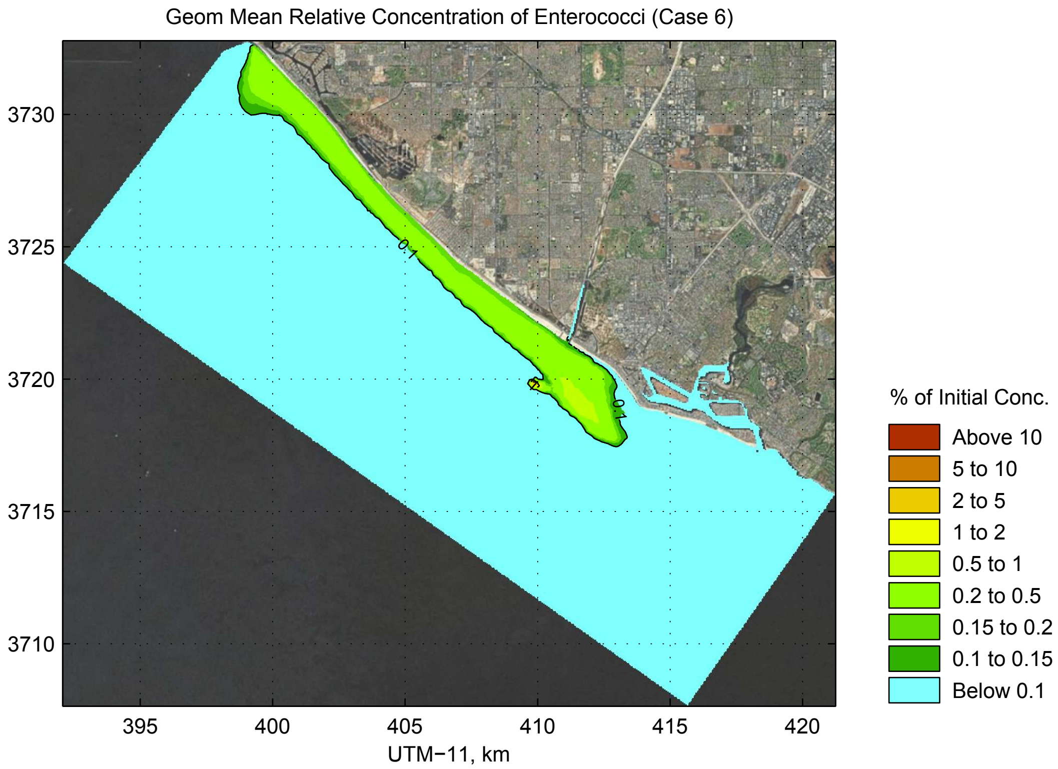


Figure D-35: Geom Mean Relative Concentration of Enterococci for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

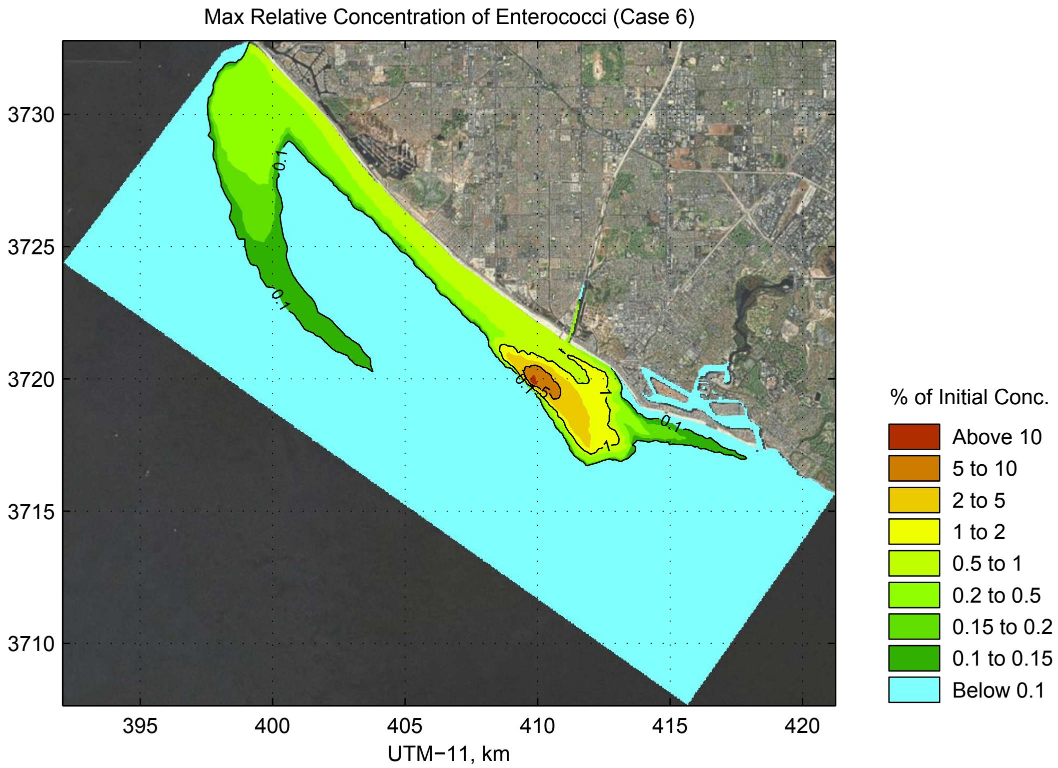


Figure D-36: Max Relative Concentration of Enterococci for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

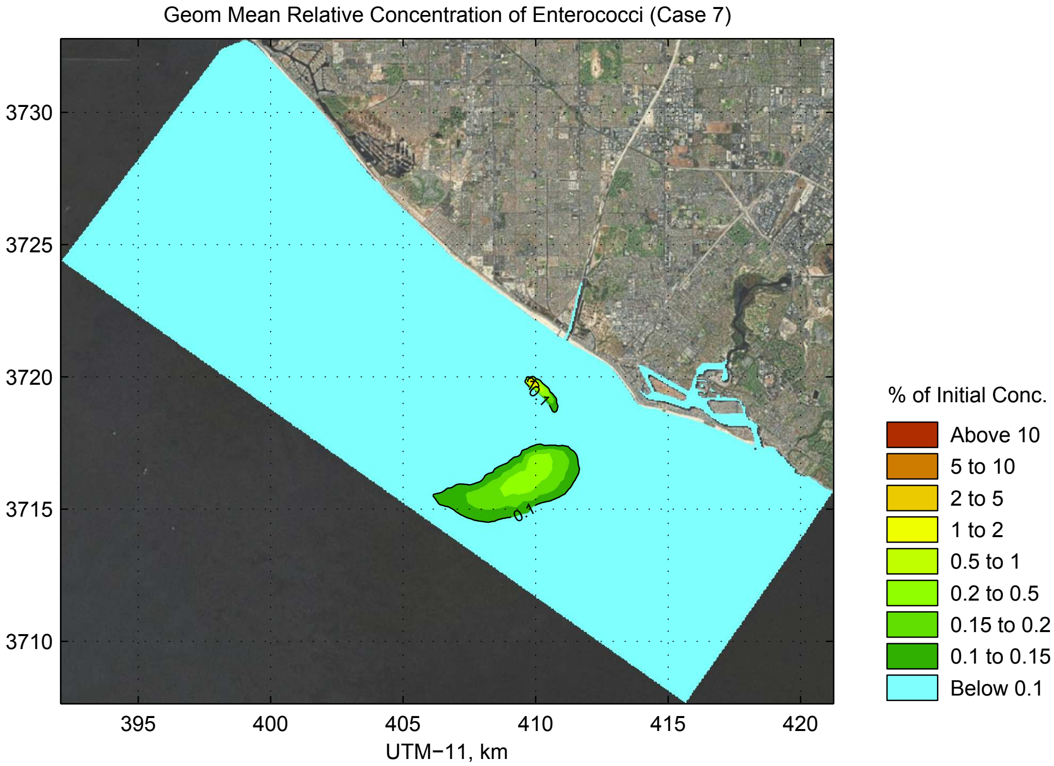


Figure D-37: Geom Mean Relative Concentration of Enterococci for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

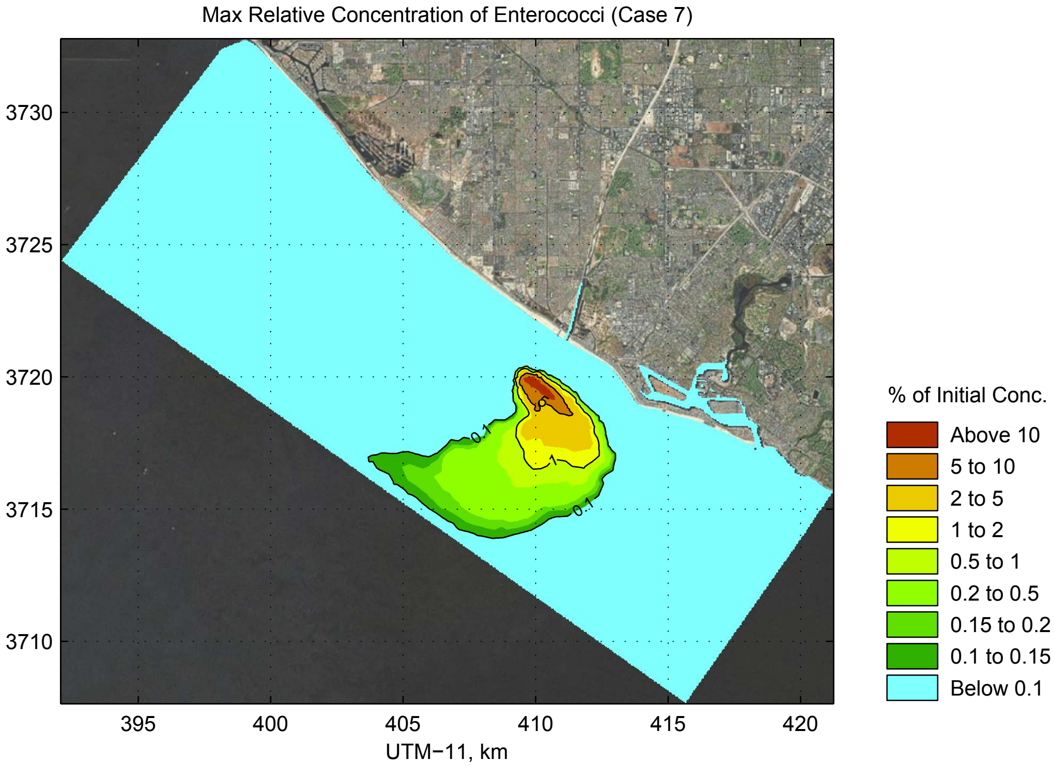


Figure D-38: Max Relative Concentration of Enterococci for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

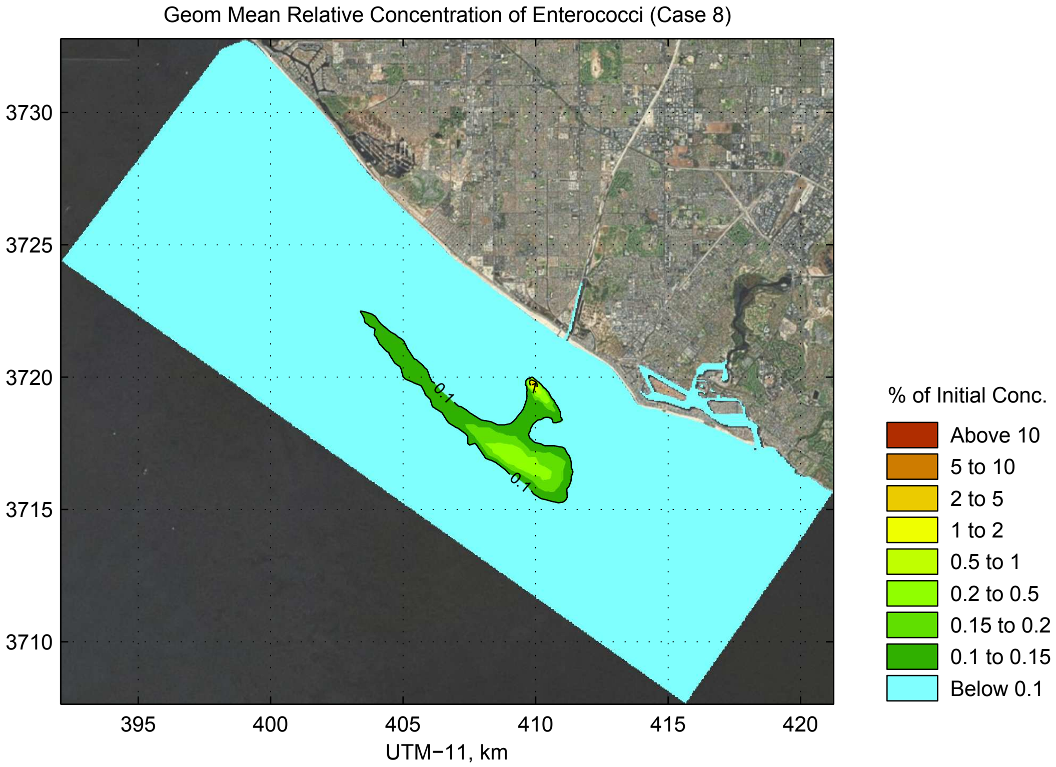


Figure D-39: Geom Mean Relative Concentration of Enterococci for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

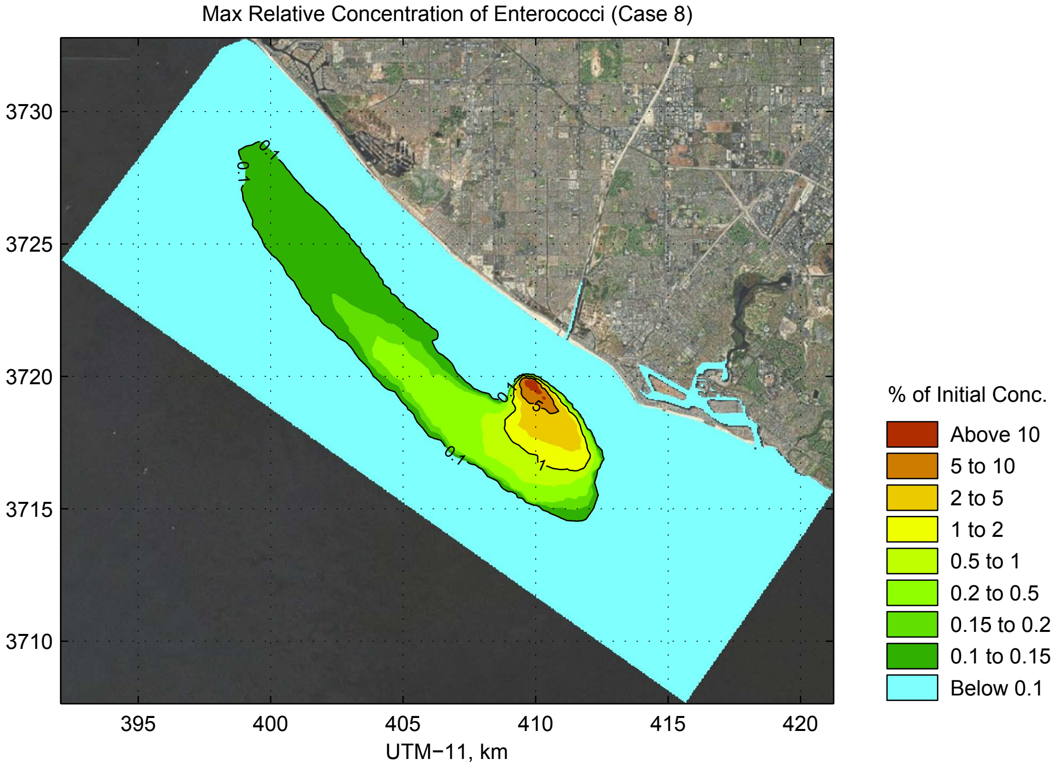


Figure D-40: Max Relative Concentration of Enterococci for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

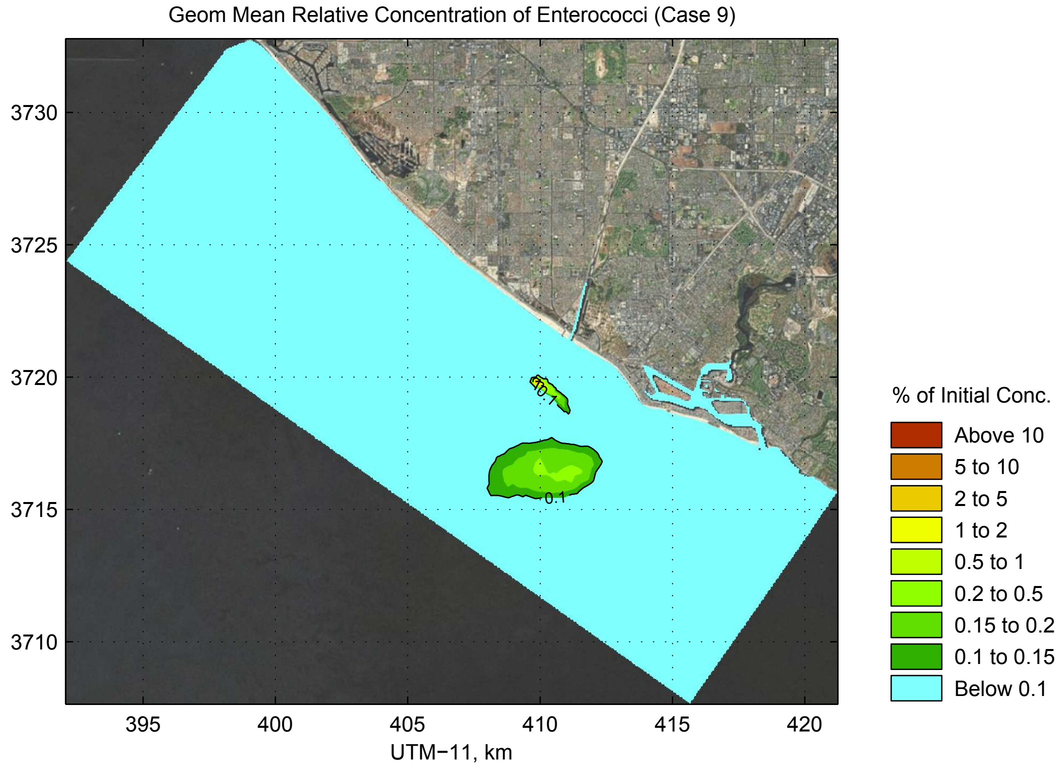


Figure D-41: Geom Mean Relative Concentration of Enterococci for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

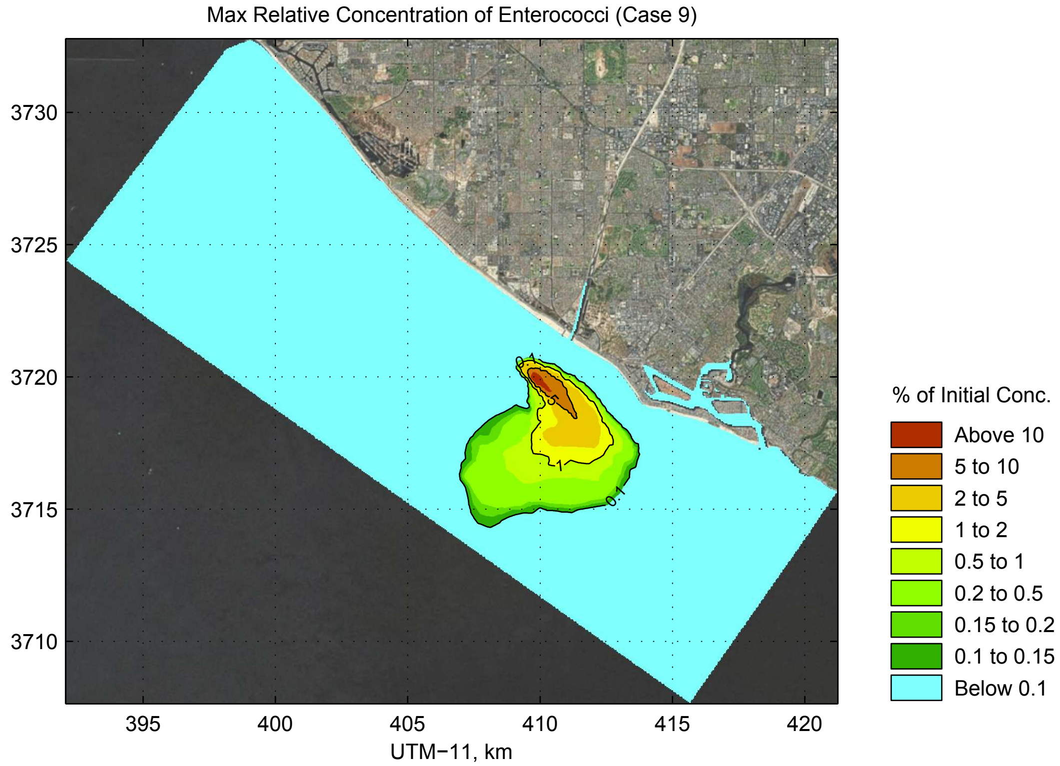


Figure D-42: Max Relative Concentration of Enterococci for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

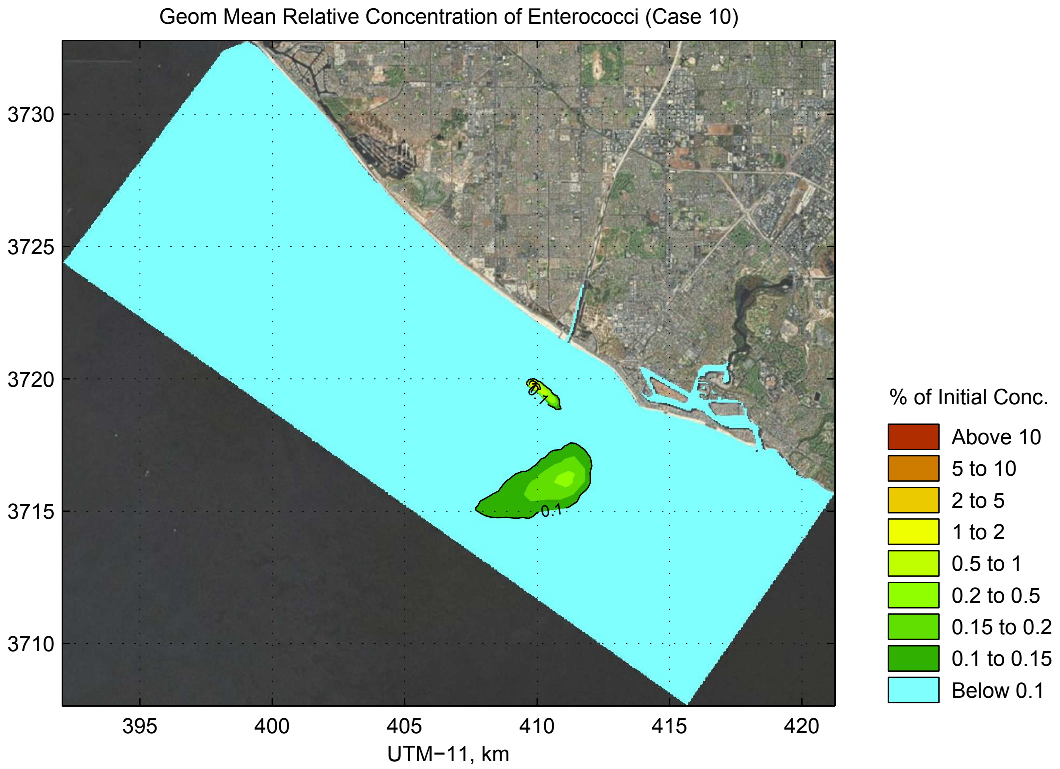


Figure D-43: Geom Mean Relative Concentration of Enterococci for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

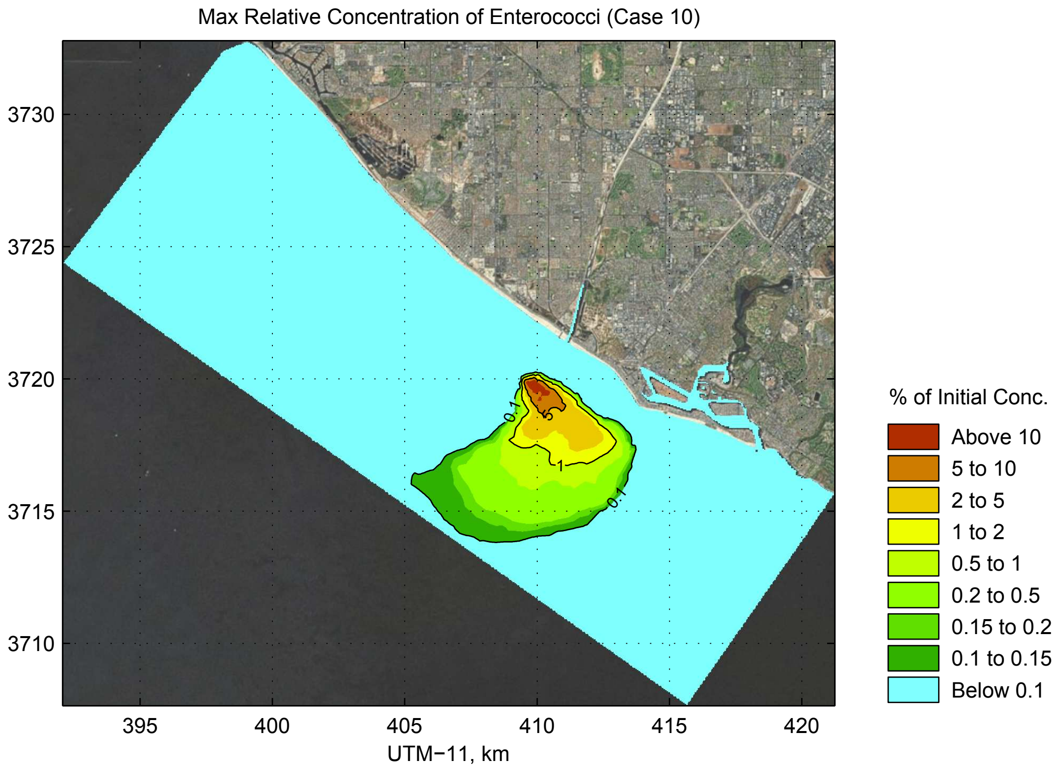


Figure D-44: Max Relative Concentration of Enterococci for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

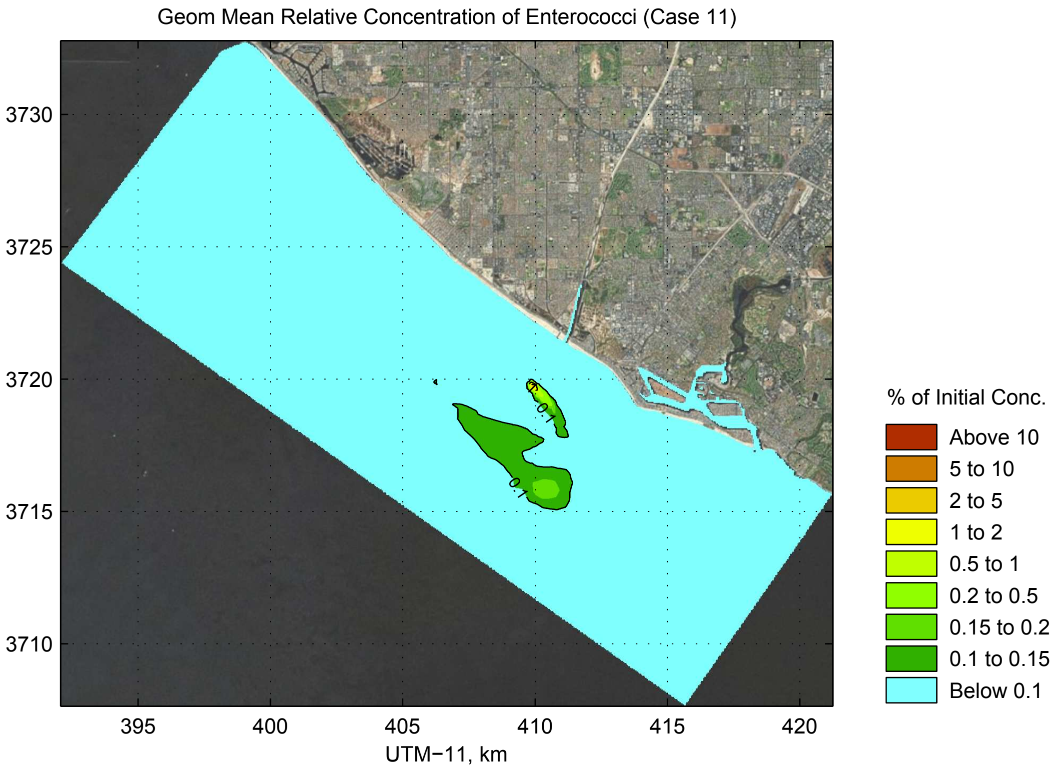


Figure D-45: Geom Mean Relative Concentration of Enterococci for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

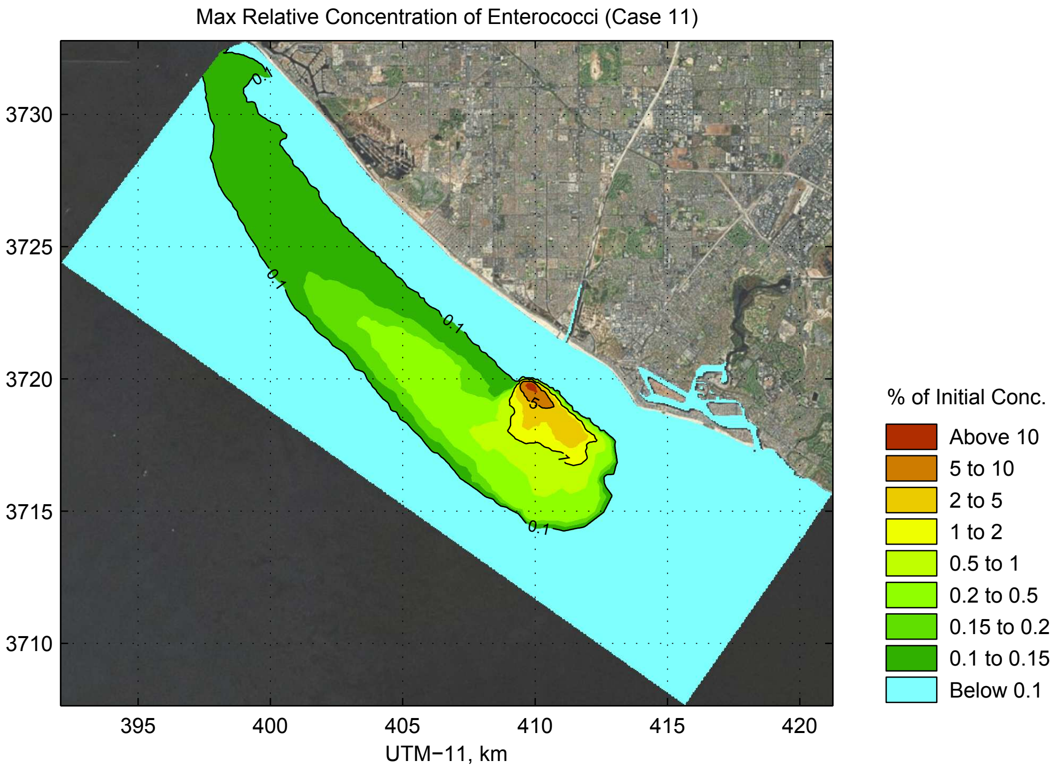


Figure D-46: Max Relative Concentration of Enterococci for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

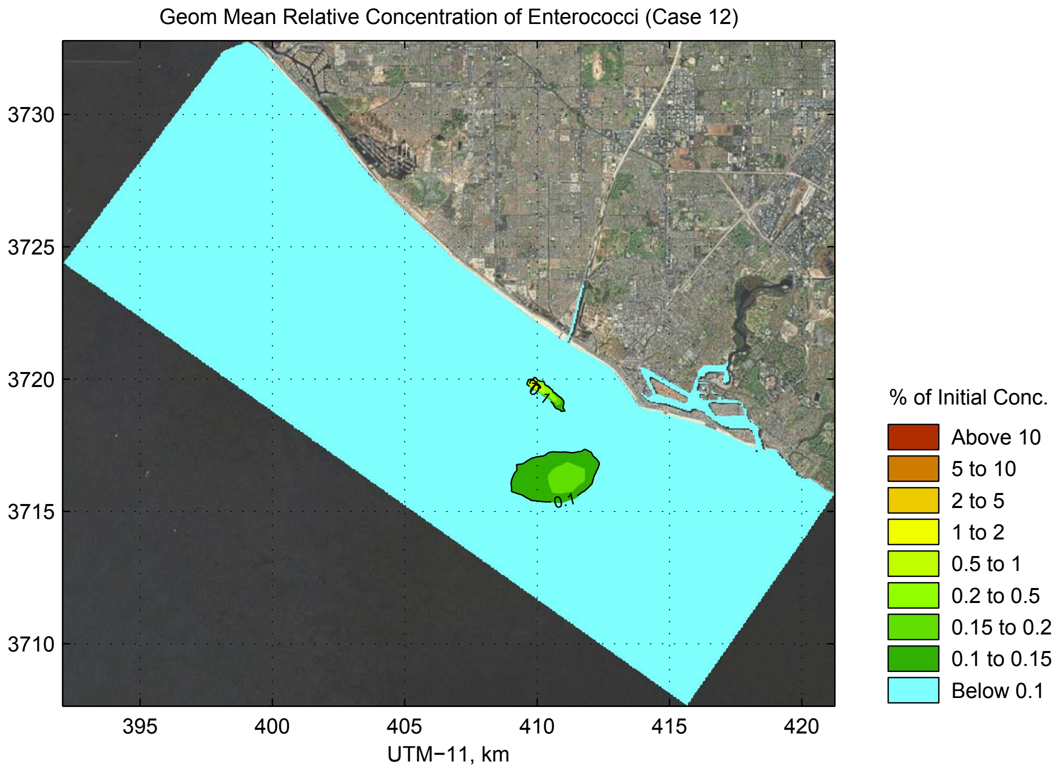


Figure D-47: Geom Mean Relative Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

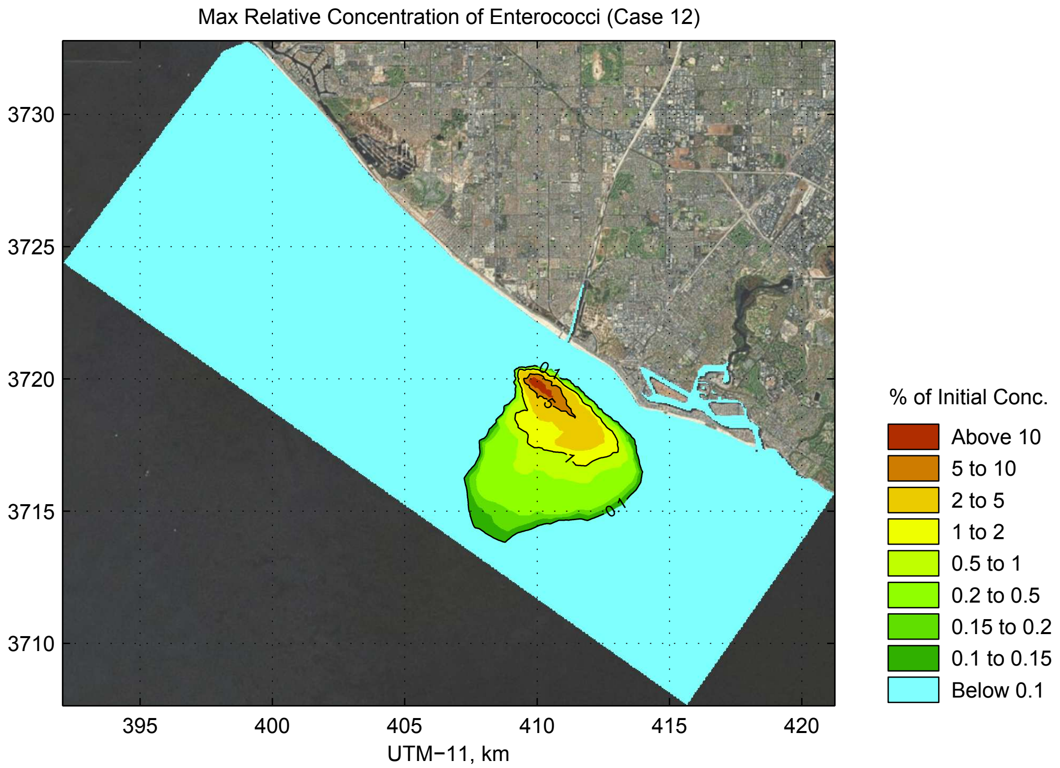


Figure D-48: Max Relative Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

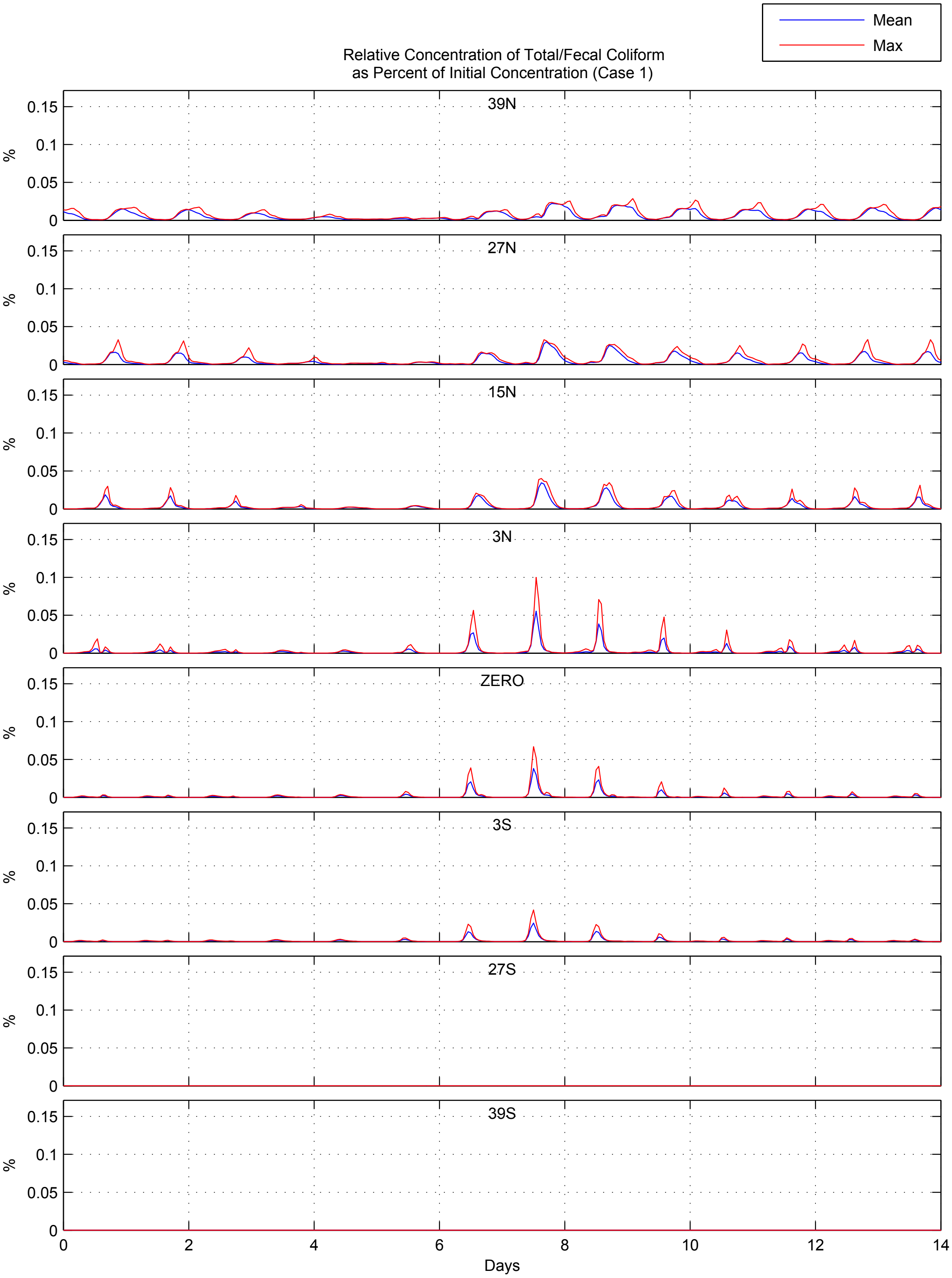


Figure D-49: Relative Concentration of Total/Fecal Coliform for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

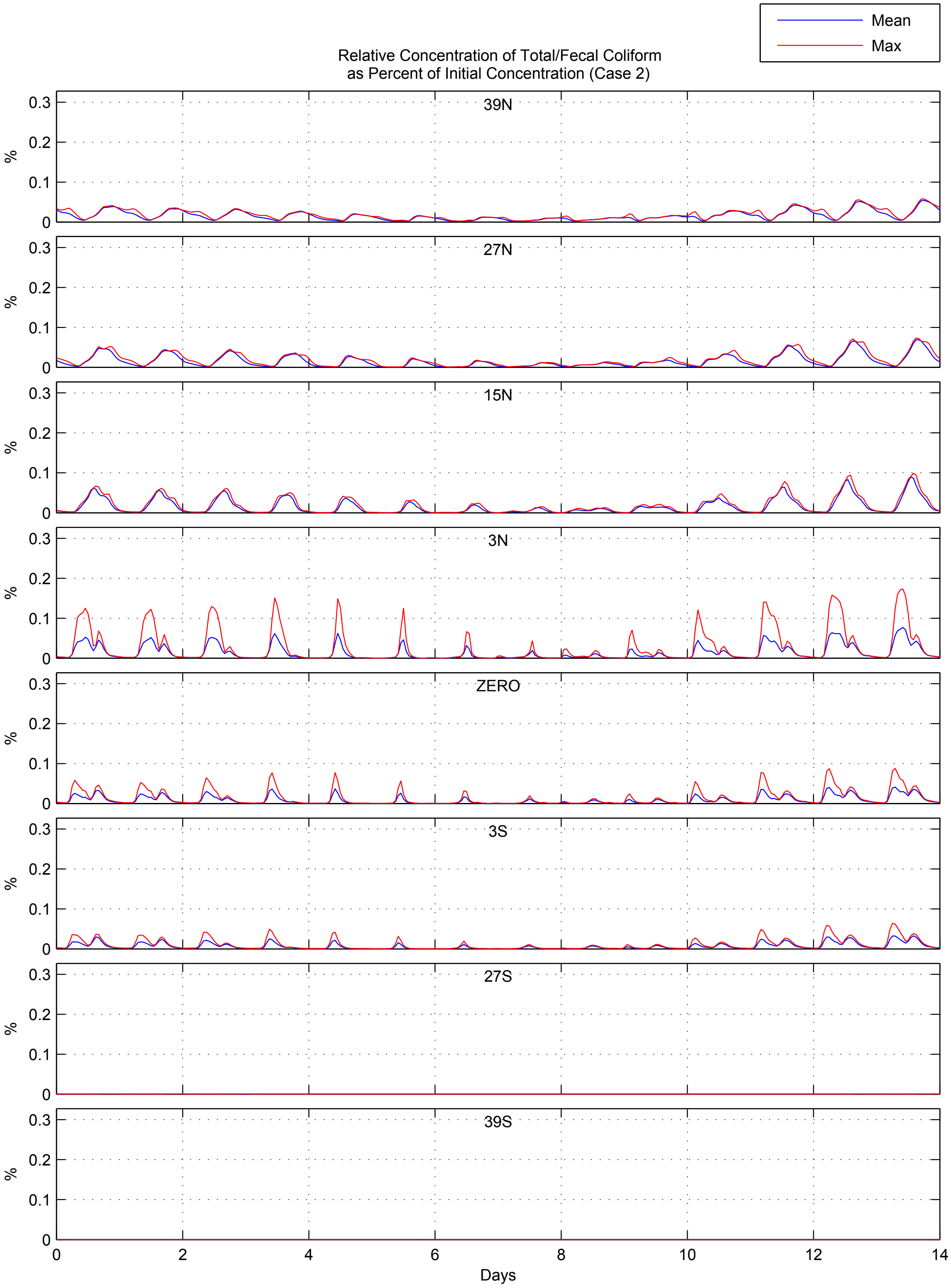


Figure D-50: Relative Concentration of Total/Fecal Coliform for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

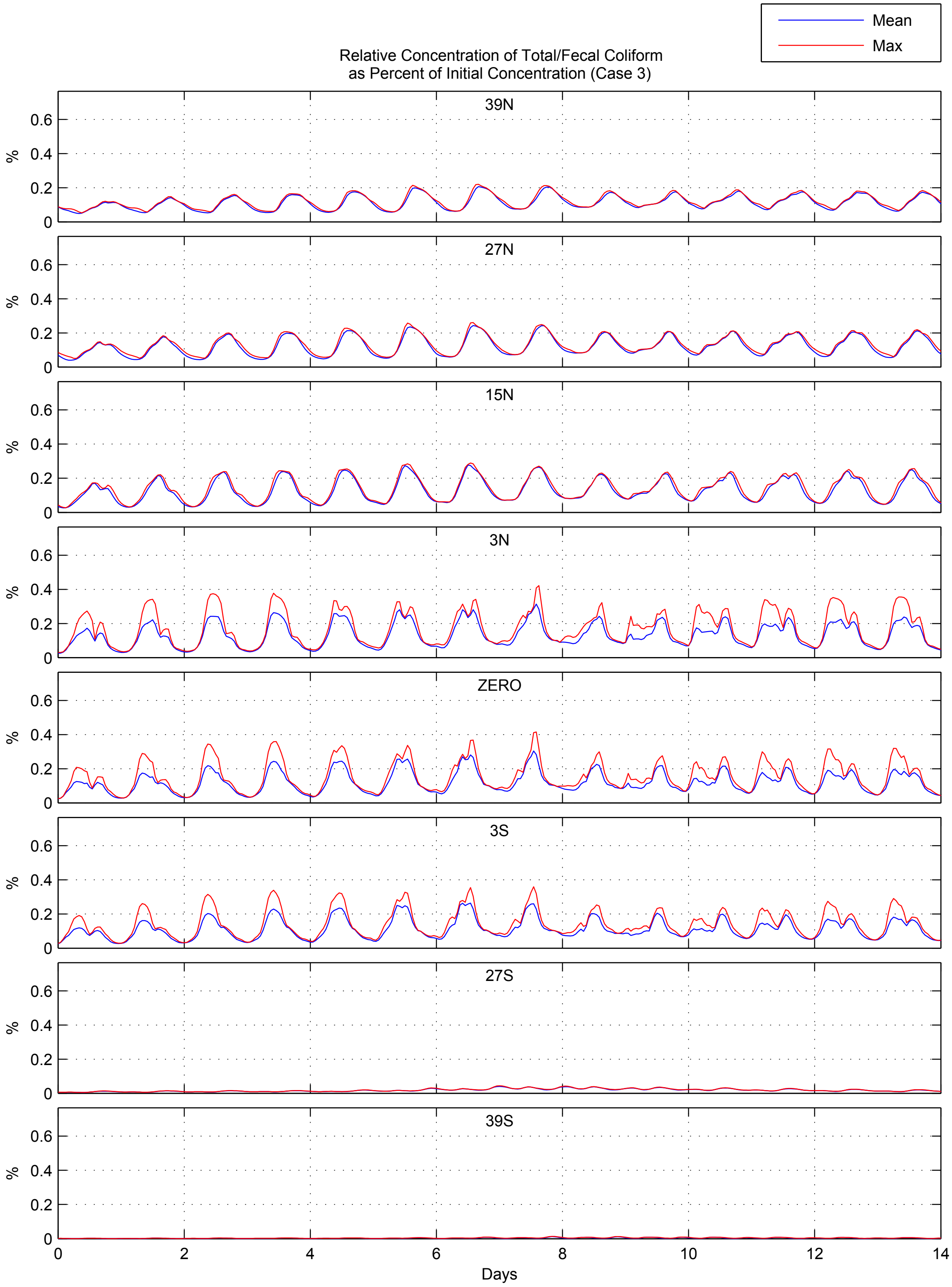


Figure D-51: Relative Concentration of Total/Fecal Coliform for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

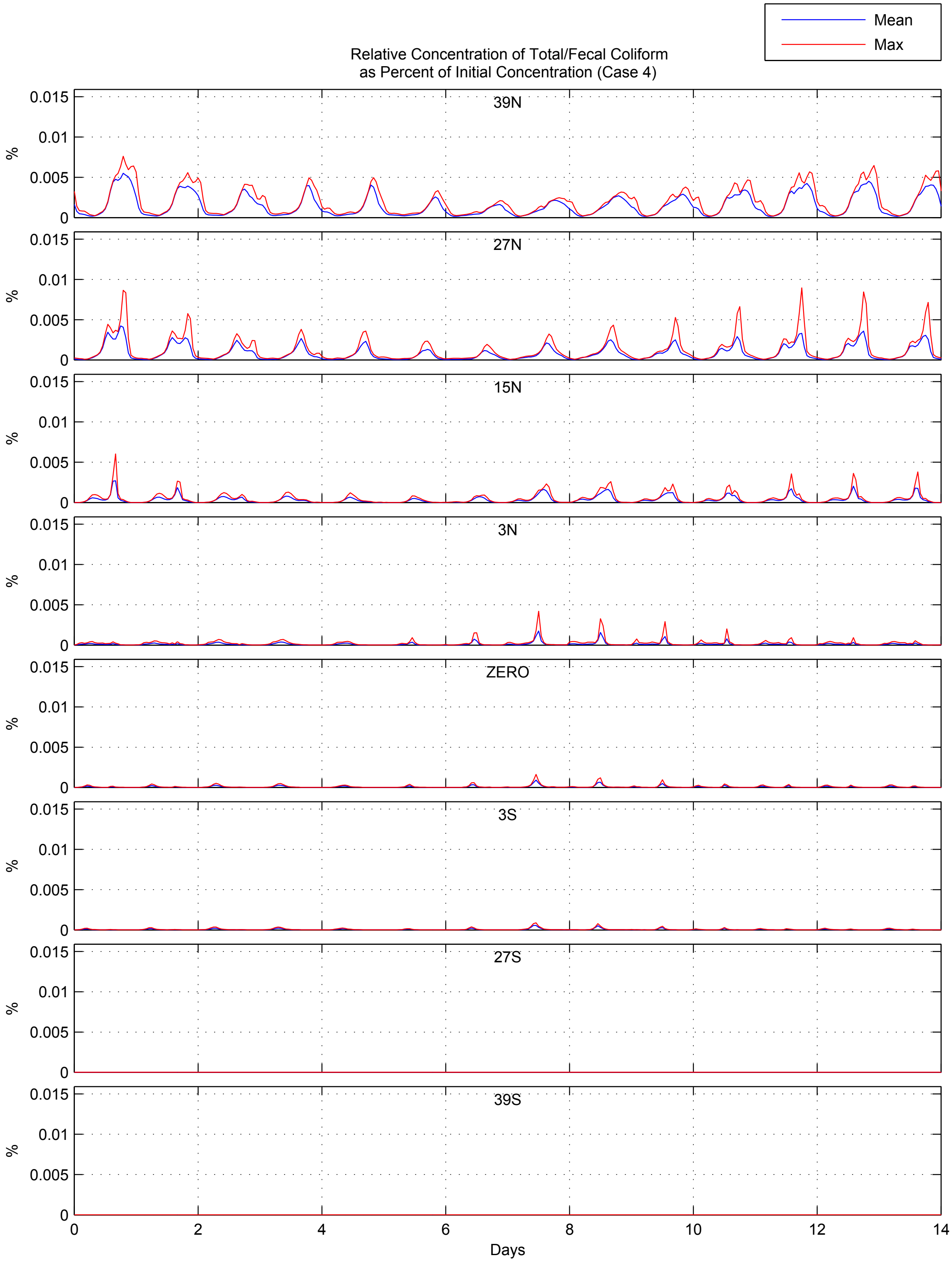


Figure D-52: Relative Concentration of Total/Fecal Coliform for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

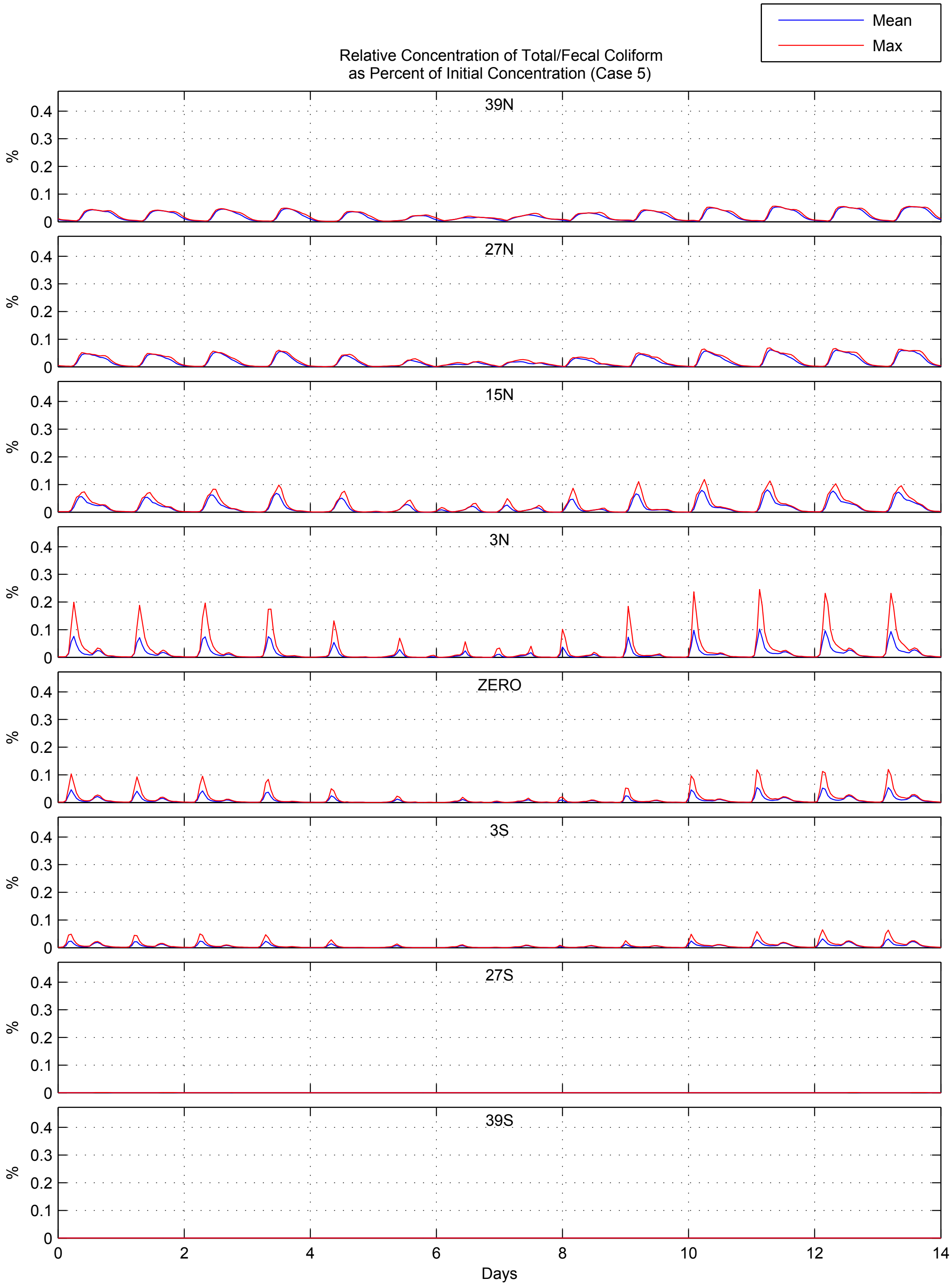


Figure D-53: Relative Concentration of Total/Fecal Coliform for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

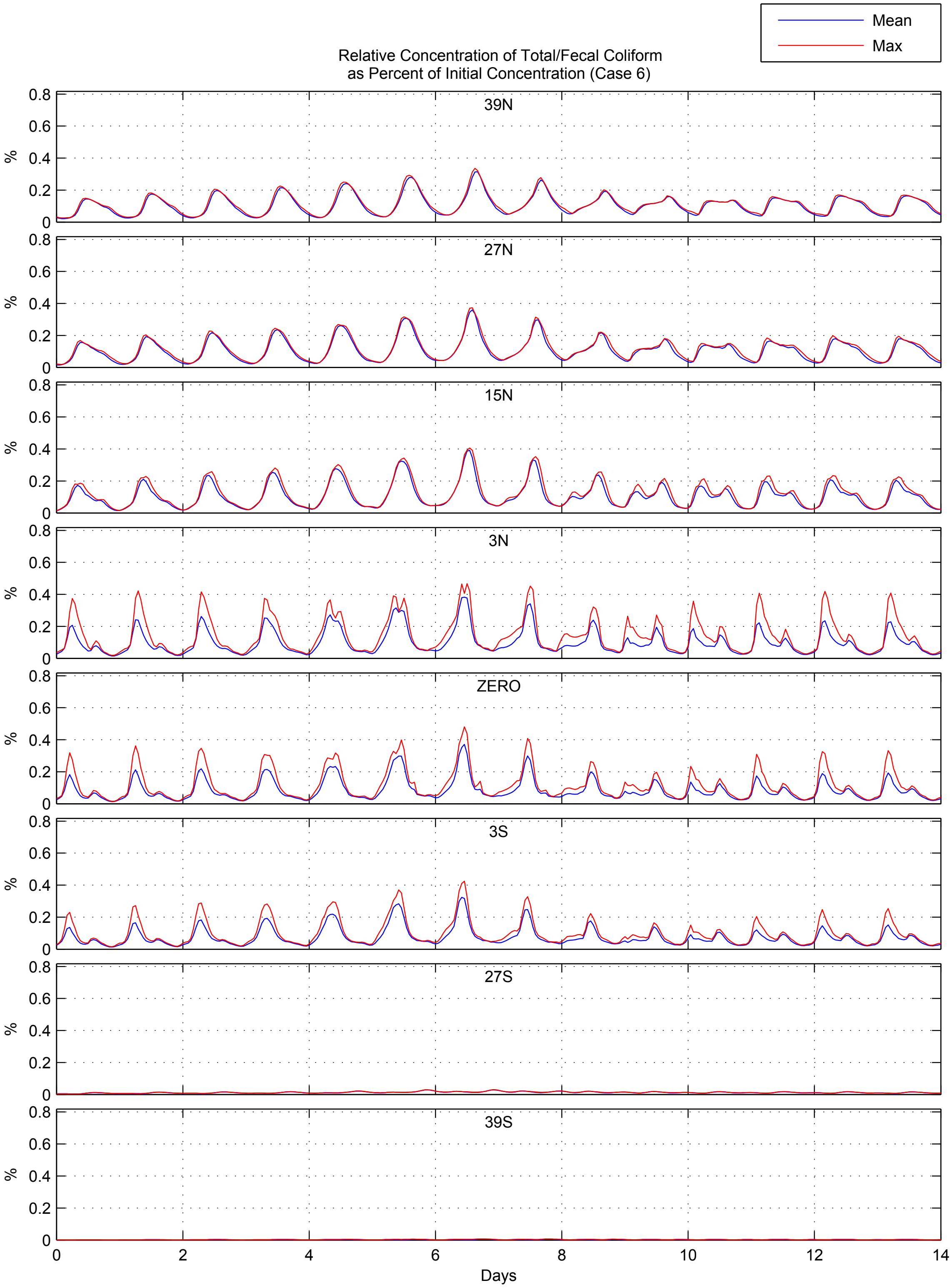


Figure D-54: Relative Concentration of Total/Fecal Coliform for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

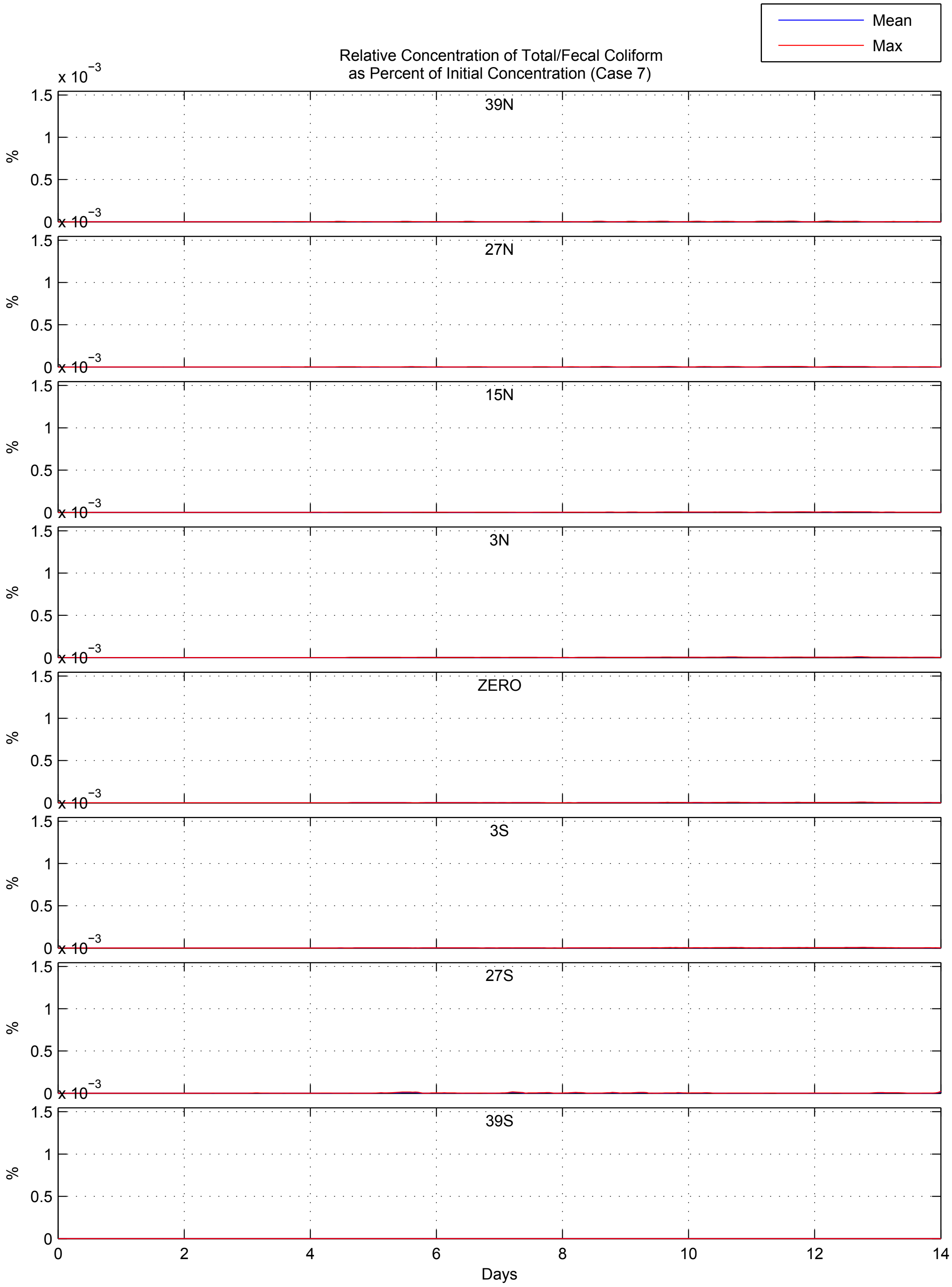


Figure D-55: Relative Concentration of Total/Fecal Coliform for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

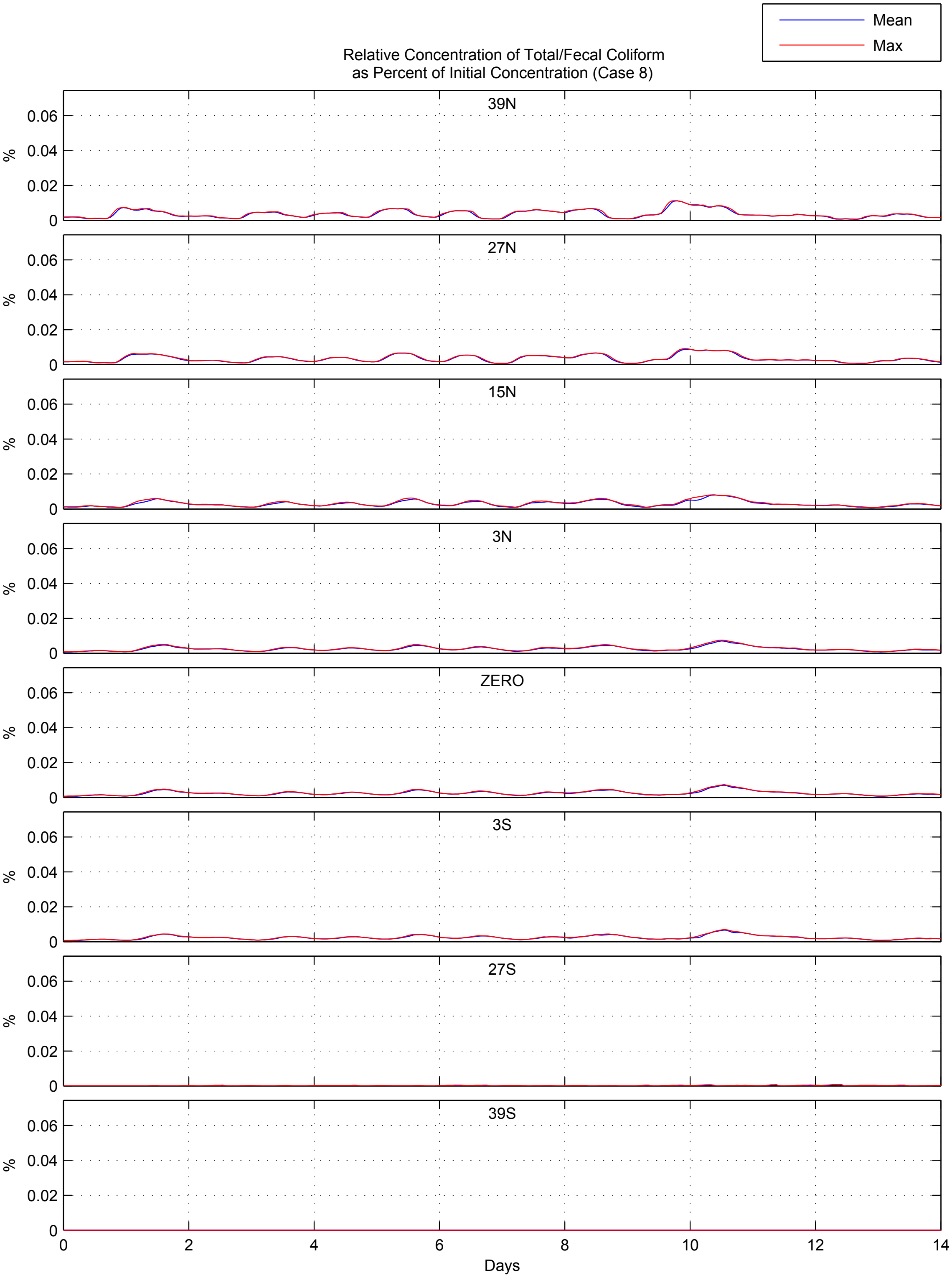


Figure D-56: Relative Concentration of Total/Fecal Coliform for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

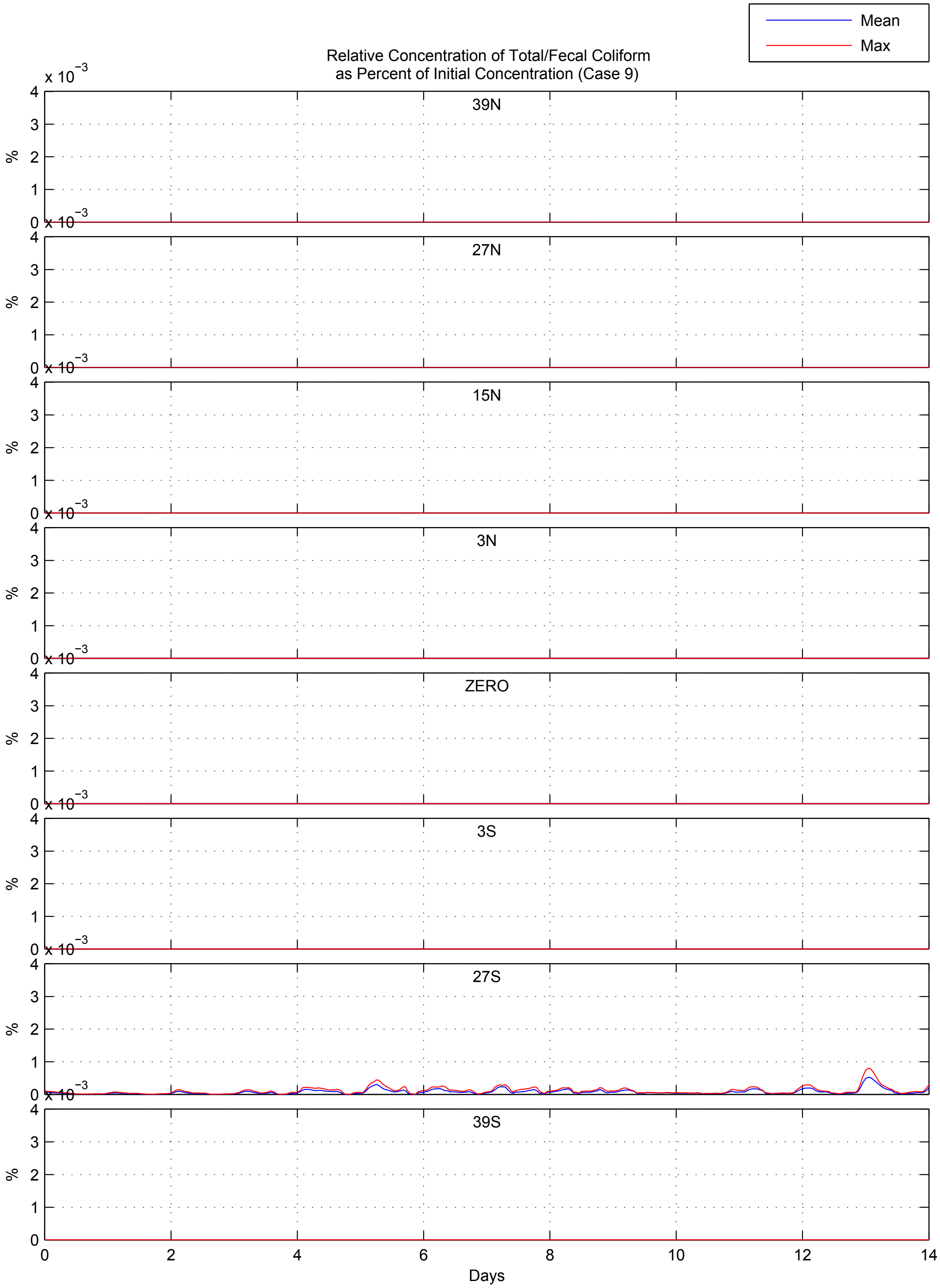


Figure D-57: Relative Concentration of Total/Fecal Coliform for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

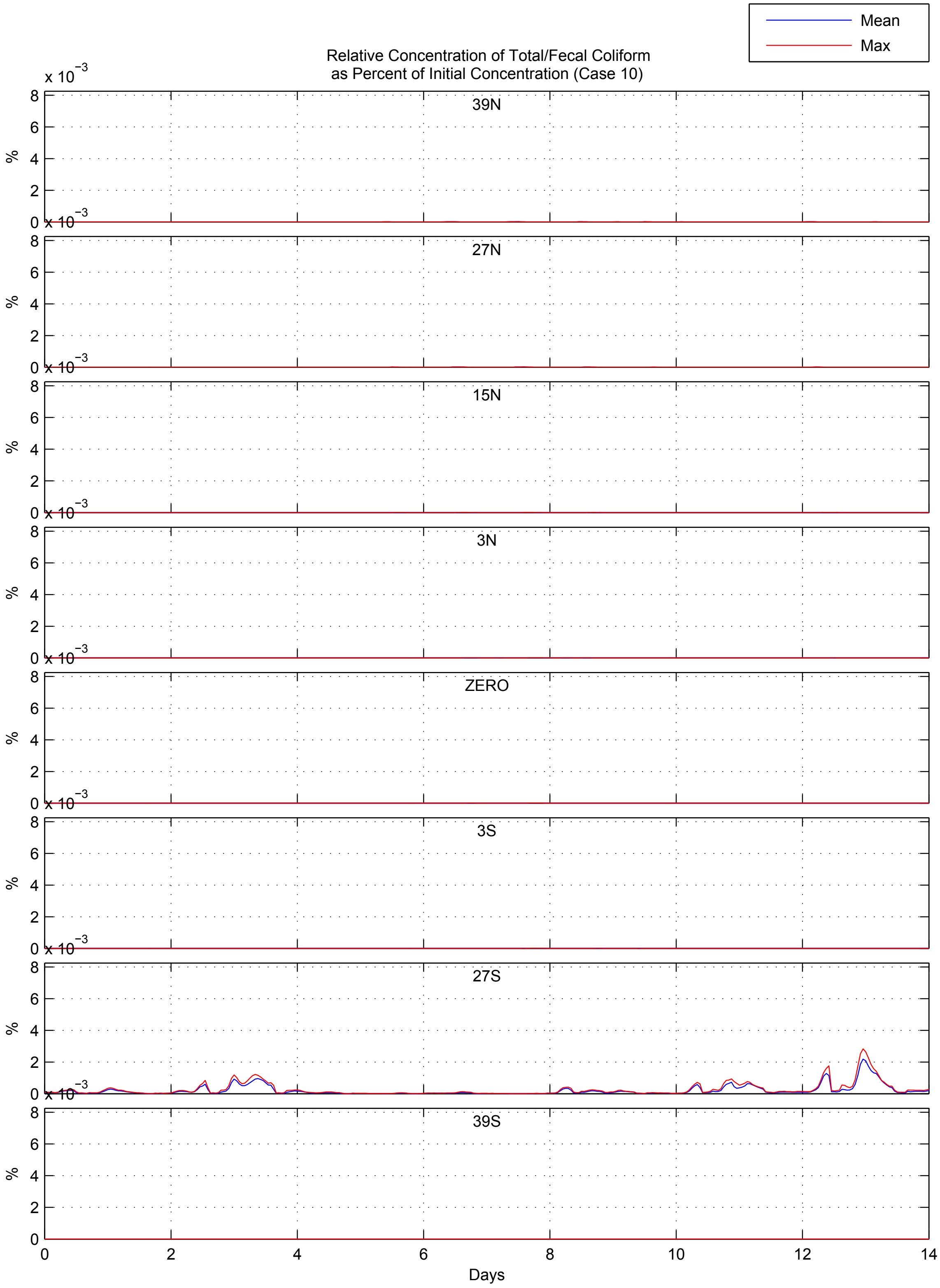


Figure D-58: Relative Concentration of Total/Fecal Coliform for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

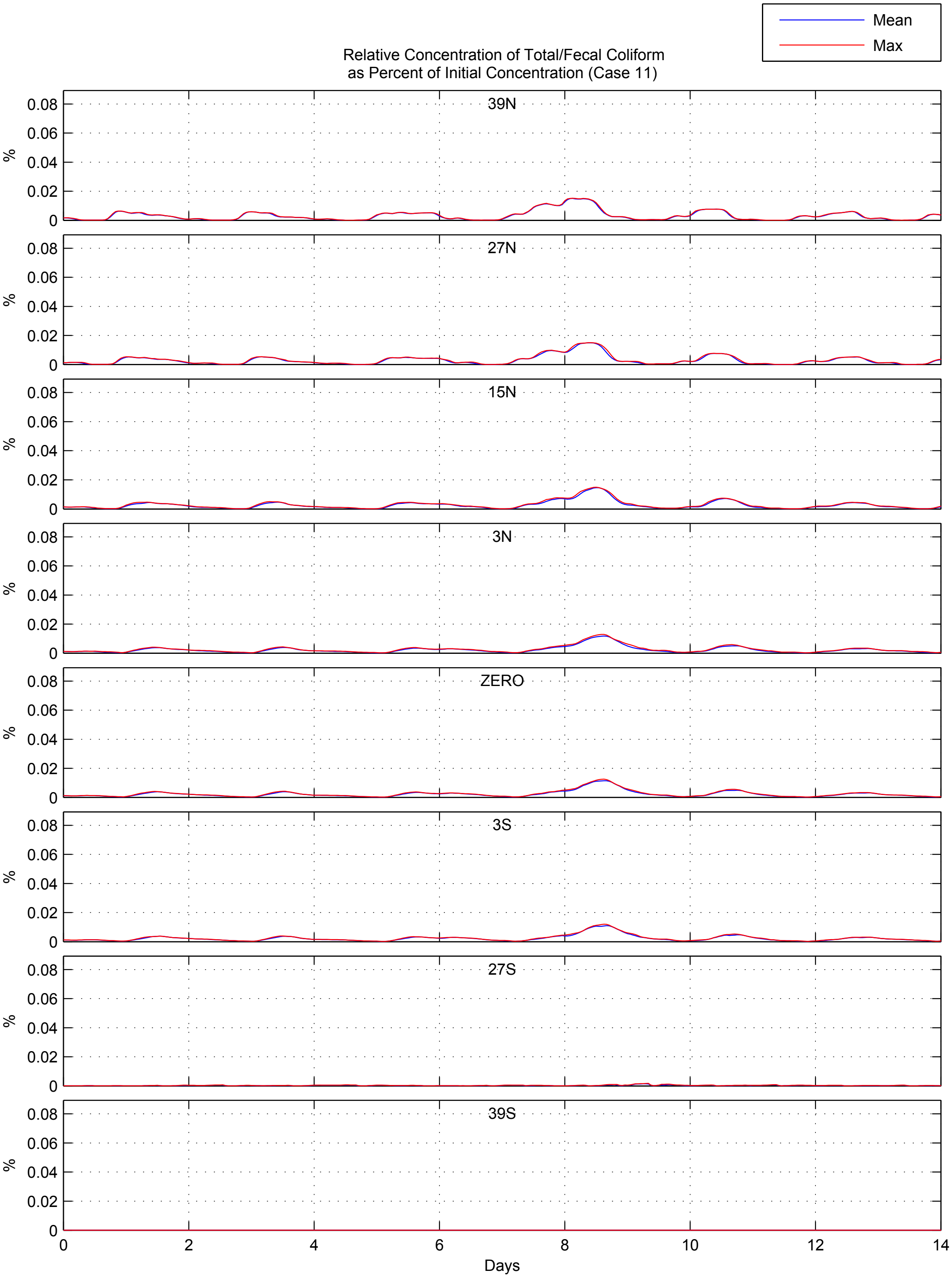


Figure D-59: Relative Concentration of Total/Fecal Coliform for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

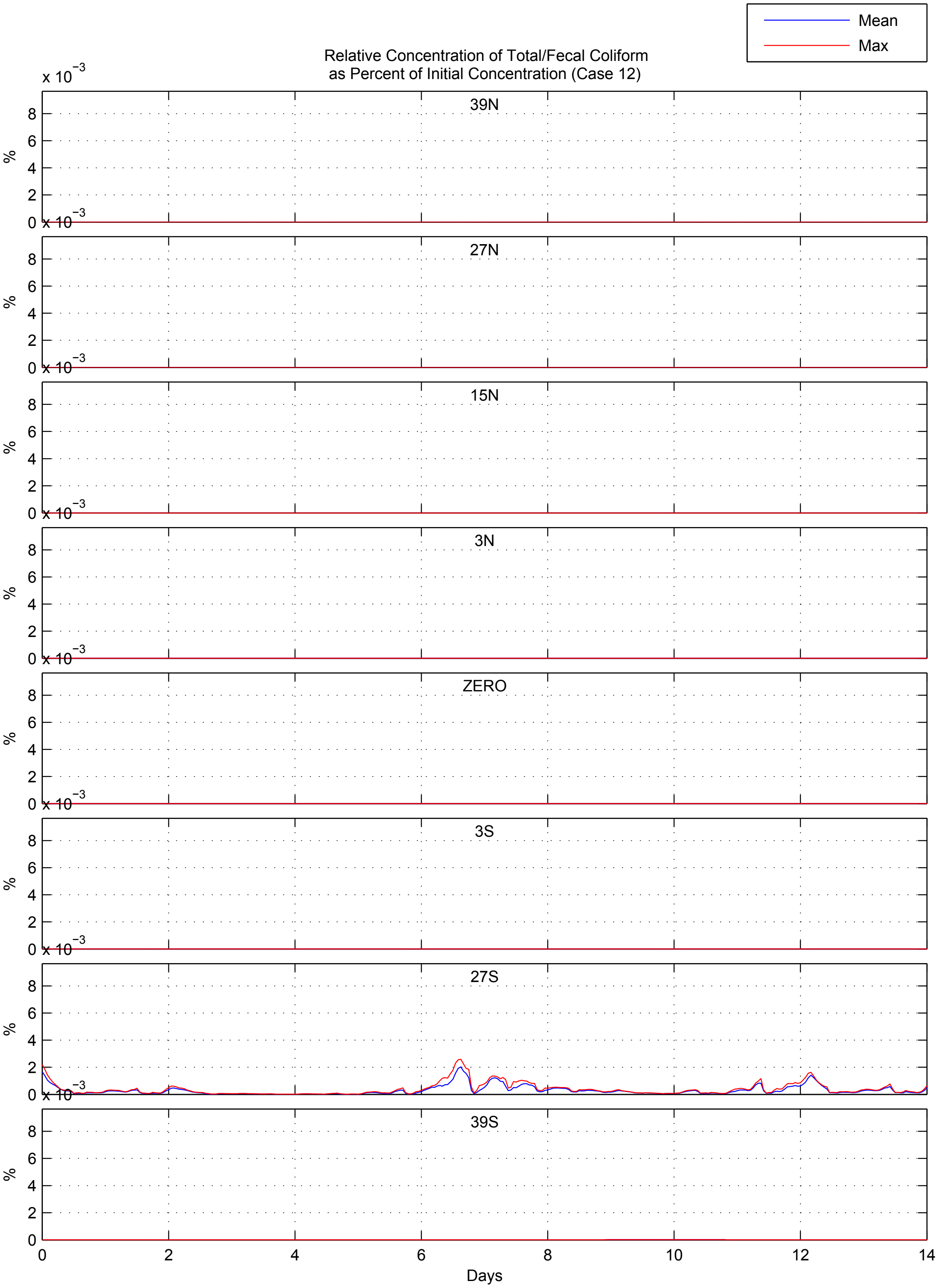


Figure D-60: Relative Concentration of Total/Fecal Coliform for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

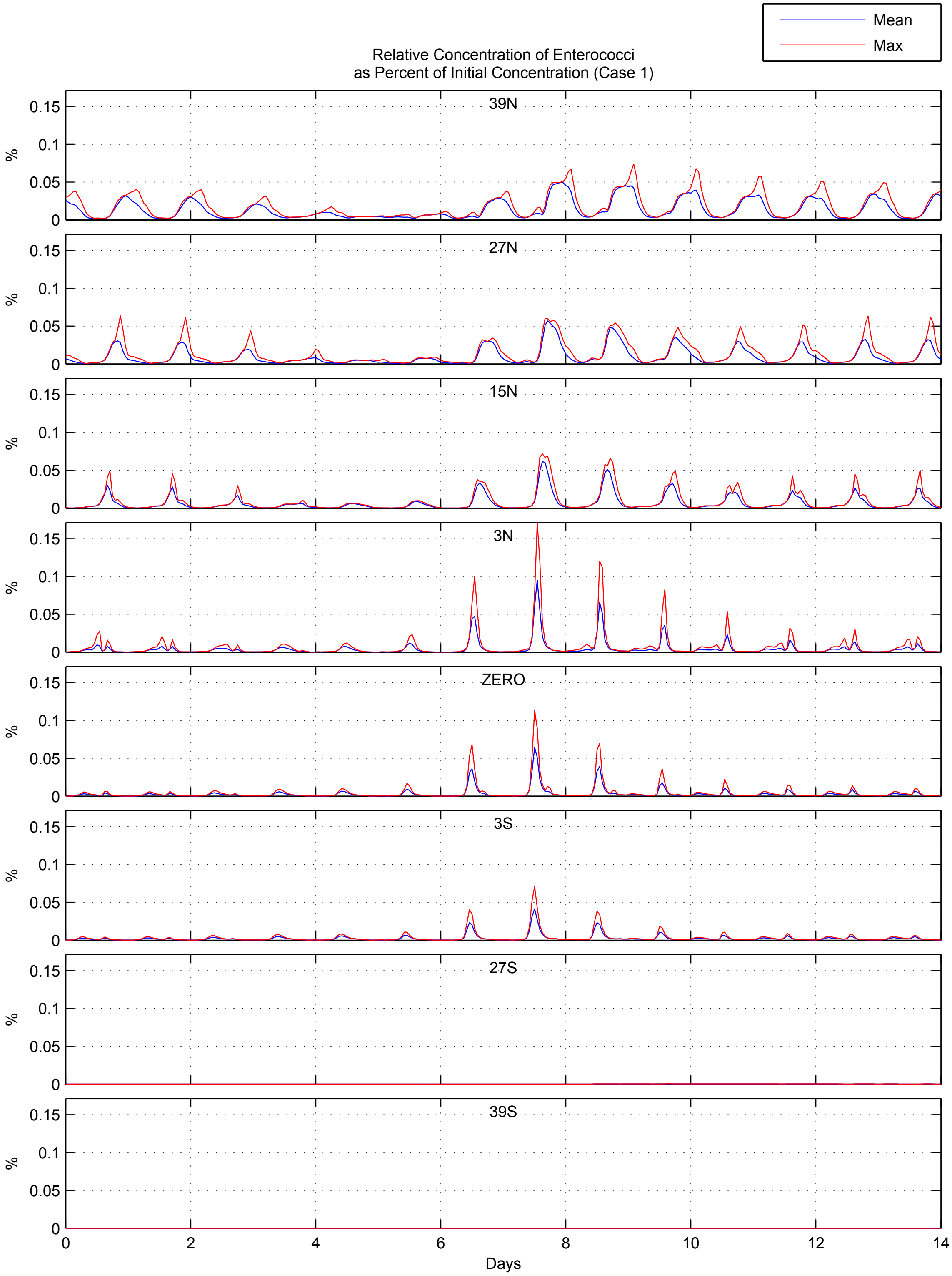


Figure D-61: Relative Concentration of Enterococci for Case 1 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

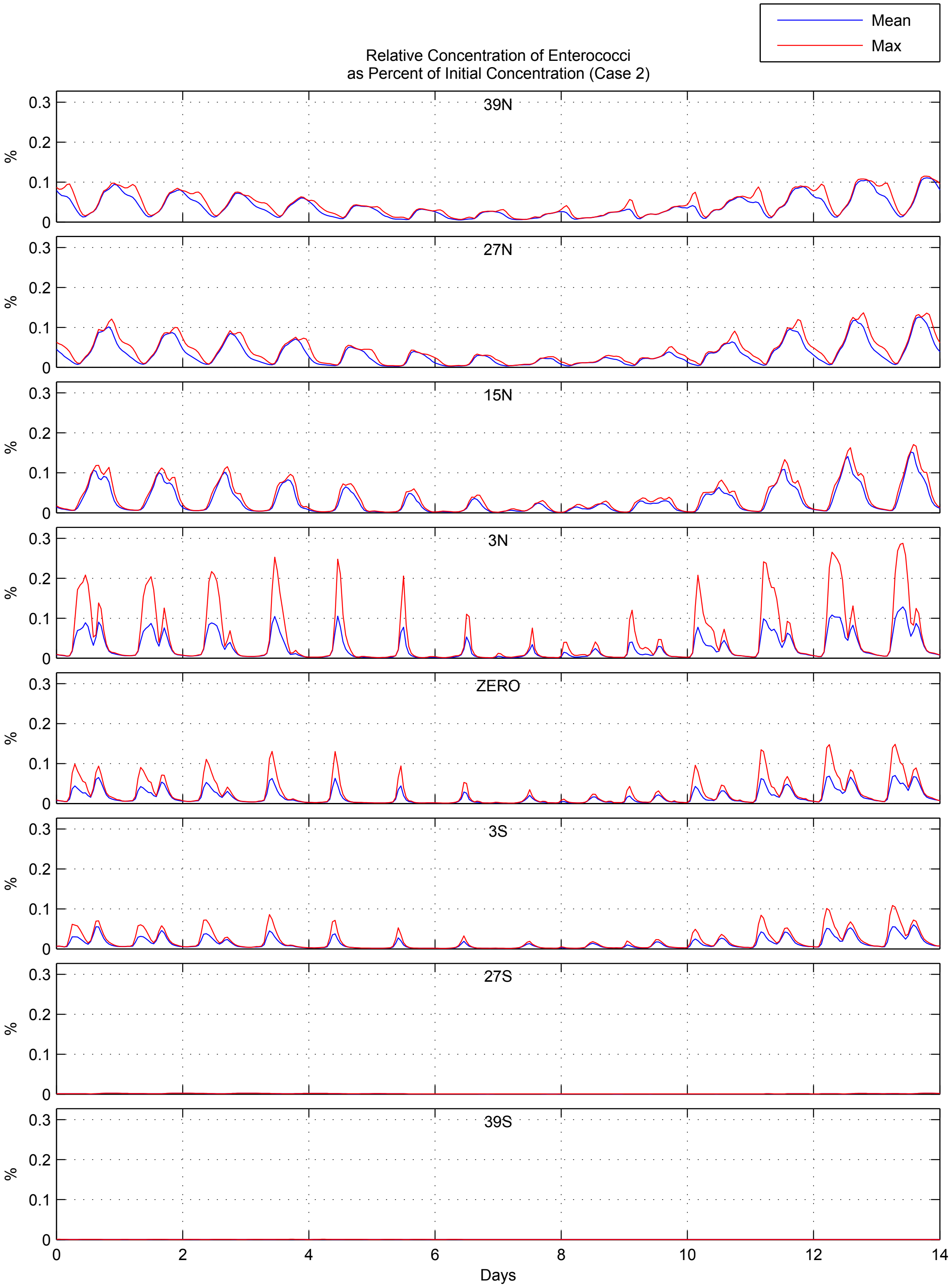


Figure D-62: Relative Concentration of Enterococci for Case 2 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

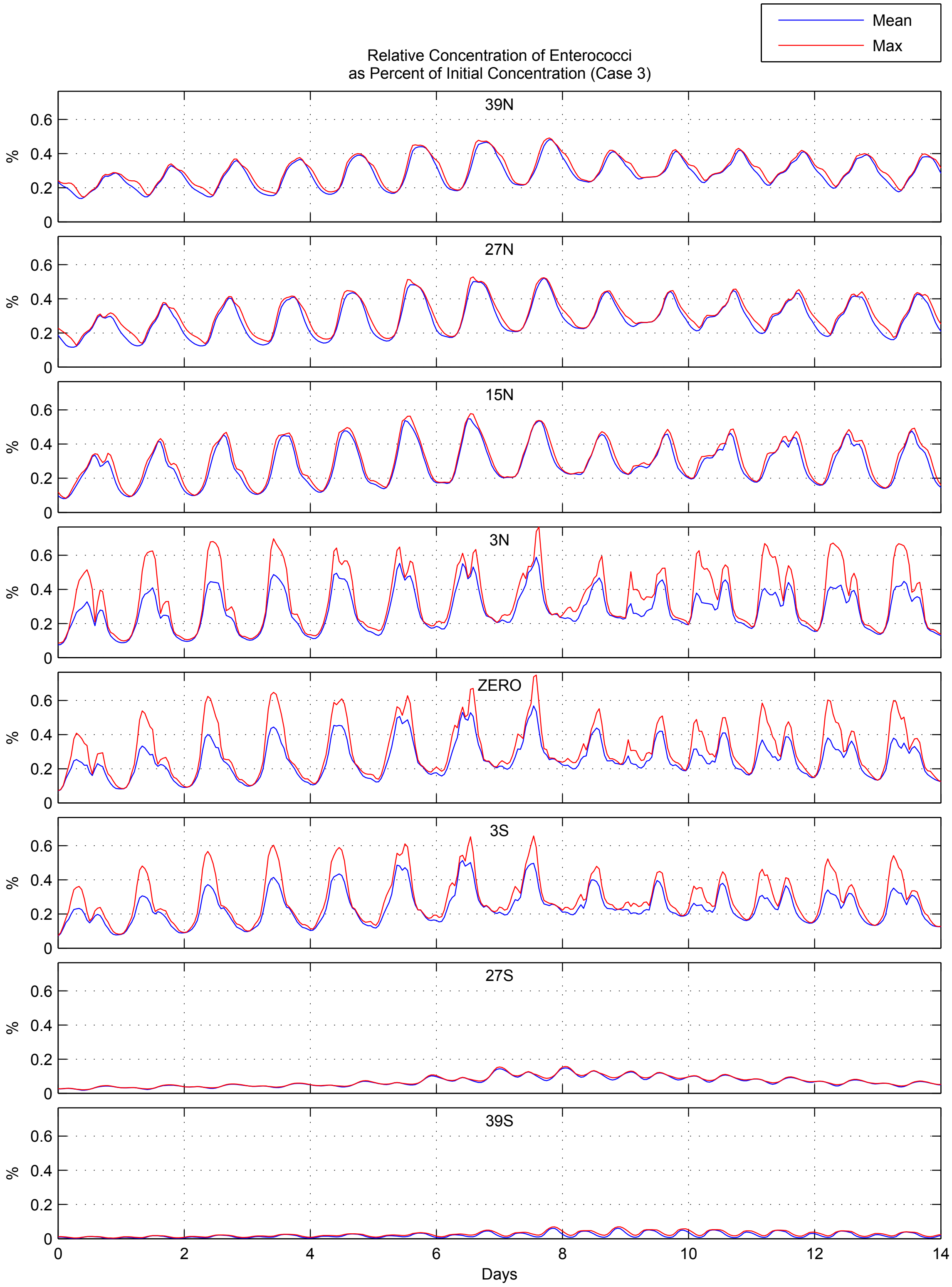


Figure D-63: Relative Concentration of Enterococci for Case 3 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 180° North)

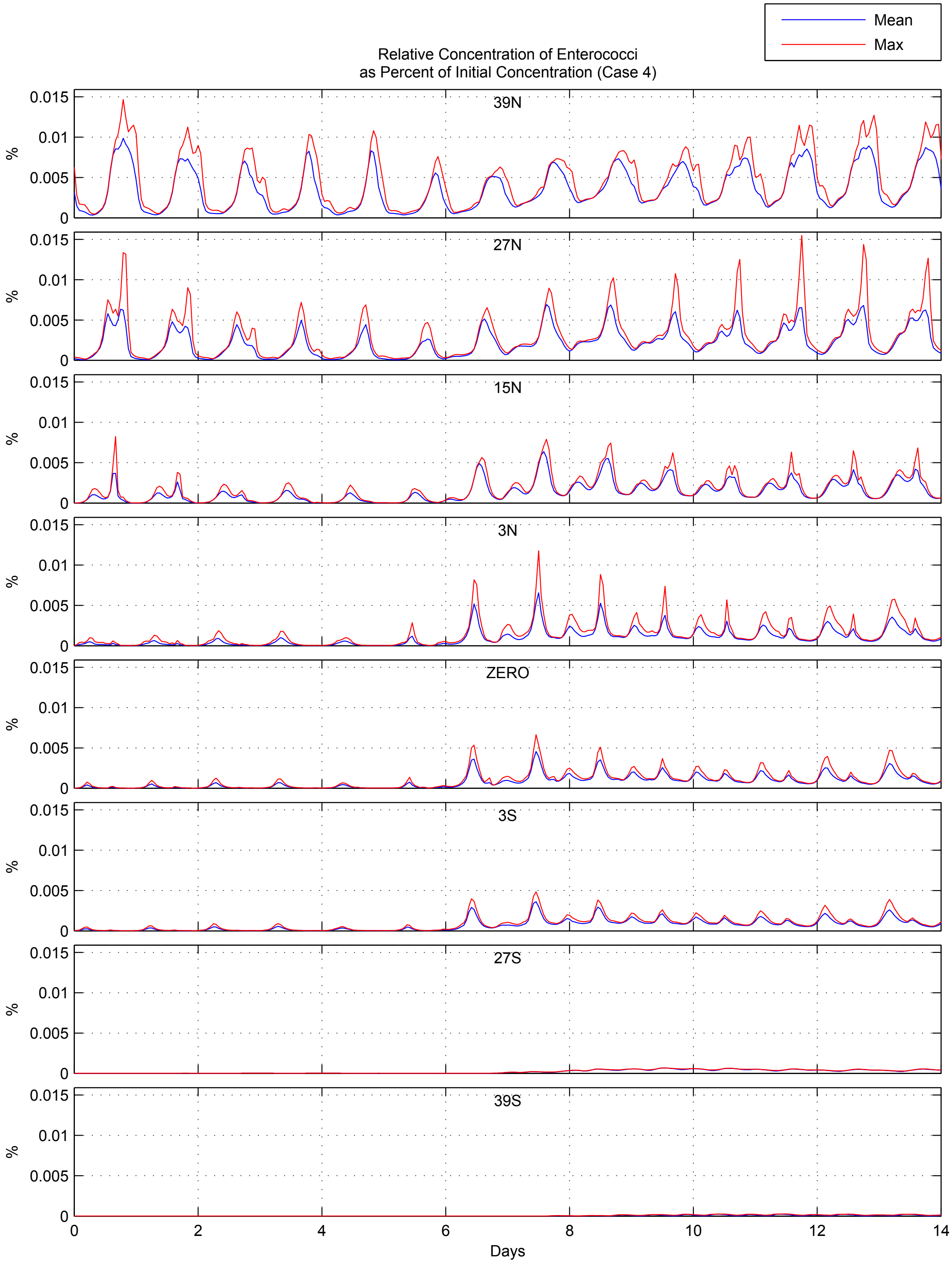


Figure D-64: Relative Concentration of Enterococci for Case 4 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

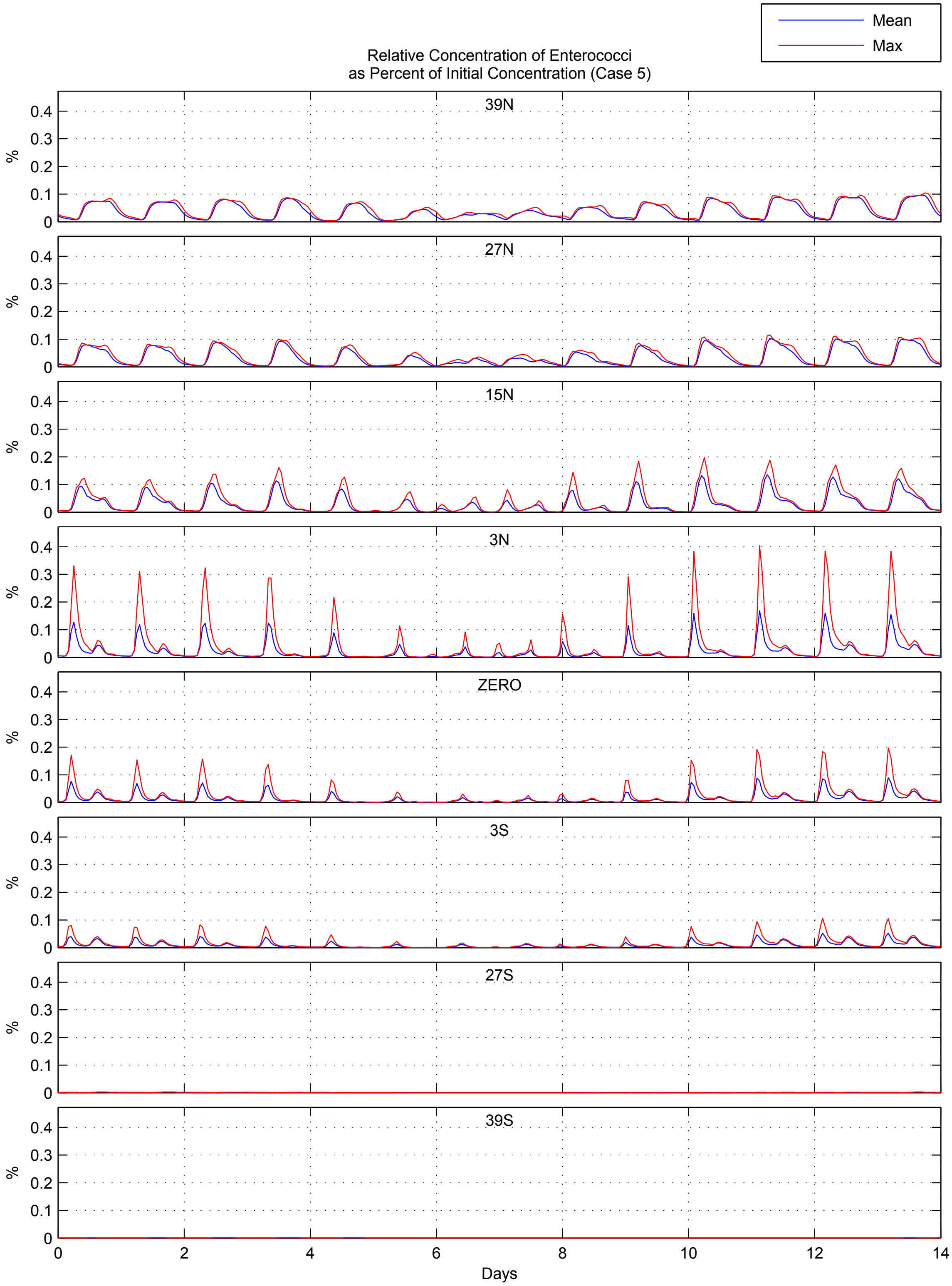


Figure D-65: Relative Concentration of Enterococci for Case 5 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

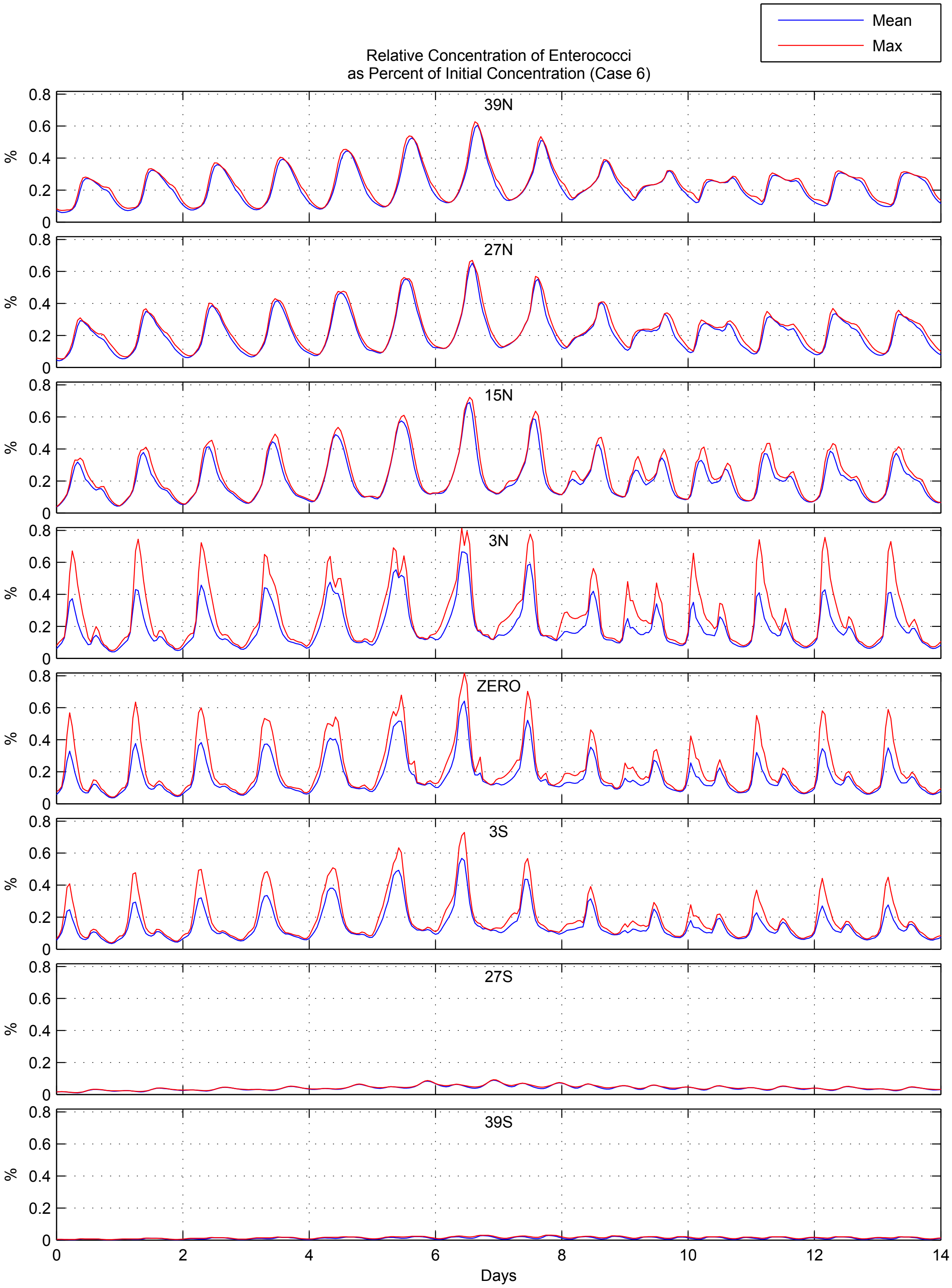


Figure D-66: Relative Concentration of Enterococci for Case 6 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 180° North)

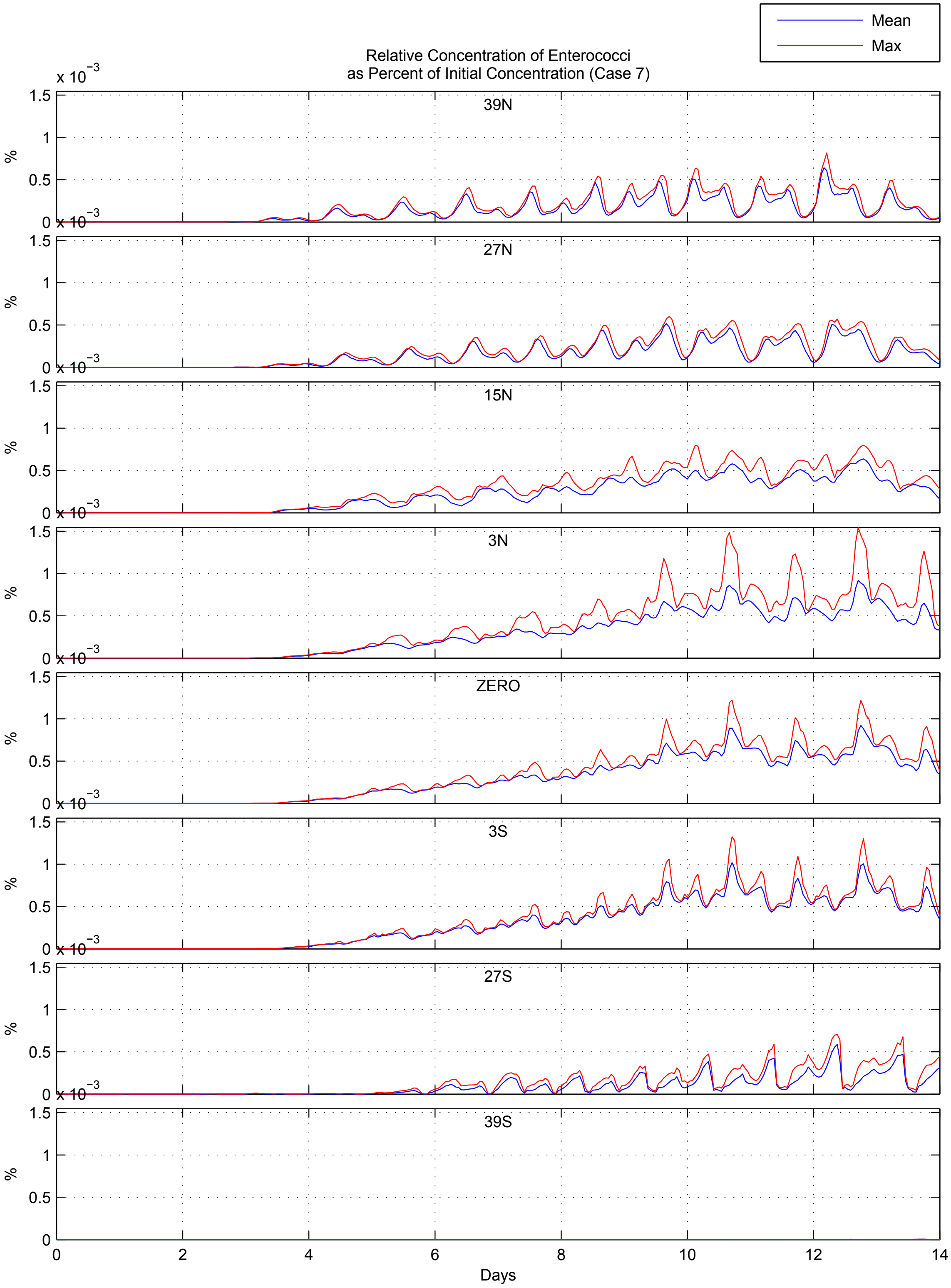


Figure D-67: Relative Concentration of Enterococci for Case 7 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

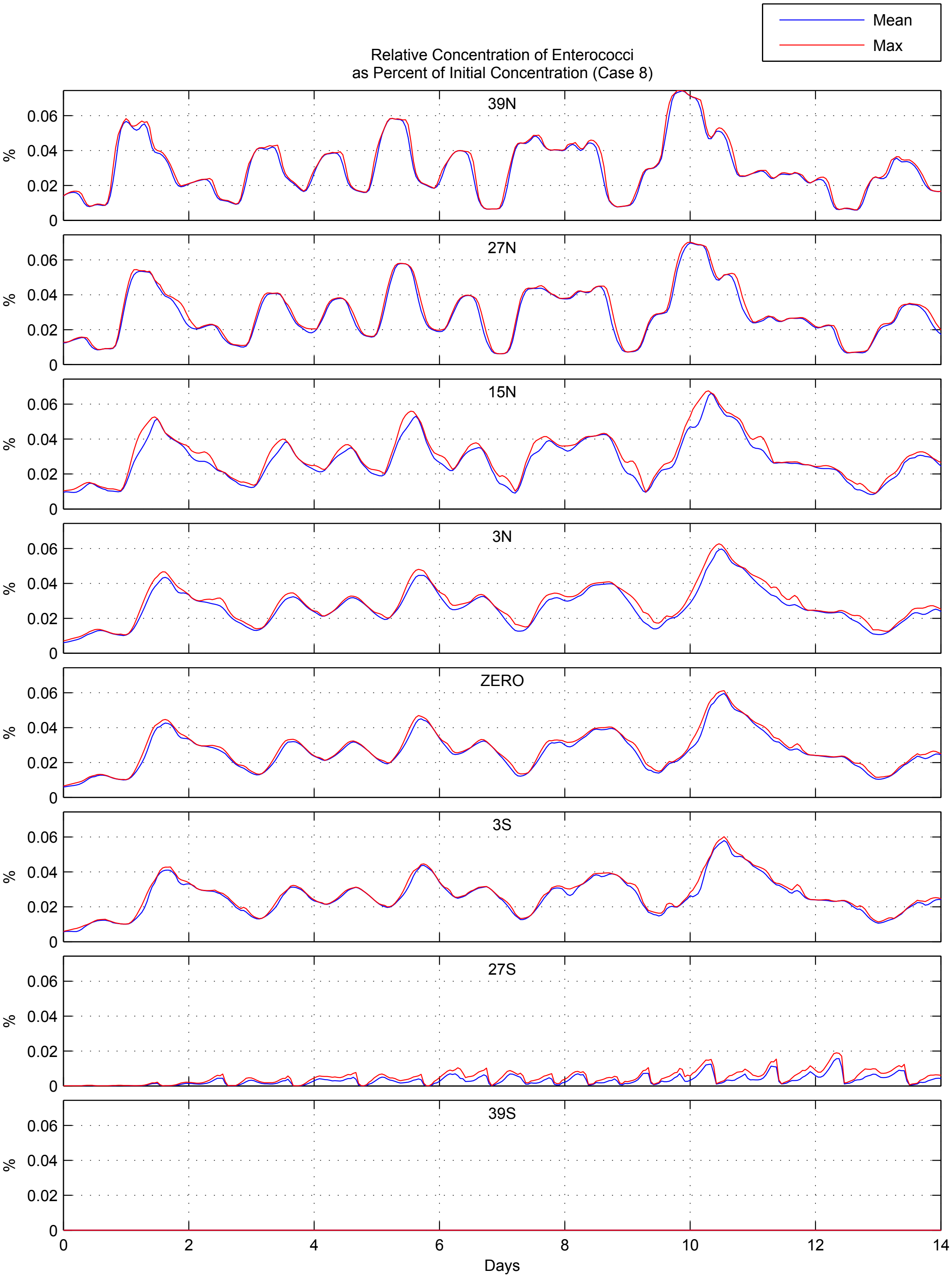


Figure D-68: Relative Concentration of Enterococci for Case 8 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

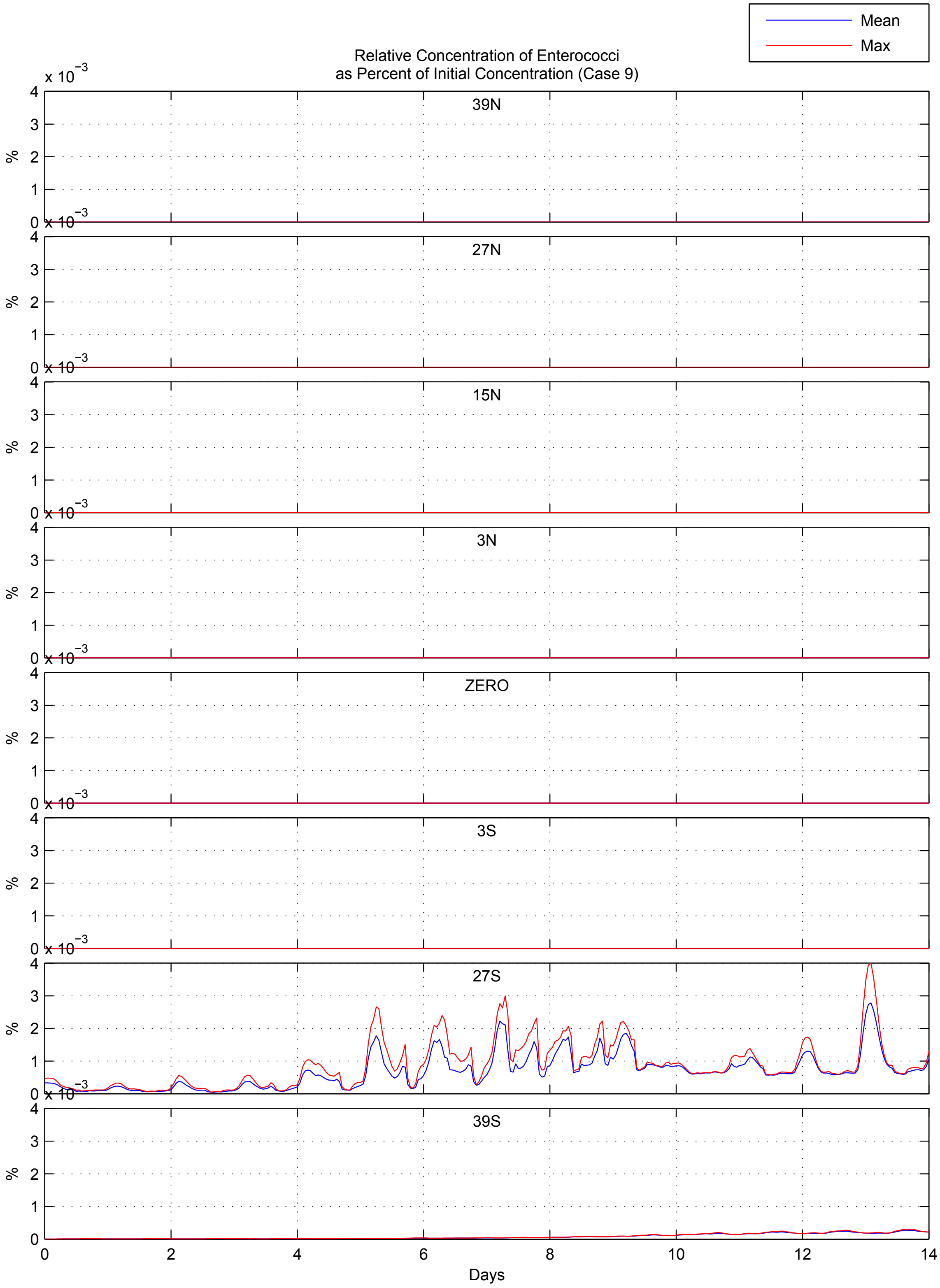


Figure D-69: Relative Concentration of Enterococci for Case 9 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.2 m, W_{dir} 270° North)

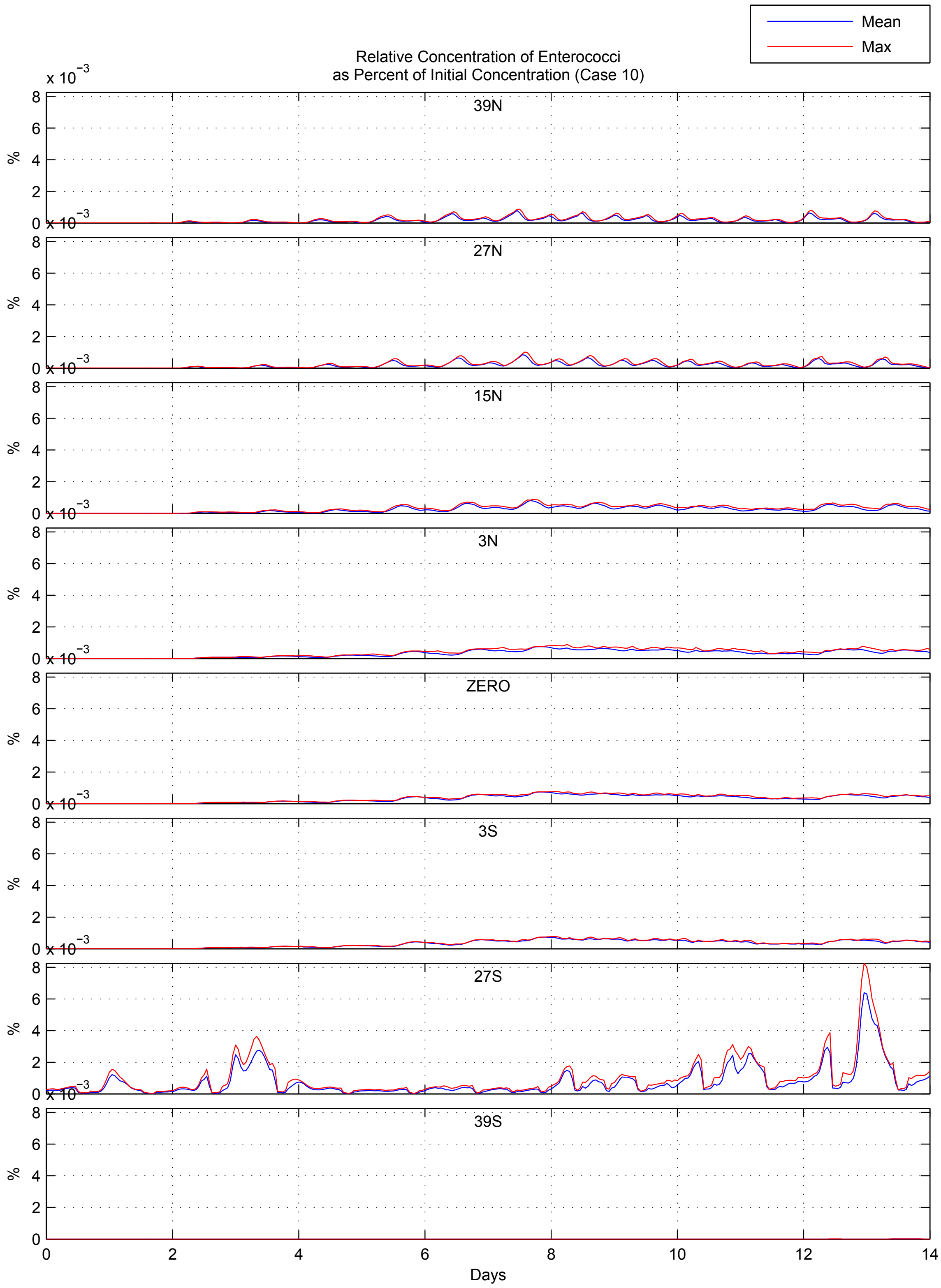


Figure D-70: Relative Concentration of Enterococci for Case 10 (Tidal Currents Only, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

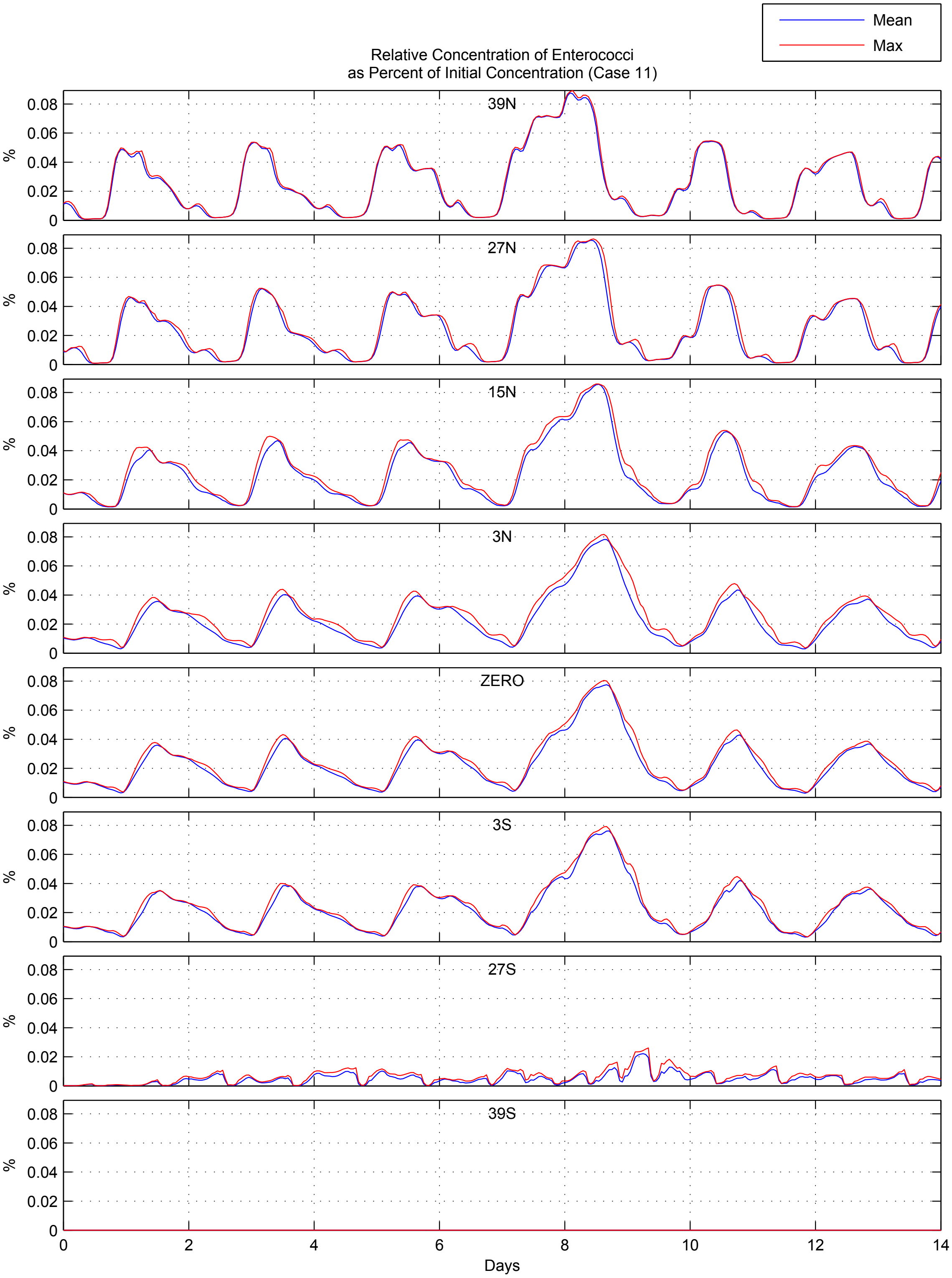


Figure D-71: Relative Concentration of Enterococci for Case 11 (Tidal Currents with 0.2 m/s NW Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

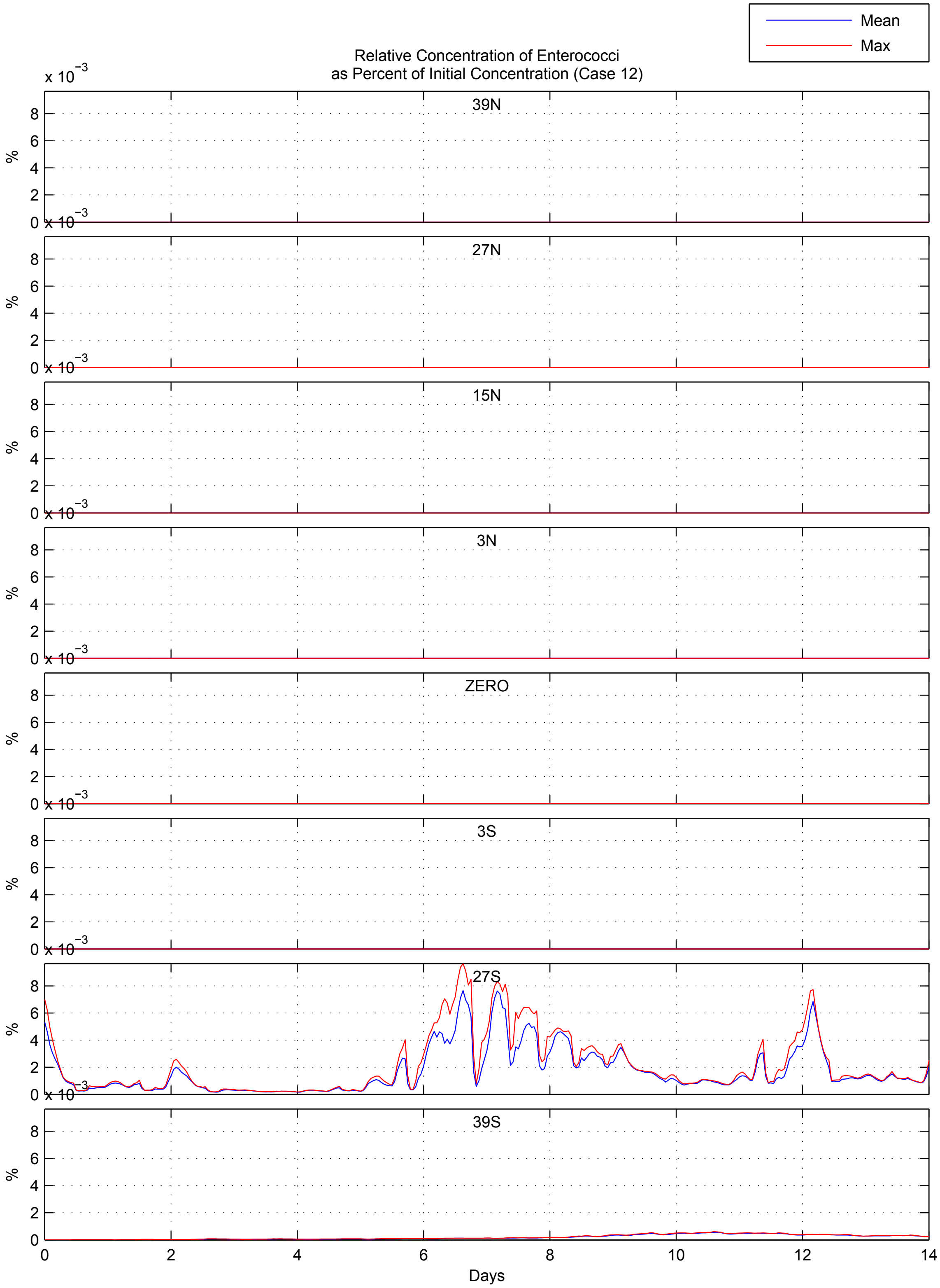


Figure D-72: Relative Concentration of Enterococci for Case 12 (Tidal Currents with 0.2 m/s SE Superimposed Current, T_p 15 sec, H_{sig} 1.4 m, W_{dir} 270° North)

Receiving Water Quality in the Vicinity of the Orange County Sanitation District's 78-inch Ocean Outfall

Prepared by the Orange County Sanitation District
Environmental Laboratory and Ocean Monitoring Division
October 17, 2011

Introduction

As part of a routine water quality sampling program[1] to monitor the location and characteristics of its treated effluent after discharge to the ocean, the Orange County Sanitation District (District) measures various physical, chemical, and biological water quality indicators. The District's water quality monitoring region is located on the southern portion of the San Pedro Shelf and extends from the shoreline to approximately 12 km offshore and to a water depth of 310 m. The entire sampling area covers approximately 102 km^2 (Figure 1). This report summarizes water quality data from the area near the 78-inch outfall terminus and at selected surfzone stations from July 1998 to June 2011 and evaluates potential impacts due to discharging highly treated effluent from the 78-inch outfall. Detailed information on sampling procedures and equipment may be found in various annual ocean monitoring reports submitted to the US Environmental Protection Agency and the Regional Water Quality Control Board, Region 8 (e.g., OCSD, 2010).

Background

Regional and local changes in oceanographic conditions can strongly influence the District's study area on daily, seasonal, and yearly timescales. Large-scale and long-term climatic events, such as the Pacific Decadal Oscillation (PDO) and El Niño/Southern Oscillation (ENSO) can also alter local conditions on decadal and multi-year timescales (OCSD 2004). These events are notable for producing changes in near coastal water surface temperature and rainfall/runoff in the study region, which can impact water quality (OCSD 2004). One of the primary differences between PDO and ENSO is that PDO events have cycles of 5–20 years, but may persist for up to 70 years, while a typical ENSO event occurs, on average, every 5 years and may last 6–18 months (Chao et al. 2000, Mantua 2000). Upwelling can also strongly influence water quality and productivity in coastal areas by providing a source of additional nutrients to the coastal environment (Fischer et al. 1979, Sverdrup et al. 1963, Valiela 1995). These natural events modify effects seen from human-related sources, such as wastewater discharges, dredged material disposal, atmospheric deposition, and runoff from the adjacent watershed.

Under normal operations, the wastewater discharge from the District's 120-inch outfall dilutes quickly by being "jetted" out through 503 discharge portholes located in the last 1.6 km of the outfall pipe. This initial dilution greatly reduces observable differences between the discharged less saline or "fresh" wastewater and surrounding seawater. Predicted changes in receiving water parameters, based on comparisons with natural conditions using a dilution ratio of 180:1 (OCSD 1991; 2004, SAIC et al. 2001) fall well within typical natural ranges to which local marine organisms are exposed. These changes, combined with the discharge plume typically staying below 20 m depth (Tetra Tech 2002, 2008) and predominant ocean currents keeping the plume offshore (OCSD 1994, Noble and Xu 2004, Noble et al. 2009, SAIC 2009), represent insignificant risks to the environment or human health.

Several significant factors change with the use of the 78-inch outfall, which will alter the potential impact of the discharge of treated effluent to the receiving water. These include discharging: (1) closer to shore (~2 km versus 7 km) and (2) in shallower, less stratified water

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[1] The programmatic goals are to assess discharge-related changes to water quality and compare them to criteria contained in the California Ocean Plan (COP; SWRCB 2005) and the District's NPDES discharge permit (Order No. R8-2004-0062, Permit No. CAO110604) to determine compliance and to evaluate potential impacts to the marine environment and public health.

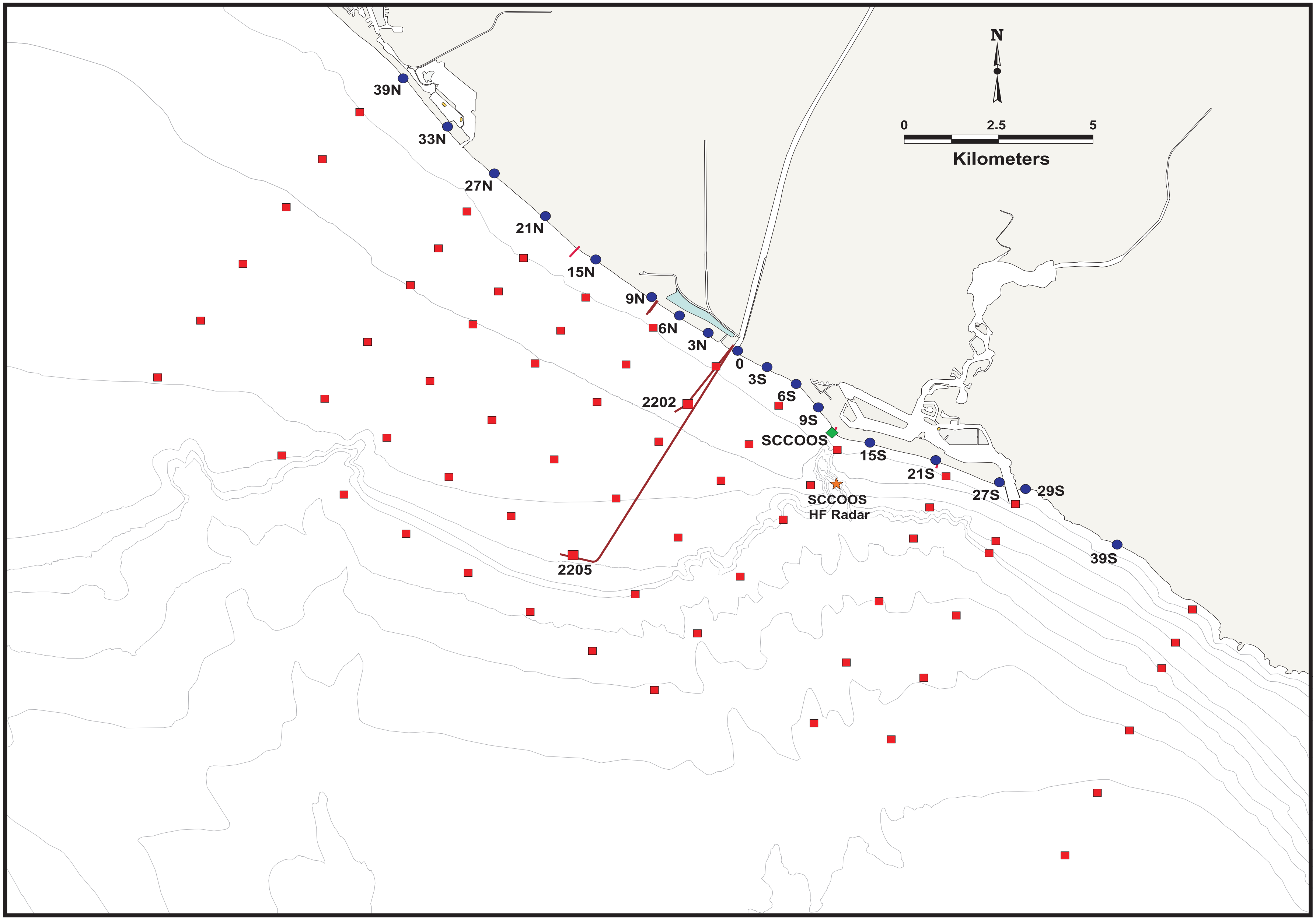

Figure 1. Sampling locations for OCSD surfzone and water quality stations and the Southern California Coastal Ocean Observations System (SCCOOS) Newport Pier and high frequency (HF) radar stations.

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(17 m versus 60 m). Additionally, the designed initial dilution for the 78-inch outfall is much less (fall season average of 36:1; Moffatt and Nichol 2011) than that of the 120-outfall (~200:1; TetraTech 2008). These differences lead to significant probabilities of the discharged effluent plume rising to the surface as well as increasing the expected changes to receiving waters (Table 1). Water quality data from Station 2202, located at the terminus of the 78-inch outfall, provide expected water quality conditions near the outfall. Data from the District's surfzone and the Southern California Coastal Ocean Observations System (SCCOOS) Newport Pier stations provide information on expected conditions at the beach.

Table 1. Expected changes to typical receiving water parameters following initial dilution of 36:1.

Parameter	Final Effluent Mean[1,2,3]	Approx. Natural Mean[4]	Expected Change (%)[5]			COP Objective[6]
Temperature (°C)	25.1	17.4	Increase up to	0.21	(1.2)	Not Applicable
Salinity (psu)	2.25	33.42	Decrease up to	-0.84	(2.5)	Not Applicable
Dissolved Oxygen (mg/L)	1.52	8.39	Decrease up to	-0.19	(2.2)	<10% decrease
pH	7.2	8.14	Decrease up to	-0.03	(0.3)	<±0.2 units
Ammonia (mg/L)	30	0.01	Increase up to	0.81	(8105)	not cause objectionable growths or degrade biota.
Total Coliform (MPN/100 mL)	34,500	10	Increase up to	932	(9322)	≤1,000
Total Coliform$_{\text{opt}}$	632	10		17	(168)	
Fecal Coliform (MPN/100 mL)	3,400	10	Increase up to	92	(916)	≤200
Fecal Coliform$_{\text{opt}}$	153	10		4	(39)	
Enterococcus (MPN/100 mL)	705	10	Increase up to	19	(188)	≤35
Enterococcus$_{\text{opt}}$	20	10		0	(0)	

[1] Effluent values from SAIC (2001)

[2] Mean values based on log mean of final effluent data; January 2006 – November 2010

[3] Mean values based on log mean of final effluent data; July 25– August 15, 2011

[4] Summer and fall mean values from Station 2202, July 1998 – May 2011

[5] Expected change formula: ((Natural value*36)+(Final Effluent value*1))/37)-Natural value

[6] Bacteria COP Objectives represent the 30-day geometric mean standards

RESULTS AND DISCUSSION

This section presents quarterly summaries of water quality from selected OCSD surfzone, offshore Station 2202, and the Southern California Coastal Ocean Observation System (SCCOOS) Newport Pier station. The analyses focus on results for summer (July–September) and fall (October–December) quarters as representative of receiving water conditions expected during the use of the 78-inch outfall.

Temperature and Density

Surfzone and Newport Pier

While within month and season differences were observed, mean (average and median) monthly temperature showed very little spatial variability (Figure 2; Tables A-1 and A-2; Figures B-1 and B-2). All stations showed the same pattern of low winter and spring temperatures that rapidly increased to a maximum in July. Temperature values in late summer and fall showed decreases to winter lows. Monthly variability ranged from 7–12% and 8–9% for the surfzone and Newport Pier, respectively. No density measures were available for the surfzone stations.

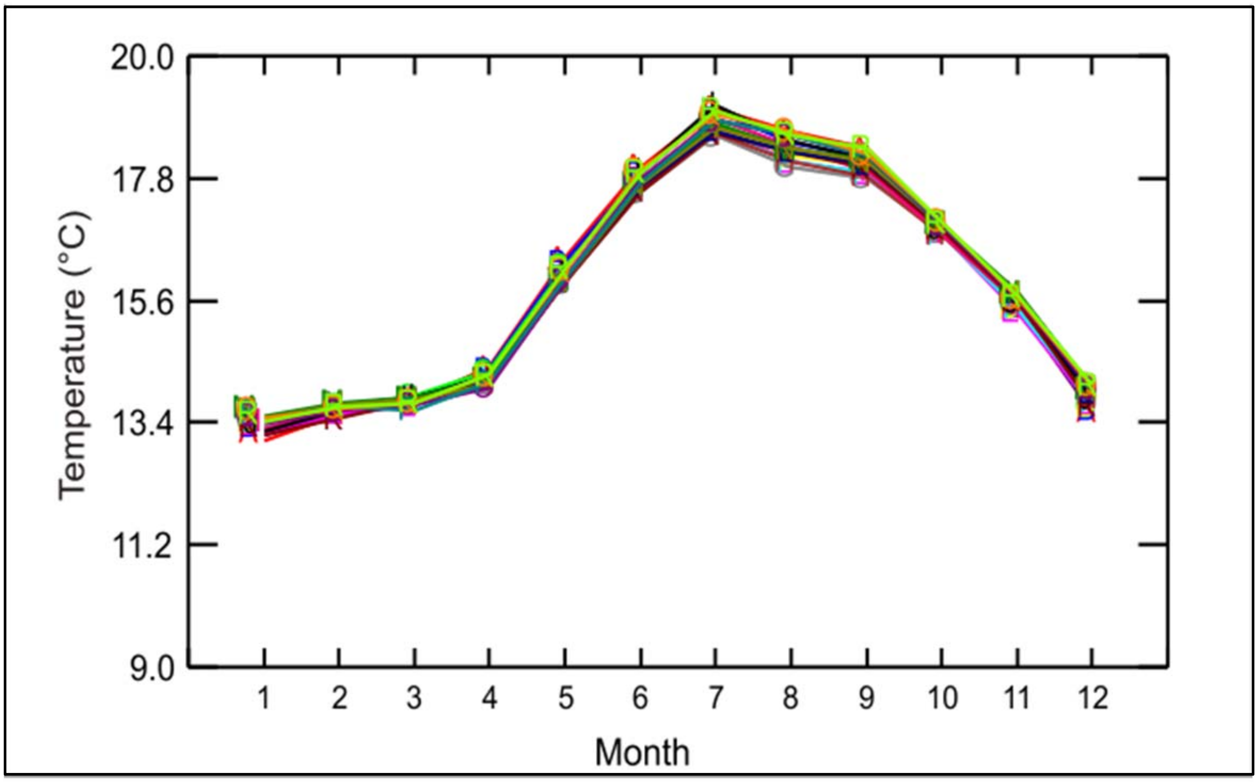

Figure 2. Monthly average temperatures for OCSD surf zone stations (April 2000 - August 2011).

Orange County Sanitation District, California.

Station 2202

Water temperature in the offshore area depended on both depth and season (Figures 3 and 4a; Table A-3). Differences between the average surface and bottom temperatures (a rough measure of stratification) ranged from 1 to 6.1°C, with the least stratification seen in winter and the greatest in summer. Fall showed an average temperature difference of around 4°C due to decreasing temperatures values above 10 m. Temperature variability ranged from 6 to 12% for

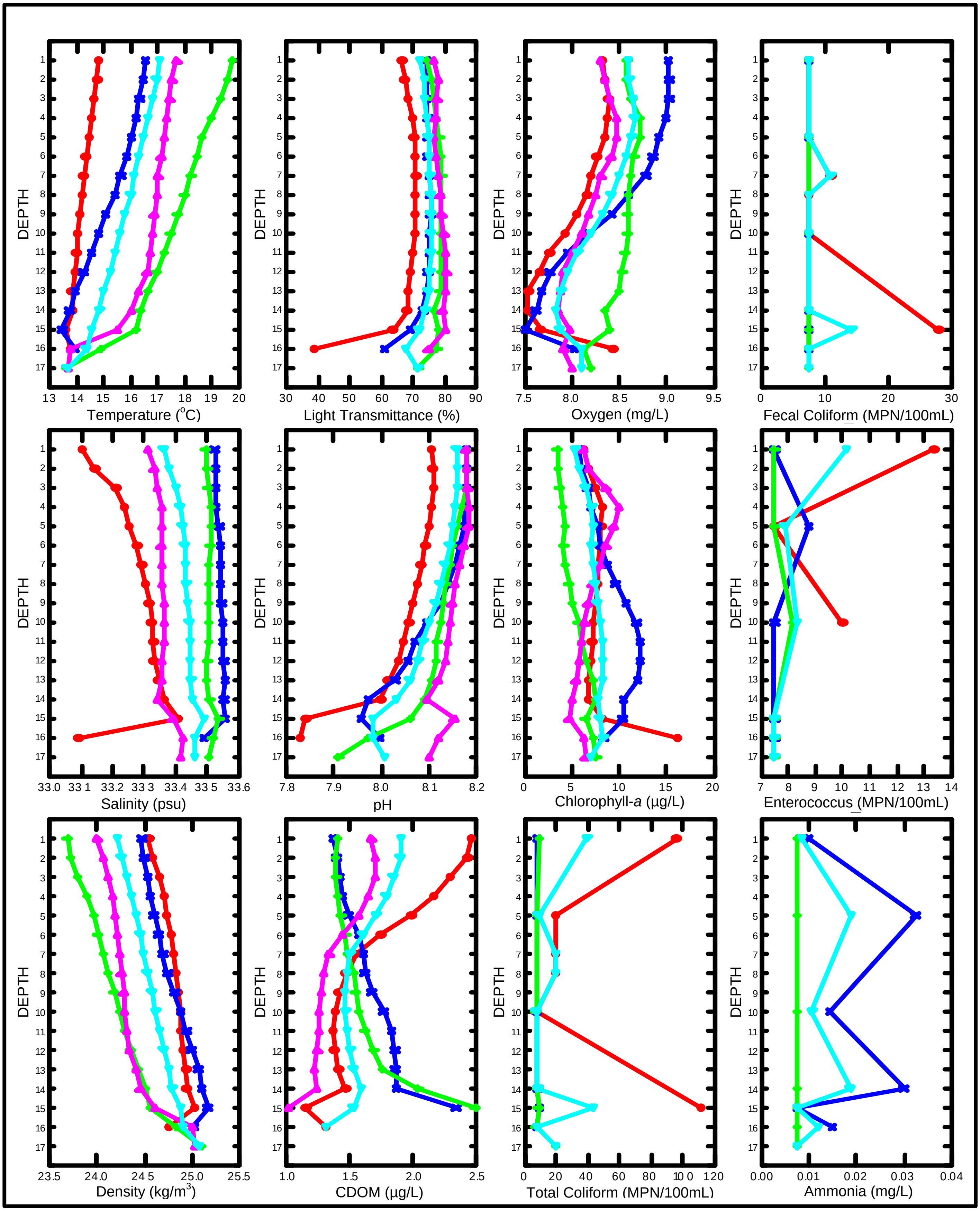

Figure 3. Average seasonal plots for OCSD Station 2202. Orange = Winter, Green = Spring, Dark Blue = Summer, Magenta = Fall, Light Blue = Annual. July 1998 –May 2011.

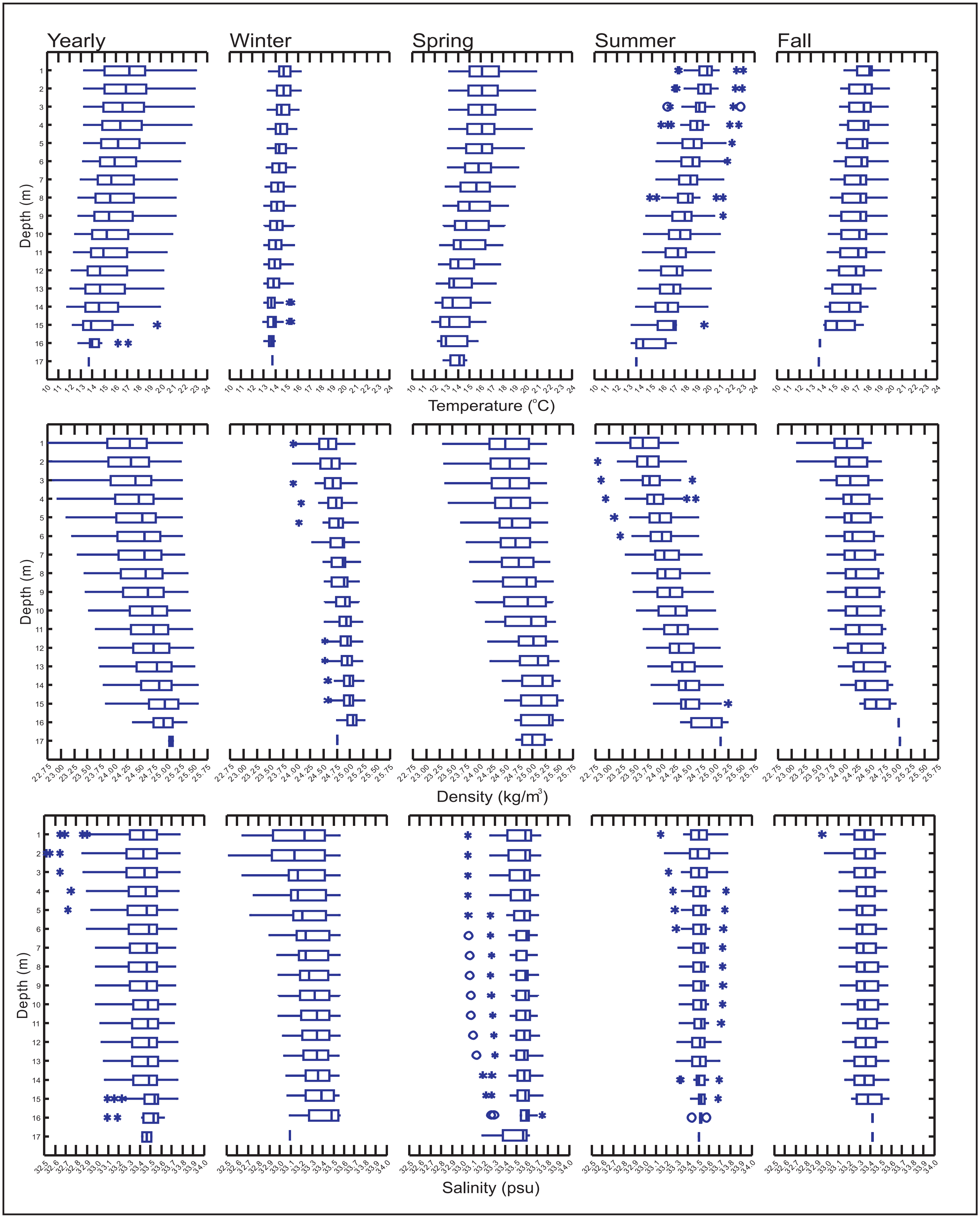

Figure 4a. **Box plots for temperature (°C), density (kg/m^3) and salinity (psu). OCSD Station 2202, July 1998–May 2011.**

Orange County Sanitation District, California.

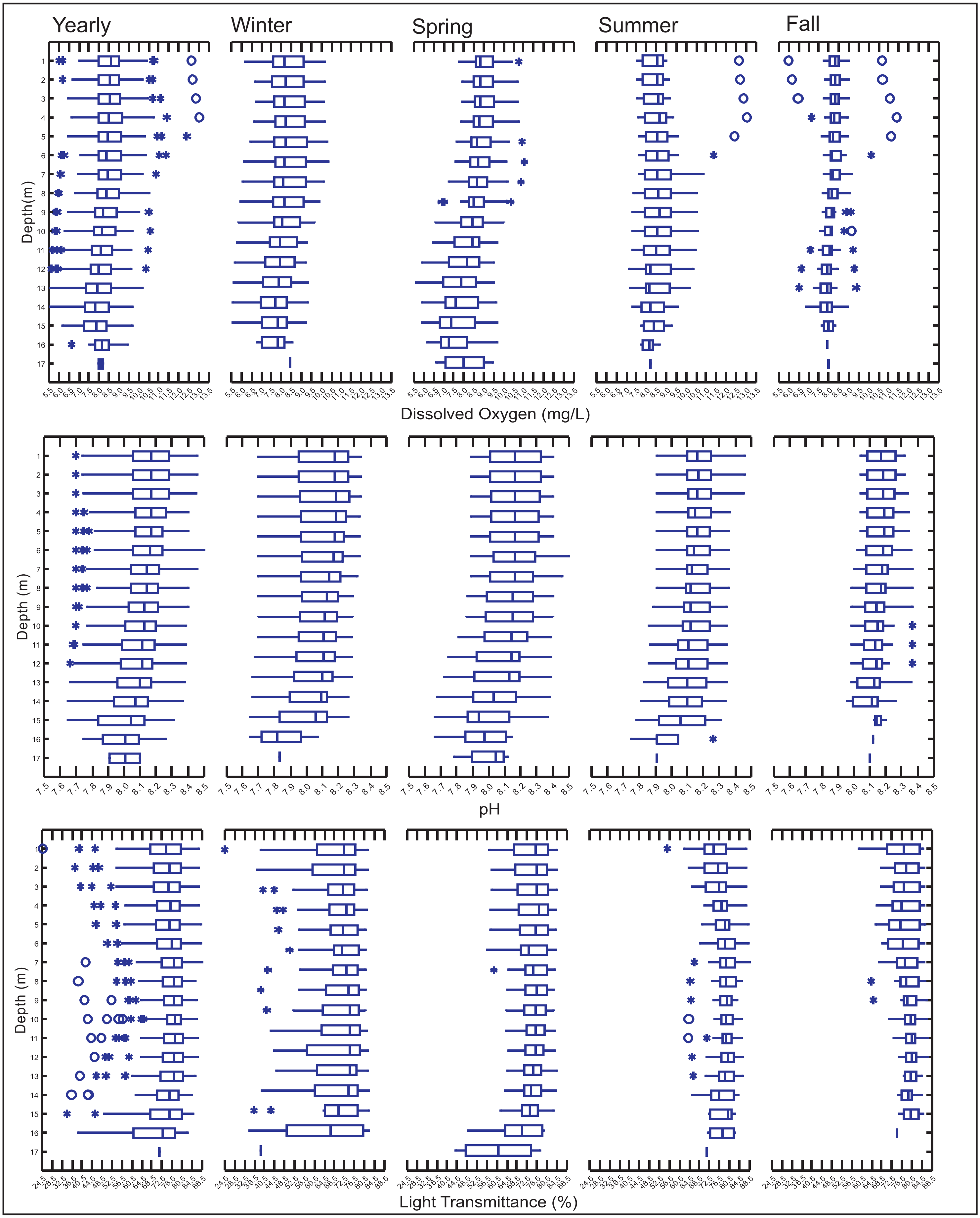

Figure 4b. **Box plots for dissolved oxygen (mg/L), pH, and light transmittance (%). OCSD Station 2202, July 1998–May 2011.**

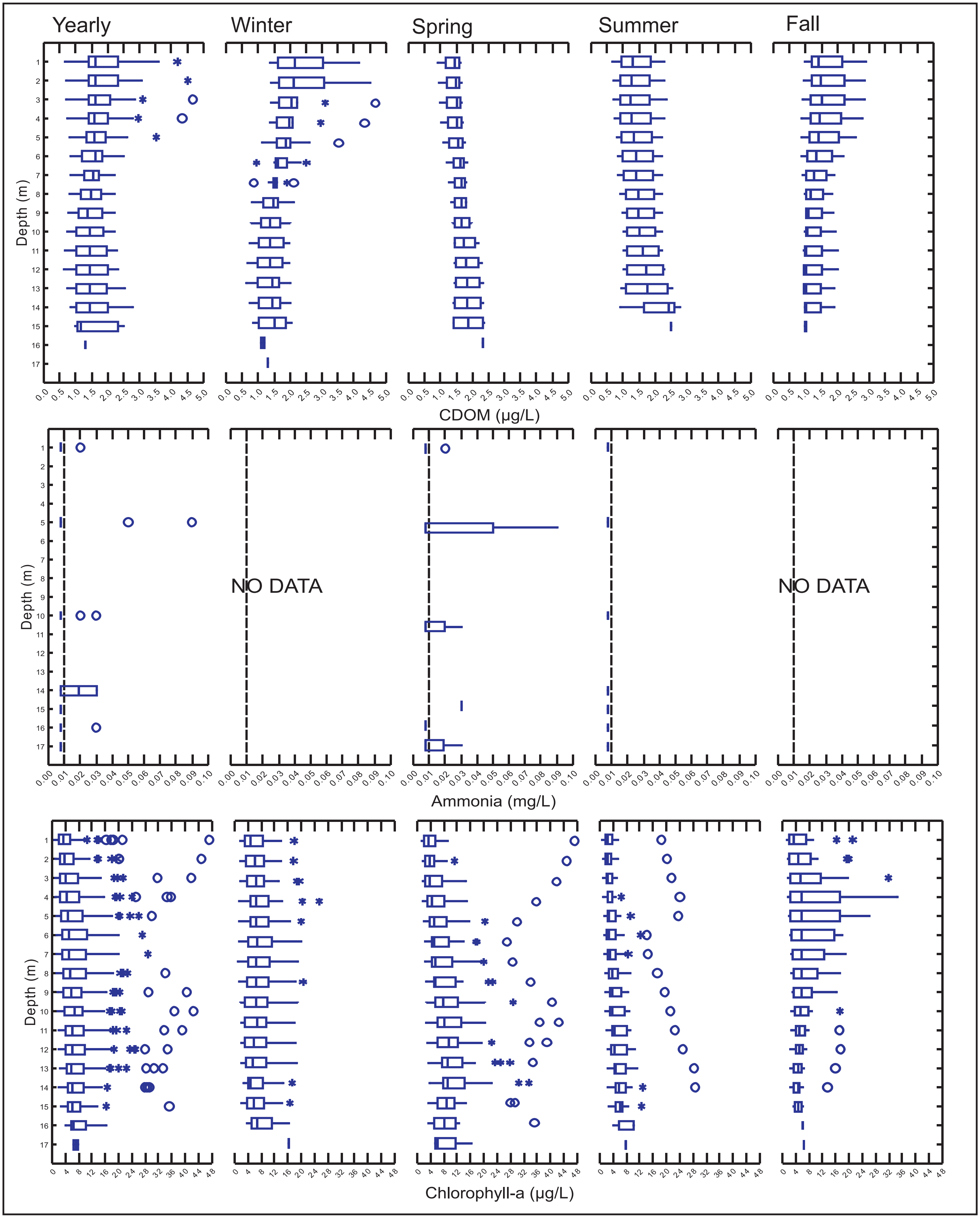

Figure 4c. **Box plots for light transmittance (%), colored dissolved organic matter (CDOM; µg/L), ammonia (mg/L), and chlorophyll-a (µg/L). Dashed vertical line for ammonia at 0.01 mg/L represents lower detection value. OCSD Station 2202, July 1998–May 2011.**

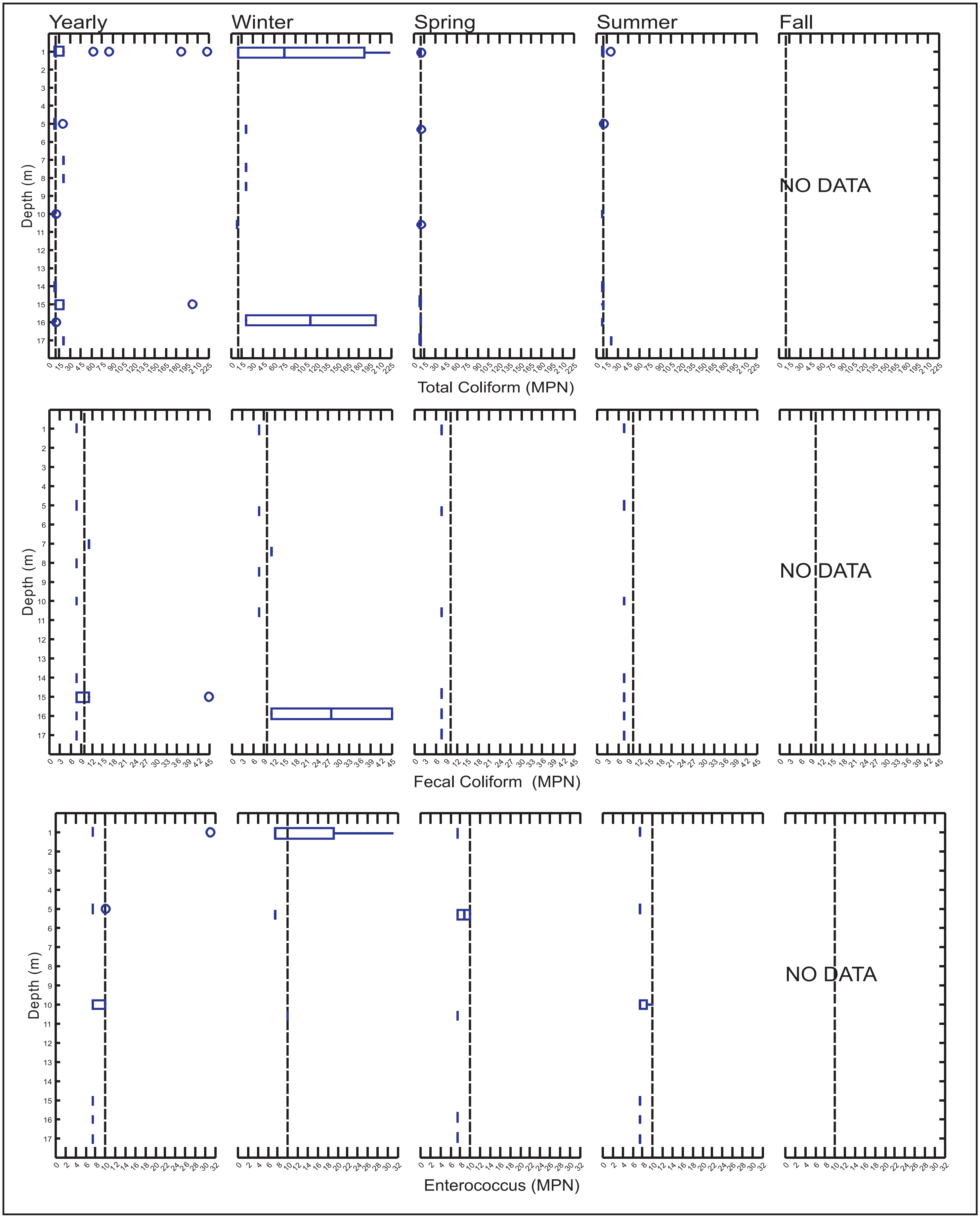

Figure 4d. Box plots for total and fecal coliform and enterococcus bacteria (MPN/100 mL). Dashed vertical line at 10 MPN represents lower detection value. OCSD Station 2202, July 1998–May 2011.

all four seasons. Inter–annual variability, regardless of depth, was 14% with 9–11% variability seen in the summer and fall. Typically, spring had the coldest water temperatures for all depths while summer had the warmest surface temperatures.

Density was primarily temperature not salinity driven. Values were highly inversely correlated (r=-0.979) with temperature and showed comparable seasonal and depth related patterns (Figures 3 and 4a; Table A-4). The least and most dense water were associated with the warmer summer surface (above 10 m) and colder spring bottom (below 10 m) water temperatures, respectively. Regardless of the season or depth, the expected natural variation was only 1–2%. Winter showed the least variability and the smallest ranges at all depths. Spring and summer had the largest range of values and similar variability at individual depths. Overall variability in fall density values matched that of spring and summer, but there was an increase in the upper 10 m as compared to summer values. .

Plume Related Changes

The predicted impact to receiving water temperature from the effluent after initial dilution represents about a 1% change (Table 1). The potential impact to the surfzone should be less, as the plume will continue to undergo mixing with background receiving waters. The predicted impacts are well below the 11–13% and 9–11% natural variability seen in the summer and fall seasons at the surfzone and Station 2202, respectively.

Salinity

Surfzone

Average monthly salinity values showed somewhat similar seasonal trends to temperature, with the exception that the highest average salinity was observed in June, with a gradual decrease through the remainder of the year (Figure 5; Tables A-1 and A-2; Figures B-3 and B-4). With the exception of five stations located near the Santa Ana River (3N, 0, 3S, 6S, and 9S), salinity also showed minor spatial variability. With the exception of 3N, differences seen after June were minor (Figure 5).

Station 2202

Offshore, the average salinity generally increased with depth and had a range of only 0.26 psu (Figures 3 and 4a; Table A-5). For the entire year, the maximum difference was just over 1.4 psu, with the greatest range (~1.25 psu) seen in the winter in the upper 5 m. These decreased winter surface salinities are not unexpected, are influenced by rain, and associated runoff from land. These small salinity ranges were reflected in the data variability that typically were well below 1% (range of 0.1–1.2%). Only in the upper 2 m during winter, did the variability exceed 1%. Average profiles showed winter to have the lowest typical salinity values above 10 m. Spring and summer showed very similar average salinity profiles. Average fall salinities decreased by almost 0.2 psu as compared to spring and summer values.

Plume Related Changes

The predicted change in salinity was -0.8 psu (Table 1) which represents a 2.5% change. This is approximately three times the range of 0.26 psu for average salinity, about twice the change observed at the surfzone stations for summer and fall, and over an order of magnitude greater than the typical variability range of 0.1 to 0.7% seen at Station 2202.

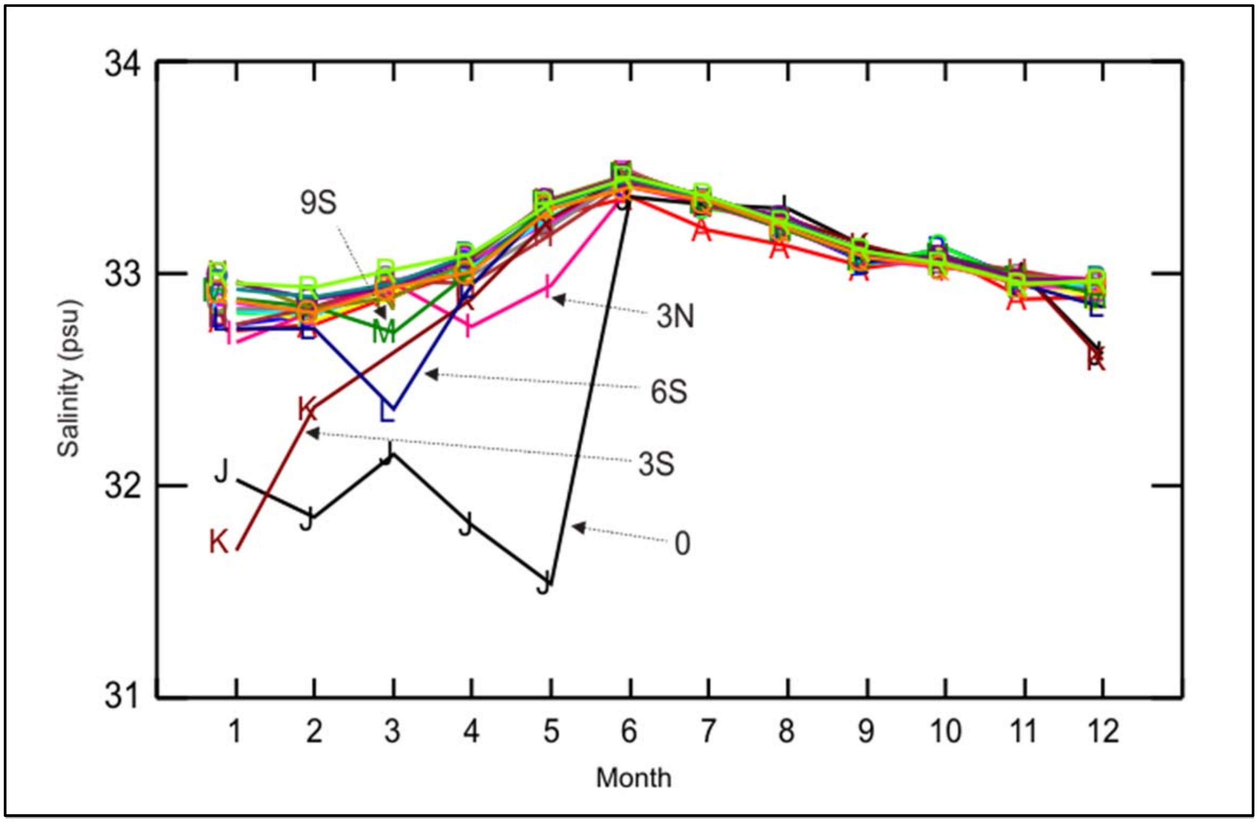

Figure 5. Monthly average salinity for OCSD surfzone stations (April 2000 - August 2011).

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Dissolved Oxygen, and pH

Changes in water temperature, salinity, and depth, along with the presence of oxygen producing phytoplankton all affect oxygen values. The highest oxygen values were at the surface with lowest in bottom waters (Figures 3 and 4b; Table A-6). Summer had the highest surface oxygen values (maximum of 13 mg/L) followed by spring; the lowest surface oxygen values occurred in the summer and fall. At depth (12–15 m), spring had the highest average values with summer and winter having the lowest; fall was intermediate between these seasons. Overall, the water column was well oxygenated with no values falling below 5 mg/L. Variability in the average oxygen values ranged from 0.4–1.5% with most values falling between 1–1.4%.

Dissolved oxygen (DO) and pH were highly correlated (r=0.996) so the spatial and seasonal pH patterns nearly mirrored DO (Figures 3 and 4b; Table A-7). Values decreased from the surface to the bottom. Spring, summer, and fall had very similar pH values above 8 m (8.13–8.18). At depths below 10 m, summer pH values began to diverge (decrease) from spring and fall values. Winter had the lowest pH values at depths above 10 m. Below 10 m, summer and winter pH values were comparable. Variability ranged from 10–20%, with the least variation seen in the fall.

Plume Related Changes

The predicted change was -0.2 mg/L and -0.03 for dissolved oxygen and pH, respectively. These changes, respectively, represent a 2.2% and 0.3% change from natural background. While the predicted change for oxygen from the effluent is nearly twice the natural variability, it is still below COP criteria of 10%. The predicted change in pH, however, is an order of magnitude below both the natural variability of 10–20% and COP criteria of 0.2 pH units.

Water Clarity

Percent Transmissivity

While average light transmittance showed little variability with depth (Figures 3 and 4b; Table A-8), there was considerable within depth variability (up to 28%) and with season. Winter had the lowest average water clarity, followed by spring, summer, and fall. Summer and fall also had the least variability (<10%) at all depths.

Secchi Depth

Average seasonal Secchi depths were generally consistent with the transmissivity results with the exception that summer had the clearest water (Figure 6). As was seen for percent transmissivity, the lowest Secchi values occurred in winter. Spring and fall had identical values.

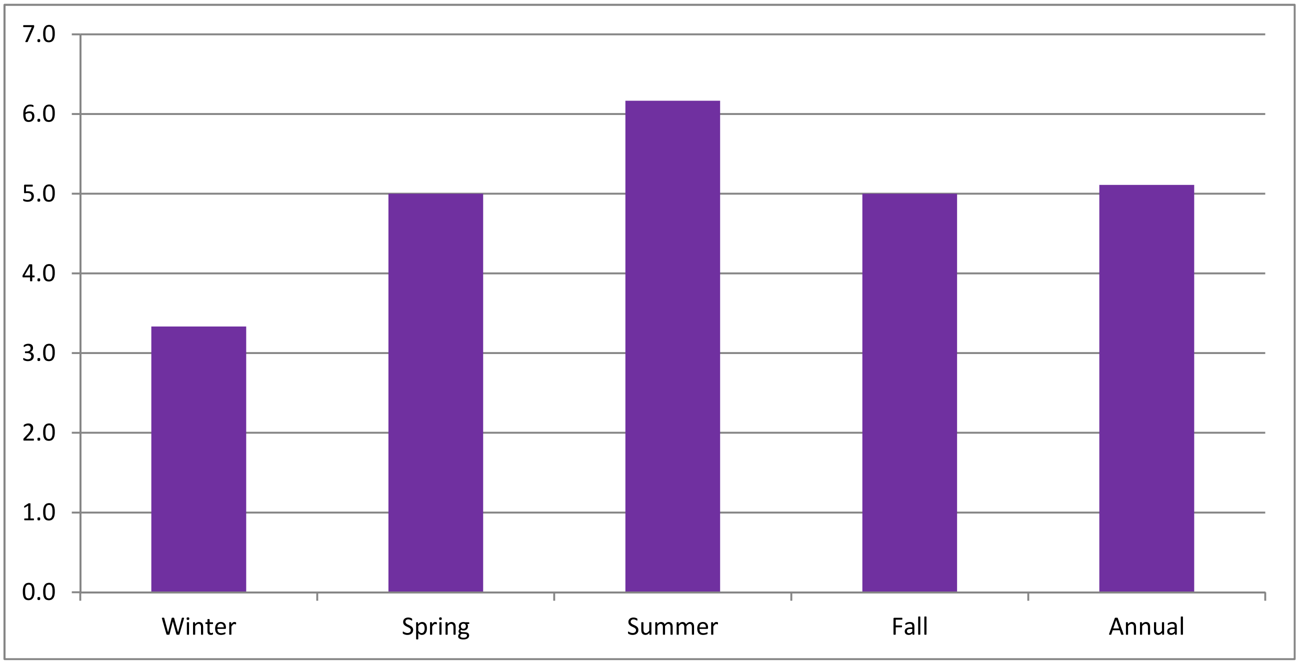

Figure 6. Mean seasonal and annual Secchi depth (m) for OCSD Station 2202, February 2007–November 2010.

Orange County Sanitation District

Colored Dissolved Organic Matter (CDOM)

Colored Dissolved Organic Matter (CDOM) measures the fluorescence of organic matter. While not solely due to effluent, CDOM has proven to be a useful submerged plume tracer (OCSD, 2008). Previously report maximum values seen offshore at Station 2205 were almost 10 µg/L, with the average at plume depths (20–50 m) ranging from 1.5 to 3 µg/L. Average values seen at 2202 were mostly below 1.5 µg/L regardless of depth or season, with some noted exceptions (Figures 3 and 4c; Table A- 9). The elevated winter surface CDOM values were probably due to impacts from winter storms. Elevated values seen at the bottom in the spring and summer could be representative of introduced organic carbon by oceanographic such as upwelling and resuspension. The maximum value seen was 4.7 µg/L. Highest values were seen in winter and lowest in fall. Winter and fall saw increased values in surface waters (>6 m), while spring and summer had their highest values at depth. Variability ranged from 14–50%.

Plume Related Changes
The District does not measure water clarity in the effluent. However, with a low particle load (e.g., total suspended solids = 6–9 mg/L), it is not expected that the discharge of effluent from the 78-inch outfall would directly cause any decrease in light transmittance. Using the maximum value of 10 µg/L seen at Station 2205, a natural background of 1.5 µg/L, and an initial dilution of 180:1, a final effluent CDOM value of 1,540 µg/L was calculated. With a 36:1 initial dilution at the 78-inch outfall, the predicted result in CDOM is 43 µg/L. Using summer and fall average values as background levels (i.e., 1.5 µg/L), the discharge from the 78-inch outfall has a predicted increase of nearly 30 times background CDOM.

Nutrients, Phytoplankton, and Bacteria
Few discrete samples were collected at Station 2202 with uneven coverage over both depths and seasons. However, the following generalizations were made.

Ammonia
All summer ammonia concentrations were below detection limits. Maximum spring values ranged 0.02 to 0.09 mg/L with the highest values seen at 5 m (Figures 3 and 4c; Table A-10). Spring ammonia concentrations were highly variable with 5 m samples having a 114% natural variability, followed by 10 m (70%) and 1 m (56%).

Chlorophyll-a
Measurements of chlorophyll-*fluorescence* are used as a surrogate to phytoplankton biomass. Chlorophyll-*a* does not distinguish between the source of chlorophyll (terrestrial versus marine) or plankton species, however high concentrations indicate larger phytoplankton biomass and reflect a potential response to increased nutrient loads. With the exception of spring, the average chlorophyll-*a* concentration typically increased with depth to a subsurface maximum and then decreased again with depth (Figures 3 and 4c; Table A-11). This subsurface maximum value ranged from 4 m below the surface in the winter and fall to 12 m below in the summer. In contrast, spring chlorophyll-*a* values generally increased from the top to bottom. Variability was high and ranged from 55% near the bottom in winter to 165% at the surface in the spring. Values for all seasons were most variable in the upper 3–4 m.

Bacteria
Of the three fecal indicator bacteria (FIB) only total coliform and enterococcus showed measurable counts; fecal coliform bacteria were above detection only in the winter (Figures 3 and 4d; Tables A-12 to A-14). Counts for all three FIBs were low, with only total coliform values exceeding 100 MPN. Variability was not considered due to the paucity of data over time and depth.

Plume Impacts
Fall ammonia concentrations were assumed to be similar to summer values. With natural concentrations below 0.01 mg/L, the expected impact of 0.81 mg/L would represent an approximate 80-fold increase in ammonia concentrations. Chlorophyll-*a* represents a secondary response of phytoplankton to nutrients. With the predicted increase in ammonia concentrations in the receiving waters, phytoplankton should also increase, though there will be a lag time due to biologic growth (Caron and Jones, 2011). Assuming that summer bacteria are reflective of fall conditions, background counts for all three FIBs will increase by 0 MPN for

enterococcus to 17 MPN for total coliform bacteria; predicted fecal coliform counts would increase by 4 MPN.

Conclusions

At 36:1 dilution, only 5 of the 11 routinely sampled water quality parameters are expected to be directly affected by the discharge. These include salinity, dissolved oxygen, CDOM, ammonia, and bacteria. It is expected that phytoplankton will respond to the both the change in salinity and the increased nutrient loads (i.e., ammonia), but it is unclear what the magnitude of this change will be. Preliminary data analysis from similar discharge to shallow water in Santa Monica Bay from November 28–30, 2006 indicated increased phytoplankton and the production of a “mini-bloom (Jones, personal communication). Because the discharge area has high natural oxygen levels (no values below 5 mg/L were measured), the change in oxygen levels due to the discharge is not expected to have a significant environmental impact. Secondary positive or negative impacts from the growth and subsequent death of phytoplankton cannot be determined. Finally, with enhanced disinfection, increases in any of the three FIBs are expected to be minor, with counts staying below both COP and AB411 water contact standards. It should be noted that the 36:1 initial dilution used in calculating potential plume impacts is an inherently conservative number. It was derived using standard EPA protocols that include zero currents, which is not a realistic scenario. Adding typical ambient flows of 20 cm/s produces higher initial dilution values that ranged from 67–190:1 (Moffatt and Nichol 2011). This increased dilution would result in further lessening any potential receiving water impacts.

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Appendix A – Supporting Tables

Table A-1. Monthly temperature and salinity statistics for OCSD surf zone (April 2000–August 2011) and SCCOOS Newport Pier (NP; January 1925–December 2010) stations.

Station	*Statistic*	Temperature											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
39N	N of Cases	224	210	235	239	248	243	250	255	225	233	211	214
39N	Maximum	16.0	18.6	17.8	18.7	20.2	22.6	23.4	23.2	22.6	20.4	23.0	16.0
39N	Average of Maximum	14.65	15.62	15.99	16.46	18.53	19.78	20.97	20.47	20.82	18.95	17.4	15.45
39N	95% Upper Control Limit	13.25	13.76	13.98	14.53	16.55	18.2	19.3	18.83	18.58	17.17	15.67	13.76
39N	Arithmetic Mean	13.06	13.56	13.79	14.38	16.36	18.01	19.07	18.63	18.33	16.98	15.48	13.59
39N	95% Lower Control Limit	12.87	13.37	13.61	14.24	16.16	17.82	18.84	18.43	18.09	16.8	15.29	13.41
39N	Average of Minimum	11.02	11.6	11.49	12.29	13.75	15.6	16.33	16.38	15.79	14.97	12.7	11.15
39N	Minimum	8.4	9.0	10.2	10.8	12.0	13.6	13.9	13.6	13.6	10.9	11.2	9.0
39N	Coefficient of Variation	0.11	0.10	0.10	0.08	0.09	0.08	0.10	0.09	0.10	0.09	0.09	0.10
39N	Standard Deviation	1.44	1.4	1.44	1.16	1.54	1.49	1.85	1.61	1.87	1.45	1.4	1.31
39N	Variance	2.06	1.97	2.07	1.34	2.39	2.22	3.41	2.6	3.49	2.12	1.95	1.71
33N	N of Cases	224	210	235	240	249	244	250	255	225	233	211	214
33N	Maximum	17.8	18.4	17.6	17.4	19.4	22.4	23.8	23.2	21.8	21.0	23.0	16.4
33N	Average of Maximum	14.94	15.41	15.7	16.23	18.36	19.82	21.09	20.26	20.43	18.95	17.47	15.54
33N	95% Upper Control Limit	13.35	13.74	13.95	14.49	16.48	18.08	19.25	18.64	18.42	17.15	15.67	13.81
33N	Arithmetic Mean	13.17	13.56	13.77	14.35	16.29	17.88	19.02	18.45	18.17	16.96	15.48	13.62
33N	95% Lower Control Limit	12.98	13.38	13.59	14.21	16.09	17.69	18.79	18.25	17.92	16.77	15.29	13.44
33N	Average of Minimum	11.31	11.67	11.53	12.13	13.52	15.48	16.09	16.18	15.45	14.94	12.98	10.95
33N	Minimum	9.4	10.2	10.4	10.4	8.7	11.9	14.6	13.2	13.6	10.1	11.5	8.0
33N	Coefficient of Variation	0.11	0.10	0.10	0.08	0.10	0.09	0.10	0.08	0.11	0.09	0.09	0.10
33N	Standard Deviation	1.42	1.34	1.4	1.11	1.56	1.54	1.83	1.56	1.91	1.49	1.39	1.35
33N	Variance	2	1.81	1.96	1.24	2.43	2.36	3.37	2.43	3.64	2.21	1.92	1.84
27N	N of Cases	224	210	235	240	249	244	249	255	225	233	211	214
27N	Maximum	16.8	18.4	17.0	17.8	19.8	21.8	24.0	22.6	22.0	20.1	19.2	16.2
27N	Average of Maximum	15.18	15.55	15.72	16.03	18.31	19.8	21.17	20.13	20.68	18.99	17.25	15.4
27N	95% Upper Control Limit	13.45	13.83	14.06	14.47	16.4	17.96	19.06	18.45	18.3	17.14	15.68	13.89
27N	Arithmetic Mean	13.25	13.64	13.88	14.32	16.21	17.75	18.82	18.25	18.04	16.95	15.5	13.71
27N	95% Lower Control Limit	13.06	13.45	13.71	14.17	16.02	17.54	18.58	18.05	17.78	16.77	15.32	13.53
27N	Average of Minimum	11.22	11.77	11.47	11.99	13.68	15.11	15.88	16.06	15.23	14.81	12.85	11.2
27N	Minimum	9.2	9.6	10.2	10.2	12.0	11.7	13.8	13.4	13.4	10.3	11.4	9.3
27N	Coefficient of Variation	0.11	0.10	0.10	0.08	0.09	0.09	0.10	0.09	0.11	0.08	0.09	0.10
27N	Standard Deviation	1.47	1.39	1.36	1.19	1.52	1.64	1.93	1.59	1.99	1.42	1.32	1.31
27N	Variance	2.17	1.94	1.86	1.41	2.32	2.69	3.71	2.51	3.95	2.02	1.74	1.73

Table A-1. Monthly temperature and salinity statistics for OCSD surf zone (April 2000–August 2011) and SCCOOS Newport Pier (NP; January 1925–December 2010) stations.

Station	*Statistic*	**Temperature**											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
21N	N of Cases	224	210	235	240	249	244	250	255	225	233	211	214
21N	Maximum	17.0	16.2	17.0	17.4	19.8	21.8	24.2	22.4	22.8	20.2	19.6	16.7
21N	Average of Maximum	15.23	15.17	15.6	16.01	18.29	19.68	21.08	20.24	20.83	18.95	17.35	15.52
21N	95% Upper Control Limit	13.45	13.74	13.97	14.35	16.21	17.87	18.97	18.4	18.29	17.12	15.65	13.88
21N	Arithmetic Mean	13.25	13.56	13.8	14.2	16.02	17.67	18.73	18.18	18.02	16.93	15.47	13.7
21N	95% Lower Control Limit	13.05	13.38	13.62	14.05	15.83	17.47	18.49	17.97	17.75	16.74	15.29	13.52
21N	Average of Minimum	11.17	11.52	11.61	12.04	13.36	14.9	15.68	15.69	15.32	14.35	12.81	11.03
21N	Minimum	8.8	10.0	10.6	10.6	12.0	12.1	13.6	13.0	13.0	8.3	10.8	9.2
21N	Coefficient of Variation	0.12	0.10	0.10	0.08	0.10	0.09	0.10	0.10	0.11	0.09	0.09	0.10
21N	Standard Deviation	1.53	1.34	1.34	1.17	1.54	1.59	1.92	1.77	2.03	1.49	1.36	1.35
21N	Variance	2.34	1.79	1.79	1.38	2.37	2.53	3.7	3.13	4.12	2.23	1.84	1.82
15N	N of Cases	224	210	235	240	248	244	249	255	225	233	211	214
15N	Maximum	16.0	17.0	17.0	17.4	20.8	22.2	24.0	22.6	22.2	21.2	18.4	16.8
15N	Average of Maximum	14.91	15.17	15.7	16.08	18.4	19.57	21.23	20.31	20.68	18.82	16.89	15.58
15N	95% Upper Control Limit	13.38	13.74	13.9	14.27	16.2	17.86	18.97	18.32	18.16	17.02	15.57	13.91
15N	Arithmetic Mean	13.19	13.56	13.71	14.12	15.99	17.65	18.7	18.09	17.88	16.82	15.39	13.73
15N	95% Lower Control Limit	13	13.37	13.53	13.96	15.79	17.45	18.44	17.86	17.61	16.63	15.2	13.55
15N	Average of Minimum	11.45	11.62	11.32	12	13.23	14.99	15.28	15.59	14.75	14.7	12.73	11.39
15N	Minimum	9.4	9.9	9.3	10.6	11.4	12.2	13.0	12.9	12.5	10.3	10.4	9.2
15N	Coefficient of Variation	0.11	0.10	0.10	0.09	0.10	0.09	0.11	0.10	0.12	0.09	0.09	0.10
15N	Standard Deviation	1.44	1.37	1.42	1.24	1.62	1.64	2.13	1.86	2.09	1.51	1.37	1.33
15N	Variance	2.06	1.86	2.01	1.54	2.62	2.68	4.53	3.48	4.35	2.28	1.87	1.76
9N	N of Cases	224	210	239	240	249	243	250	255	225	233	211	214
9N	Maximum	16.0	16.8	17.2	17.6	20.6	22.0	24.4	22.4	22.2	19.8	18.6	16.6
9N	Average of Maximum	14.99	15.31	15.6	16.05	18.42	19.63	20.96	20.03	20.56	18.75	17.38	15.54
9N	95% Upper Control Limit	13.48	13.85	13.96	14.26	16.13	17.77	18.84	18.24	18.07	17.01	15.71	14.02
9N	Arithmetic Mean	13.29	13.66	13.78	14.1	15.91	17.55	18.56	18.01	17.79	16.82	15.54	13.84
9N	95% Lower Control Limit	13.11	13.46	13.6	13.93	15.69	17.34	18.29	17.78	17.52	16.62	15.37	13.67
9N	Average of Minimum	11.35	11.58	11.6	11.86	12.54	14.88	15.02	15.29	14.81	14.46	13.08	11.47
9N	Minimum	9.4	9.0	8.7	10.0	9.4	12.4	12.8	11.9	12.3	9.8	11.3	9.4
9N	Coefficient of Variation	0.11	0.11	0.10	0.09	0.11	0.10	0.12	0.10	0.12	0.09	0.08	0.10
9N	Standard Deviation	1.43	1.45	1.39	1.3	1.78	1.71	2.18	1.88	2.09	1.55	1.26	1.32
9N	Variance	2.04	2.09	1.95	1.69	3.17	2.91	4.75	3.52	4.36	2.4	1.59	1.75

Table A-1. Monthly temperature and salinity statistics for OCSD surf zone (April 2000–August 2011) and SCCOOS Newport Pier (NP; January 1925–December 2010) stations.

Station	*Statistic*	**Temperature**											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
6N	N of Cases	224	209	239	239	249	244	250	255	225	233	211	214
6N	Maximum	16.2	16.4	17.2	17.4	20.6	22.0	25.0	22.8	22.2	19.9	20.3	16.4
6N	Average of Maximum	14.93	15.24	15.77	16.09	18.61	19.58	21.03	20.01	20.66	18.81	17.43	15.71
6N	95% Upper Control Limit	13.49	13.82	14	14.28	16.15	17.84	18.89	18.35	18.12	16.99	15.76	14.04
6N	Arithmetic Mean	13.29	13.62	13.82	14.11	15.94	17.63	18.61	18.11	17.84	16.78	15.58	13.85
6N	95% Lower Control Limit	13.1	13.42	13.63	13.94	15.72	17.42	18.34	17.88	17.57	16.57	15.4	13.66
6N	Average of Minimum	11.38	11.5	11.4	11.99	12.83	15.18	15.13	15.64	14.72	14.16	13.1	11.59
6N	Minimum	9.3	9.4	8.4	10.0	9.8	12.4	13.0	13.2	11.8	9.4	11.3	9.2
6N	Coefficient of Variation	0.11	0.11	0.10	0.10	0.11	0.09	0.12	0.11	0.12	0.10	0.09	0.10
6N	Standard Deviation	1.5	1.47	1.44	1.35	1.71	1.66	2.22	1.9	2.08	1.61	1.33	1.4
6N	Variance	2.24	2.16	2.08	1.82	2.93	2.77	4.93	3.62	4.32	2.58	1.77	1.96
3N	N of Cases	224	210	239	240	249	244	250	255	225	233	211	214
3N	Maximum	16.3	16.5	17.4	17.4	20.8	23.0	29.6	24.8	22.2	19.4	18.4	16.6
3N	Average of Maximum	14.87	15.14	15.74	16.17	18.58	19.86	21.79	20.34	20.73	18.69	17.14	15.61
3N	95% Upper Control Limit	13.47	13.84	14.02	14.36	16.23	17.99	19.16	18.61	18.21	17.02	15.72	14.04
3N	Arithmetic Mean	13.27	13.66	13.83	14.19	16.02	17.78	18.88	18.38	17.94	16.82	15.54	13.85
3N	95% Lower Control Limit	13.07	13.47	13.65	14.03	15.81	17.58	18.6	18.15	17.66	16.62	15.36	13.66
3N	Average of Minimum	11.57	11.56	11.46	11.97	12.88	15.43	15.43	15.97	14.79	14.27	13.01	11.45
3N	Minimum	9.3	9.2	8.4	10.3	11.0	13.4	13.0	12.9	11.9	9.3	11.4	7.2
3N	Coefficient of Variation	0.11	0.10	0.11	0.09	0.11	0.09	0.12	0.10	0.12	0.09	0.09	0.10
3N	Standard Deviation	1.51	1.36	1.46	1.31	1.71	1.64	2.27	1.87	2.07	1.58	1.33	1.41
3N	Variance	2.28	1.86	2.13	1.72	2.92	2.69	5.14	3.51	4.3	2.48	1.77	2
ZERO	N of Cases	224	210	234	240	248	244	250	255	225	233	211	214
ZERO	Maximum	15.8	19.2	17.4	20.4	21.0	24.2	25.6	23.1	23.4	21.4	19.8	16.2
ZERO	Average of Maximum	14.85	15.57	15.89	16.48	19.18	20.42	22.23	20.53	21.12	18.86	17.47	15.68
ZERO	95% Upper Control Limit	13.46	13.81	14.06	14.42	16.38	18.14	19.39	18.7	18.4	17.11	15.77	14.05
ZERO	Arithmetic Mean	13.26	13.6	13.87	14.23	16.16	17.93	19.12	18.47	18.12	16.91	15.58	13.84
ZERO	95% Lower Control Limit	13.06	13.4	13.67	14.05	15.94	17.71	18.84	18.25	17.84	16.71	15.39	13.63
ZERO	Average of Minimum	11.16	11.22	11.25	11.83	12.37	15.5	15.65	15.73	14.91	14.32	12.81	10.78
ZERO	Minimum	8.4	7.7	8.0	8.8	10.1	13.4	13.0	13.0	11.5	9.8	9.1	4.9
ZERO	Coefficient of Variation	0.12	0.11	0.11	0.10	0.11	0.10	0.12	0.10	0.12	0.09	0.09	0.11
ZERO	Standard Deviation	1.54	1.51	1.5	1.46	1.74	1.71	2.22	1.8	2.13	1.54	1.38	1.55
ZERO	Variance	2.37	2.29	2.26	2.12	3.04	2.92	4.93	3.24	4.53	2.38	1.9	2.39

Table A-1. Monthly temperature and salinity statistics for OCSD surf zone (April 2000–August 2011) and SCCOOS Newport Pier (NP; January 1925–December 2010) stations.

Station	*Statistic*	**Temperature**											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
3S	N of Cases	224	210	235	240	249	244	250	256	225	233	211	214
3S	Maximum	15.7	16.8	17.2	17.6	19.4	21.8	23.6	22.3	22.5	19.9	19.0	18.0
3S	Average of Maximum	15	15.39	15.78	16.17	18.38	19.7	21.04	20.45	20.54	18.87	17.41	15.75
3S	95% Upper Control Limit	13.37	13.67	13.97	14.29	16.13	17.76	18.85	18.5	18.27	17.1	15.78	13.91
3S	Arithmetic Mean	13.18	13.47	13.79	14.13	15.93	17.56	18.6	18.27	17.99	16.89	15.59	13.72
3S	95% Lower Control Limit	12.99	13.28	13.6	13.97	15.72	17.35	18.34	18.04	17.72	16.68	15.4	13.52
3S	Average of Minimum	10.67	11.24	11.25	11.79	12.68	15	15.34	15.58	14.73	14.25	12.71	11.03
3S	Minimum	7.9	9.4	8.8	10.1	11.0	11.9	12.7	13.1	11.8	8.9	9.8	9.4
3S	Coefficient of Variation	0.11	0.11	0.11	0.09	0.10	0.09	0.11	0.10	0.12	0.09	0.09	0.11
3S	Standard Deviation	1.47	1.42	1.46	1.28	1.67	1.62	2.01	1.88	2.08	1.6	1.4	1.45
3S	Variance	2.16	2.01	2.13	1.64	2.79	2.62	4.04	3.54	4.34	2.55	1.95	2.1
6S	N of Cases	224	210	235	240	249	244	250	256	224	233	211	214
6S	Maximum	16.5	18.2	17.2	18.3	19.2	21.6	24.8	22.0	22.2	19.5	18.4	17.0
6S	Average of Maximum	15.28	15.55	15.66	16.19	18.44	19.64	21.17	20.18	20.65	18.7	17.41	15.65
6S	95% Upper Control Limit	13.67	13.91	14.03	14.35	16.17	17.86	18.91	18.51	18.33	17.14	15.91	14.1
6S	Arithmetic Mean	13.49	13.72	13.85	14.18	15.96	17.67	18.65	18.28	18.05	16.95	15.73	13.92
6S	95% Lower Control Limit	13.31	13.54	13.67	14.02	15.75	17.47	18.39	18.04	17.77	16.75	15.56	13.75
6S	Average of Minimum	11.29	11.63	11.28	11.95	12.74	15.4	15.17	15.44	14.55	14.61	13.11	11.5
6S	Minimum	8.9	9.8	8.8	10.4	11.0	13.0	13.2	11.4	10.3	9.4	9.9	9.4
6S	Coefficient of Variation	0.10	0.10	0.10	0.09	0.11	0.09	0.11	0.10	0.12	0.09	0.08	0.10
6S	Standard Deviation	1.38	1.35	1.41	1.29	1.7	1.52	2.08	1.9	2.11	1.52	1.32	1.32
6S	Variance	1.91	1.82	1.99	1.66	2.89	2.3	4.33	3.59	4.43	2.3	1.75	1.76
9S	N of Cases	224	210	234	240	249	244	250	256	225	233	211	214
9S	Maximum	16.4	17.2	17.8	17.4	19.2	21.6	24.2	22.4	22.2	19.6	18.4	16.4
9S	Average of Maximum	15.21	15.3	15.79	16.08	18.18	19.71	21.26	20.33	20.74	18.64	17.31	15.77
9S	95% Upper Control Limit	13.7	13.93	14.03	14.34	16.18	17.89	19.03	18.56	18.41	17.17	15.93	14.19
9S	Arithmetic Mean	13.51	13.76	13.84	14.18	15.97	17.7	18.77	18.32	18.15	16.98	15.75	14.02
9S	95% Lower Control Limit	13.33	13.59	13.66	14.02	15.77	17.51	18.51	18.08	17.89	16.79	15.57	13.84
9S	Average of Minimum	11.31	12.04	11.49	12.03	12.92	15.38	15.21	15.07	15.17	14.87	13.1	11.58
9S	Minimum	9.3	10.2	8.8	11.0	11.2	13.1	13.2	9.4	12.7	9.9	7.9	9.6
9S	Coefficient of Variation	0.10	0.09	0.10	0.09	0.10	0.09	0.11	0.11	0.11	0.09	0.08	0.09
9S	Standard Deviation	1.4	1.26	1.43	1.26	1.66	1.52	2.08	1.95	1.99	1.47	1.33	1.33
9S	Variance	1.95	1.6	2.04	1.6	2.74	2.3	4.34	3.8	3.98	2.17	1.76	1.77

Table A-1. Monthly temperature and salinity statistics for OCSD surf zone (April 2000–August 2011) and SCCOOS Newport Pier (NP; January 1925–December 2010) stations.

Station	*Statistic*	**Temperature**											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NP	N of Cases	2758	2544	2827	2743	2801	2736	2788	2770	2682	2778	2655	2726
NP	Maximum	17.5	17.3	19.5	19.5	22.5	22.9	25.0	23.9	23.9	23.3	21.1	18.7
NP	Average of Maximum	14.97	15.12	15.76	16.69	18.18	19.62	20.99	21.42	20.81	19.42	17.74	16
NP	95% Upper Control Limit	14.09	14.11	14.41	15.01	16.32	17.78	18.79	19.21	18.63	17.9	16.39	14.89
NP	Arithmetic Mean	14.05	14.07	14.36	14.95	16.26	17.72	18.72	19.15	18.56	17.84	16.33	14.84
NP	95% Lower Control Limit	14.01	14.02	14.31	14.89	16.19	17.66	18.65	19.08	18.5	17.79	16.28	14.79
NP	Average of Minimum	12.99	13.02	12.83	13.07	13.96	15.24	15.73	16.45	16.18	15.89	14.68	13.6
NP	Minimum	10.0	10.2	9.9	10.0	10.4	11.7	12.0	12.3	12.2	12.2	11.1	10.6
NP	Coefficient of Variation	0.08	0.08	0.09	0.10	0.10	0.09	0.10	0.09	0.09	0.08	0.08	0.09
NP	Standard Deviation	1.11	1.11	1.33	1.54	1.66	1.61	1.85	1.75	1.72	1.44	1.38	1.28
NP	Variance	1.22	1.24	1.77	2.38	2.74	2.59	3.44	3.08	2.96	2.09	1.9	1.64
15S	N of Cases	224	210	234	240	249	244	250	255	225	233	212	214
15S	Maximum	15.9	17.8	17.8	19.1	19.4	22.0	23.6	22.8	21.8	19.7	18.4	17.9
15S	Average of Maximum	14.95	15.68	15.81	16.23	18.29	19.67	21.12	20.38	20.63	18.73	17.31	15.88
15S	95% Upper Control Limit	13.66	13.92	14.01	14.27	16.15	17.88	18.98	18.56	18.35	17.15	15.91	14.21
15S	Arithmetic Mean	13.47	13.73	13.82	14.1	15.95	17.69	18.72	18.33	18.09	16.96	15.73	14.03
15S	95% Lower Control Limit	13.28	13.54	13.62	13.93	15.74	17.5	18.47	18.09	17.83	16.76	15.56	13.84
15S	Average of Minimum	11.43	11.85	11.21	11.9	12.53	15.32	15.43	15.24	15.05	14.87	13.31	11.45
15S	Minimum	9.3	9.8	8.3	9.7	10.7	12.8	12.9	11.3	12.5	10.1	8.4	9.1
15S	Coefficient of Variation	0.11	0.10	0.11	0.10	0.10	0.08	0.11	0.11	0.11	0.09	0.08	0.10
15S	Standard Deviation	1.44	1.39	1.54	1.34	1.67	1.5	2.07	1.94	1.99	1.54	1.31	1.38
15S	Variance	2.08	1.94	2.36	1.8	2.78	2.25	4.29	3.75	3.97	2.38	1.72	1.9
21S	N of Cases	223	210	235	240	249	244	250	256	224	233	211	213
21S	Maximum	16.0	16.6	17.8	19.1	19.4	21.4	24.0	22.9	21.8	19.9	18.4	16.4
21S	Average of Maximum	14.91	15.18	15.72	16.08	18.17	19.66	20.98	20.48	20.75	18.83	17.03	15.63
21S	95% Upper Control Limit	13.57	13.79	13.93	14.2	16.19	17.97	19.1	18.79	18.47	17.16	15.81	14.18
21S	Arithmetic Mean	13.39	13.61	13.73	14.03	15.98	17.79	18.84	18.56	18.2	16.96	15.63	14
21S	95% Lower Control Limit	13.2	13.42	13.53	13.87	15.77	17.6	18.57	18.33	17.93	16.76	15.45	13.83
21S	Average of Minimum	11.4	11.64	11.18	11.91	12.44	15.58	15.33	15.79	15.26	14.8	13.24	11.57
21S	Minimum	9.5	9.2	8.3	10.1	10.0	13.4	12.4	12.2	12.0	9.9	9.2	8.9
21S	Coefficient of Variation	0.10	0.10	0.11	0.09	0.11	0.08	0.11	0.10	0.11	0.09	0.08	0.09
21S	Standard Deviation	1.4	1.35	1.58	1.32	1.68	1.49	2.11	1.88	2.03	1.57	1.33	1.31
21S	Variance	1.97	1.82	2.48	1.75	2.83	2.23	4.46	3.54	4.11	2.47	1.77	1.73

Table A-1. Monthly temperature and salinity statistics for OCSD surf zone (April 2000–August 2011) and SCCOOS Newport Pier (NP; January 1925–December 2010) stations.

Station	*Statistic*	**Temperature**											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
27S	N of Cases	224	210	235	240	249	244	250	256	225	233	211	214
27S	Maximum	16.0	19.0	17.0	20.7	19.8	22.6	24.4	22.4	22.2	20.2	18.6	16.6
27S	Average of Maximum	14.91	15.54	15.46	16.44	18.15	19.75	21.19	20.45	20.85	18.95	17.18	15.71
27S	95% Upper Control Limit	13.61	13.88	13.83	14.3	16.2	17.92	19.12	18.83	18.48	17.19	15.86	14.24
27S	Arithmetic Mean	13.44	13.69	13.63	14.12	16	17.73	18.86	18.59	18.21	16.99	15.68	14.06
27S	95% Lower Control Limit	13.26	13.5	13.42	13.94	15.8	17.54	18.6	18.35	17.95	16.79	15.51	13.88
27S	Average of Minimum	11.69	11.63	11.34	11.9	12.88	15.53	15.57	16.05	15.25	14.78	13.46	11.72
27S	Minimum	9.8	7.2	8.3	8.9	11.0	13.2	11.9	11.4	12.5	9.9	10.7	9.3
27S	Coefficient of Variation	0.10	0.10	0.12	0.10	0.10	0.09	0.11	0.10	0.11	0.09	0.08	0.09
27S	Standard Deviation	1.36	1.42	1.57	1.44	1.59	1.51	2.11	1.95	1.99	1.55	1.29	1.33
27S	Variance	1.85	2.01	2.46	2.07	2.54	2.28	4.44	3.79	3.97	2.41	1.66	1.77
29S	N of Cases	224	210	235	240	249	244	250	256	225	233	211	214
29S	Maximum	16.2	16.2	17.8	17.8	20.4	21.8	24.8	25.4	22.2	20.0	18.8	16.8
29S	Average of Maximum	14.95	15.04	15.85	16.2	18.45	20.16	21.08	20.95	20.84	19.1	17.35	15.61
29S	95% Upper Control Limit	13.66	13.82	13.97	14.41	16.34	18.15	19.23	18.9	18.52	17.23	15.82	14.23
29S	Arithmetic Mean	13.48	13.66	13.77	14.25	16.14	17.95	18.95	18.65	18.23	17.03	15.65	14.07
29S	95% Lower Control Limit	13.29	13.49	13.57	14.09	15.94	17.75	18.68	18.4	17.95	16.82	15.47	13.91
29S	Average of Minimum	11.68	12.13	11.4	12.04	13.13	15.65	15.14	15.89	14.9	14.68	13.37	12.04
29S	Minimum	9.4	8.8	7.8	10.1	11.4	12.7	12.6	11.3	11.8	10.1	10.8	10.2
29S	Coefficient of Variation	0.10	0.09	0.11	0.09	0.10	0.09	0.12	0.11	0.12	0.09	0.08	0.09
29S	Standard Deviation	1.41	1.23	1.56	1.28	1.62	1.6	2.19	2.03	2.16	1.58	1.3	1.2
29S	Variance	1.98	1.52	2.44	1.64	2.61	2.55	4.82	4.1	4.66	2.48	1.69	1.44
39S	N of Cases	221	210	235	240	248	244	250	256	224	234	211	213
39S	Maximum	17.8	17.0	19.4	18.0	19.6	21.6	24.6	23.4	22.2	19.9	19.6	17.0
39S	Average of Maximum	15.14	15.26	15.98	16.34	18.42	20.03	21.34	20.67	20.97	18.97	17.35	15.58
39S	95% Upper Control Limit	13.62	13.88	13.96	14.43	16.37	18.11	19.3	18.83	18.62	17.22	15.85	14.25
39S	Arithmetic Mean	13.42	13.7	13.75	14.25	16.18	17.91	19.03	18.58	18.35	17.01	15.67	14.08
39S	95% Lower Control Limit	13.22	13.51	13.55	14.08	15.98	17.72	18.76	18.34	18.09	16.8	15.49	13.92
39S	Average of Minimum	11.58	11.97	11.18	11.63	13.24	15.69	15.67	15.68	15.37	14.83	13.34	12.13
39S	Minimum	9.1	9.2	7.8	9.3	11.6	13.4	12.8	10.6	13.2	9.4	10.9	9.3
39S	Coefficient of Variation	0.11	0.10	0.12	0.10	0.09	0.09	0.11	0.11	0.11	0.10	0.08	0.09
39S	Standard Deviation	1.51	1.33	1.6	1.37	1.53	1.55	2.15	1.98	2.01	1.64	1.32	1.26
39S	Variance	2.27	1.77	2.56	1.88	2.33	2.39	4.64	3.91	4.05	2.7	1.74	1.58

Table A-1. Monthly temperature salinity statistics for OCSD surf zone (April 2000 –August 2011) and SCCOOS Newport Pier (NP; January 1925 – December 2010) stations.

Station	*Statistic*	Salinity											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
39N	N of Cases	65	59	63	63	68	61	67	49	40	47	62	58
39N	Maximum	33.8	33.4	33.5	33.7	34.1	34.5	34	33.7	33.8	33.9	33.7	33.6
39N	Average of Maximum	33.57	33.3	33.33	33.5	33.77	33.87	33.57	33.43	33.35	33.57	33.23	33.27
39N	95% Upper Control Limit	33.04	32.86	33.01	33.2	33.36	33.48	33.28	33.22	33.16	33.21	33	32.97
39N	Arithmetic Mean	32.73	32.76	32.9	33.02	33.27	33.36	33.21	33.13	33.03	33.08	32.88	32.89
39N	95% Lower Control Limit	32.43	32.66	32.79	32.83	33.18	33.24	33.13	33.04	32.89	32.95	32.76	32.81
39N	Average of Minimum	28.6	32.03	31.87	30.9	32.67	32.83	32.67	32.93	32.5	32.57	32.3	32.4
39N	Minimum	23.7	31.3	30.4	28.5	32.5	32.4	32.3	32.6	32.3	32.1	31.5	32.3
39N	Coefficient of Variation	0.04	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
39N	Standard Deviation	1.23	0.39	0.43	0.73	0.37	0.46	0.29	0.31	0.41	0.45	0.48	0.3
39N	Variance	1.5	0.15	0.19	0.54	0.14	0.21	0.09	0.1	0.17	0.2	0.23	0.09
33N	N of Cases	65	59	63	64	68	61	67	49	40	47	62	58
33N	Maximum	33.6	33.4	33.5	33.9	34.2	34.5	34.1	33.8	33.8	33.8	33.9	33.7
33N	Average of Maximum	33.3	33.07	33.2	33.47	33.7	33.83	33.7	33.5	33.4	33.5	33.37	33.2
33N	95% Upper Control Limit	32.98	32.9	33.02	33.21	33.4	33.53	33.41	33.32	33.19	33.25	33.1	33
33N	Arithmetic Mean	32.76	32.81	32.94	33.05	33.3	33.42	33.34	33.21	33.04	33.12	32.96	32.91
33N	95% Lower Control Limit	32.55	32.71	32.86	32.88	33.2	33.31	33.26	33.11	32.9	32.99	32.82	32.82
33N	Average of Minimum	29.77	31.97	32.53	31.3	32.43	33.03	33	32.9	32.5	32.67	32.13	32.27
33N	Minimum	26.6	31.5	32.2	29.5	32	32.7	32.7	32.4	32.4	32.2	30.8	32.1
33N	Coefficient of Variation	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
33N	Standard Deviation	0.87	0.35	0.3	0.66	0.42	0.43	0.29	0.37	0.46	0.43	0.56	0.33
33N	Variance	0.75	0.12	0.09	0.43	0.18	0.18	0.09	0.14	0.21	0.18	0.31	0.11
27N	N of Cases	65	59	63	64	68	61	67	49	40	47	62	58
27N	Maximum	33.4	33.5	33.6	33.8	34.3	34.8	34.1	33.9	33.7	34.7	33.9	33.6
27N	Average of Maximum	33.3	33.17	33.27	33.43	33.77	34.17	33.63	33.53	33.35	33.67	33.37	33.27
27N	95% Upper Control Limit	32.94	32.91	33.03	33.18	33.41	33.59	33.38	33.35	33.21	33.27	33.09	33
27N	Arithmetic Mean	32.82	32.81	32.95	33.03	33.31	33.46	33.31	33.25	33.05	33.12	32.95	32.91
27N	95% Lower Control Limit	32.69	32.71	32.86	32.88	33.2	33.34	33.24	33.15	32.89	32.97	32.81	32.82
27N	Average of Minimum	31.2	32	32.47	31.53	32.7	32.97	32.93	33.03	32.1	32.6	32.13	32.27
27N	Minimum	30.2	31.3	32.2	30.3	32.4	32.7	32.6	32.7	31.7	32	31.5	32
27N	Coefficient of Variation	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
27N	Standard Deviation	0.5	0.39	0.33	0.61	0.43	0.49	0.28	0.35	0.49	0.5	0.56	0.34
27N	Variance	0.25	0.15	0.11	0.37	0.18	0.24	0.08	0.12	0.24	0.25	0.31	0.12

Table A-1. Monthly temperature salinity statistics for OCSD surf zone (April 2000 –August 2011) and SCCOOS Newport Pier (NP; January 1925 – December 2010) stations.

Station	Statistic	Salinity											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21N	N of Cases	65	59	63	64	68	61	66	49	40	47	62	58
21N	Maximum	33.4	33.4	33.6	33.8	34.2	34.6	34.1	33.8	33.7	33.9	33.9	33.6
21N	Average of Maximum	33.1	33.07	33.33	33.53	33.77	33.93	33.67	33.53	33.35	33.33	33.33	33.23
21N	95% Upper Control Limit	32.94	32.9	33.01	33.19	33.37	33.6	33.4	33.34	33.2	33.21	33.09	32.99
21N	Arithmetic Mean	32.84	32.78	32.91	33.03	33.26	33.48	33.33	33.23	33.05	33.07	32.95	32.88
21N	95% Lower Control Limit	32.74	32.66	32.81	32.87	33.16	33.36	33.26	33.12	32.91	32.93	32.82	32.78
21N	Average of Minimum	31.63	31.73	32.17	31.2	32.47	33.1	33.03	32.8	32.25	32.67	32.33	32.07
21N	Minimum	31.3	30.4	31.2	30.1	32.2	32.6	32.8	32	32.1	32.1	31.8	31.7
21N	Coefficient of Variation	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
21N	Standard Deviation	0.41	0.45	0.4	0.64	0.44	0.48	0.28	0.38	0.46	0.48	0.54	0.39
21N	Variance	0.16	0.21	0.16	0.41	0.2	0.23	0.08	0.14	0.21	0.23	0.29	0.15
15N	N of Cases	65	59	63	64	68	61	67	49	40	47	62	58
15N	Maximum	33.5	33.4	33.7	33.7	34.3	34.6	34	33.8	33.7	33.9	33.9	33.6
15N	Average of Maximum	33.37	33.13	33.43	33.5	33.87	34.03	33.63	33.5	33.35	33.27	33.33	33.23
15N	95% Upper Control Limit	32.98	32.92	33.05	33.21	33.38	33.59	33.39	33.35	33.22	33.2	33.1	33.02
15N	Arithmetic Mean	32.86	32.81	32.96	33.07	33.24	33.48	33.33	33.24	33.09	33.05	32.95	32.92
15N	95% Lower Control Limit	32.74	32.7	32.87	32.93	33.11	33.37	33.26	33.12	32.95	32.9	32.79	32.83
15N	Average of Minimum	31.33	31.93	32.37	31.77	32.43	33.13	33.03	32.73	32.55	32.57	32.2	32.2
15N	Minimum	30.2	30.9	31.8	30.7	32	32.8	32.7	31.8	32.5	31.9	31.2	32
15N	Coefficient of Variation	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01
15N	Standard Deviation	0.48	0.42	0.37	0.55	0.54	0.44	0.28	0.39	0.42	0.5	0.59	0.35
15N	Variance	0.23	0.18	0.13	0.3	0.29	0.19	0.08	0.15	0.18	0.25	0.35	0.12
9N	N of Cases	65	59	63	64	68	60	67	49	40	47	62	58
9N	Maximum	33.6	33.8	33.7	33.9	34.3	34.5	34.1	33.8	33.9	33.9	33.9	33.7
9N	Average of Maximum	33.33	33.37	33.27	33.53	33.8	33.87	33.67	33.53	33.4	33.37	33.3	33.3
9N	95% Upper Control Limit	33.03	32.96	33.06	33.17	33.36	33.58	33.4	33.34	33.22	33.2	33.13	33.05
9N	Arithmetic Mean	32.83	32.84	32.97	32.99	33.22	33.47	33.33	33.23	33.07	33.05	32.98	32.95
9N	95% Lower Control Limit	32.64	32.71	32.88	32.81	33.08	33.35	33.25	33.12	32.92	32.9	32.84	32.85
9N	Average of Minimum	30.2	31.7	32.33	31.63	32.2	33	32.93	32.93	32.55	32.5	32.3	32.23
9N	Minimum	27.3	30.3	31.8	30.4	31.9	32.6	32.4	32.3	32.4	32	31.6	31.8
9N	Coefficient of Variation	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01
9N	Standard Deviation	0.79	0.5	0.36	0.72	0.59	0.45	0.31	0.39	0.46	0.51	0.56	0.38
9N	Variance	0.62	0.25	0.13	0.52	0.34	0.2	0.1	0.15	0.21	0.26	0.31	0.14

Table A-1. Monthly temperature salinity statistics for OCSD surf zone (April 2000 –August 2011) and SCCOOS Newport Pier (NP; January 1925 – December 2010) stations.

Station	Statistic	Salinity											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6N	N of Cases	65	59	63	63	68	61	67	49	40	47	62	58
6N	Maximum	33.6	33.5	33.7	33.7	34.3	34.3	34.1	33.8	33.9	33.9	33.9	33.6
6N	Average of Maximum	33.3	33.27	33.3	33.5	33.87	33.77	33.67	33.53	33.45	33.4	33.37	33.23
6N	95% Upper Control Limit	33.1	32.96	33.05	33.15	33.34	33.55	33.39	33.35	33.23	33.22	33.15	33.04
6N	Arithmetic Mean	32.76	32.84	32.96	32.95	33.18	33.44	33.32	33.24	33.08	33.07	33.01	32.94
6N	95% Lower Control Limit	32.42	32.72	32.87	32.75	33.02	33.33	33.24	33.13	32.92	32.91	32.87	32.85
6N	Average of Minimum	28.7	31.77	32.23	31.27	31.83	33	32.9	33.03	32.6	32.37	32.37	32.23
6N	Minimum	22.2	30.3	32	29.2	31.1	32.7	32.5	32.4	32.2	31.6	31.8	32
6N	Coefficient of Variation	0.04	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01
6N	Standard Deviation	1.37	0.47	0.36	0.8	0.67	0.44	0.32	0.38	0.47	0.54	0.56	0.35
6N	Variance	1.88	0.22	0.13	0.64	0.44	0.19	0.1	0.15	0.22	0.29	0.31	0.12
3N	N of Cases	65	59	63	64	68	61	67	49	40	47	62	58
3N	Maximum	33.6	33.7	33.7	33.7	34.2	34.1	34.1	33.8	33.9	33.9	33.8	33.8
3N	Average of Maximum	33.33	33.37	33.33	33.5	33.7	33.7	33.67	33.6	33.45	33.33	33.33	33.37
3N	95% Upper Control Limit	33.06	32.94	33.05	33.09	33.21	33.53	33.41	33.32	33.22	33.22	33.13	33.06
3N	Arithmetic Mean	32.68	32.83	32.96	32.75	32.94	33.41	33.33	33.21	33.07	33.03	32.99	32.97
3N	95% Lower Control Limit	32.29	32.71	32.87	32.42	32.67	33.28	33.25	33.1	32.92	32.83	32.84	32.87
3N	Average of Minimum	28.3	31.73	32.33	29.93	31.2	32.93	32.97	32.9	32.5	31.87	32.4	32.37
3N	Minimum	21	30.7	31.9	25.5	29.4	32.2	32.5	32.2	32.1	30	31.8	31.8
3N	Coefficient of Variation	0.05	0.01	0.01	0.04	0.03	0.01	0.01	0.01	0.01	0.02	0.02	0.01
3N	Standard Deviation	1.55	0.45	0.36	1.35	1.1	0.49	0.33	0.37	0.48	0.66	0.57	0.37
3N	Variance	2.39	0.2	0.13	1.81	1.21	0.24	0.11	0.14	0.23	0.43	0.32	0.14
ZERO	N of Cases	65	59	63	64	68	61	67	49	40	47	62	58
ZERO	Maximum	33.6	33.8	33.8	33.8	34.3	34.8	34.2	33.9	33.8	34	33.8	33.6
ZERO	Average of Maximum	33.37	33.4	33.27	33.5	33.77	34.13	33.83	33.7	33.4	33.3	33.4	33.27
ZERO	95% Upper Control Limit	32.83	32.57	32.88	32.64	32.69	33.58	33.43	33.42	33.28	33.19	33.14	33.12
ZERO	Arithmetic Mean	32.03	31.85	32.15	31.82	31.54	33.36	33.33	33.31	33.12	33.04	32.99	32.62
ZERO	95% Lower Control Limit	31.23	31.13	31.42	30.99	30.38	33.14	33.22	33.19	32.97	32.88	32.85	32.12
ZERO	Average of Minimum	25.6	25.8	27.27	26.37	24.67	31.7	32.7	33.1	32.55	32.6	32.3	27.63
ZERO	Minimum	14.5	19.5	17	16.6	13	28.7	32	32.6	32.1	32.1	31.7	19
ZERO	Coefficient of Variation	0.1	0.09	0.09	0.1	0.15	0.03	0.01	0.01	0.01	0.02	0.02	0.06
ZERO	Standard Deviation	3.22	2.77	2.91	3.3	4.78	0.85	0.43	0.4	0.48	0.53	0.57	1.89
ZERO	Variance	10.39	7.65	8.45	10.91	22.81	0.72	0.18	0.16	0.23	0.28	0.33	3.58

Table A-1. Monthly temperature salinity statistics for OCSD surf zone (April 2000 –August 2011) and SCCOOS Newport Pier (NP; January 1925 – December 2010) stations.

Station	*Statistic*	**Salinity**											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
3S	N of Cases	64	59	62	63	68	61	67	49	40	47	62	58
3S	Maximum	33.4	33.6	33.7	33.7	34.2	34.3	34.1	34	34.2	33.9	34	33.6
3S	Average of Maximum	33.23	33.3	33.3	33.47	33.77	33.77	33.67	33.63	33.6	33.53	33.4	33.27
3S	95% Upper Control Limit	32.72	32.69	32.12	33.13	33.38	33.59	33.43	33.38	33.29	33.2	33.14	32.97
3S	Arithmetic Mean	31.69	32.37	30.8	32.88	33.25	33.47	33.35	33.26	33.13	33.04	32.99	32.59
3S	95% Lower Control Limit	30.66	32.05	29.49	32.63	33.13	33.36	33.27	33.13	32.98	32.88	32.84	32.21
3S	Average of Minimum	20.4	28.93	25.93	30.47	32.27	32.97	33	33	32.8	32.33	32.03	28.1
3S	Minimum	13.6	26.6	13.2	27.2	31.7	32.6	32.5	32.4	32.4	31.8	31.1	23.7
3S	Coefficient of Variation	0.13	0.04	0.17	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.04
3S	Standard Deviation	4.12	1.24	5.18	0.99	0.53	0.46	0.33	0.43	0.49	0.54	0.6	1.45
3S	Variance	16.99	1.54	26.82	0.98	0.29	0.21	0.11	0.19	0.24	0.29	0.36	2.1
6S	N of Cases	65	59	63	64	68	61	67	49	39	47	62	58
6S	Maximum	33.5	33.4	33.6	33.7	34.3	34.7	34.1	33.8	33.7	34	33.9	33.7
6S	Average of Maximum	33.2	33.07	33.3	33.5	33.83	33.93	33.67	33.57	33.35	33.43	33.33	33.33
6S	95% Upper Control Limit	33	32.85	32.88	33.19	33.43	33.57	33.43	33.35	33.21	33.23	33.12	33.01
6S	Arithmetic Mean	32.74	32.74	32.36	32.94	33.33	33.45	33.36	33.23	33.05	33.08	32.95	32.85
6S	95% Lower Control Limit	32.48	32.64	31.84	32.69	33.23	33.34	33.28	33.11	32.9	32.92	32.77	32.69
6S	Average of Minimum	28.93	31.77	27.97	30.2	32.6	32.87	32.93	32.8	32.35	32.43	31.63	31.13
6S	Minimum	27.1	31.6	19.2	26.2	32.4	32.3	32.4	31.8	31.9	31.8	30.2	30.2
6S	Coefficient of Variation	0.03	0.01	0.06	0.03	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
6S	Standard Deviation	1.04	0.41	2.07	1	0.41	0.44	0.3	0.42	0.48	0.53	0.68	0.61
6S	Variance	1.09	0.17	4.3	1.01	0.17	0.2	0.09	0.18	0.23	0.28	0.46	0.37
9S	N of Cases	65	59	62	64	68	61	67	49	40	47	62	58
9S	Maximum	33.5	33.5	33.6	33.7	34.2	34.5	34.1	33.8	33.7	34	33.8	33.7
9S	Average of Maximum	33.17	33.13	33.37	33.5	33.77	33.83	33.67	33.53	33.35	33.4	33.3	33.33
9S	95% Upper Control Limit	32.98	32.93	32.97	33.15	33.44	33.58	33.41	33.34	33.23	33.24	33.13	33.01
9S	Arithmetic Mean	32.88	32.85	32.72	33.01	33.34	33.46	33.33	33.2	33.07	33.09	32.98	32.9
9S	95% Lower Control Limit	32.78	32.76	32.48	32.87	33.24	33.35	33.26	33.07	32.92	32.93	32.83	32.78
9S	Average of Minimum	31.87	32.4	30.77	31.63	32.73	32.87	32.87	32.7	32.4	32.33	32.3	31.83
9S	Minimum	31	32.2	27.6	30.9	32.5	32.5	32.3	31.5	32	31.7	31.7	31.3
9S	Coefficient of Variation	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
9S	Standard Deviation	0.39	0.34	0.97	0.57	0.42	0.46	0.31	0.48	0.48	0.54	0.58	0.43
9S	Variance	0.15	0.11	0.94	0.32	0.18	0.21	0.1	0.23	0.23	0.29	0.34	0.19

Table A-1. Monthly temperature salinity statistics for OCSD surf zone (April 2000 –August 2011) and SCCOOS Newport Pier (NP; January 1925 – December 2010) stations.

Station	*Statistic*	**Salinity**											
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NP	N of Cases	2729	2500	2776	2689	2754	2704	2721	2692	2636	2698	2606	2691
NP	Maximum	35.3	34.8	34.5	34.2	34.9	34.5	34.7	34.5	34.6	34.8	34.4	34.4
NP	Average of Maximum	33.7	33.67	33.67	33.73	33.87	33.9	33.88	33.82	33.81	33.78	33.73	33.71
NP	95% Upper Control Limit	33.39	33.25	33.25	33.45	33.59	33.64	33.64	33.6	33.57	33.53	33.52	33.47
NP	Arithmetic Mean	33.37	33.22	33.21	33.43	33.57	33.63	33.64	33.6	33.56	33.52	33.51	33.46
NP	95% Lower Control Limit	33.35	33.18	33.17	33.41	33.55	33.62	33.63	33.59	33.55	33.51	33.5	33.45
NP	Average of Minimum	32.77	32.2	32.21	32.91	33.25	33.33	33.48	33.36	33.32	33.31	33.19	33.1
NP	Minimum	27.1	16	18.5	26.6	26.1	27.6	31.8	27.1	26.8	28.3	28.4	26.7
NP	Coefficient of Variation	0.01	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NP	Standard Deviation	0.48	0.98	1.08	0.51	0.51	0.23	0.17	0.22	0.22	0.24	0.22	0.29
NP	Variance	0.23	0.96	1.16	0.26	0.26	0.05	0.03	0.05	0.05	0.06	0.05	0.09
15S	N of Cases	65	59	63	64	68	61	67	48	40	47	62	58
15S	Maximum	33.5	33.5	33.7	33.8	34.2	34.5	34.1	33.8	33.8	34	33.9	33.8
15S	Average of Maximum	33.3	33.17	33.43	33.53	33.73	33.87	33.7	33.53	33.4	33.4	33.27	33.33
15S	95% Upper Control Limit	33.05	32.93	33.05	33.19	33.45	33.58	33.43	33.37	33.25	33.21	33.14	33.06
15S	Arithmetic Mean	32.96	32.83	32.89	33.06	33.35	33.47	33.36	33.25	33.1	33.04	32.99	32.95
15S	95% Lower Control Limit	32.88	32.74	32.72	32.94	33.25	33.36	33.28	33.14	32.95	32.87	32.85	32.84
15S	Average of Minimum	32.13	32.33	31.37	31.93	32.47	33.1	32.83	32.97	32.55	32.2	32.37	31.93
15S	Minimum	31.4	32.1	29.1	31.5	32.3	32.7	32.4	32.3	32.5	31.3	32	31.1
15S	Coefficient of Variation	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
15S	Standard Deviation	0.34	0.35	0.65	0.49	0.4	0.43	0.32	0.4	0.46	0.58	0.57	0.42
15S	Variance	0.12	0.12	0.42	0.24	0.16	0.19	0.1	0.16	0.21	0.33	0.33	0.17
21S	N of Cases	64	59	63	64	68	61	67	49	39	47	62	58
21S	Maximum	33.5	33.6	33.7	33.7	34.2	34.6	34.1	33.9	33.7	34	33.9	33.8
21S	Average of Maximum	33.23	33.33	33.3	33.43	33.83	33.93	33.7	33.6	33.3	33.4	33.37	33.37
21S	95% Upper Control Limit	33.04	32.97	33.04	33.2	33.45	33.58	33.42	33.38	33.22	33.24	33.12	33.08
21S	Arithmetic Mean	32.95	32.88	32.94	33.08	33.34	33.46	33.34	33.27	33.07	33.08	32.97	32.97
21S	95% Lower Control Limit	32.86	32.78	32.83	32.97	33.24	33.34	33.25	33.15	32.93	32.92	32.82	32.87
21S	Average of Minimum	32.17	32.37	32.03	32.03	32.2	32.93	32.83	33.03	32.55	32.43	32.4	32.17
21S	Minimum	31.4	32.1	31.7	31.7	31.9	32.5	32.1	32.6	32.5	31.9	31.9	31.6
21S	Coefficient of Variation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
21S	Standard Deviation	0.36	0.36	0.42	0.45	0.43	0.46	0.36	0.39	0.44	0.54	0.58	0.4
21S	Variance	0.13	0.13	0.17	0.21	0.19	0.22	0.13	0.16	0.19	0.29	0.33	0.16

Table A-1. Monthly temperature salinity statistics for OCSD surf zone (April 2000 –August 2011) and SCCOOS Newport Pier (NP; January 1925 – December 2010) stations.

Station	Statistic	Salinity											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27S	N of Cases	65	59	63	64	68	61	67	49	40	47	62	58
27S	Maximum	33.5	33.5	33.7	33.7	34.2	34.6	34.1	33.9	33.8	34	33.9	33.7
27S	Average of Maximum	33.23	33.27	33.43	33.5	33.8	33.9	33.7	33.63	33.4	33.37	33.43	33.3
27S	95% Upper Control Limit	33.01	32.99	33.04	33.2	33.43	33.58	33.42	33.36	33.26	33.2	33.11	33.07
27S	Arithmetic Mean	32.92	32.89	32.95	33.09	33.33	33.45	33.35	33.24	33.11	33.04	32.94	32.97
27S	95% Lower Control Limit	32.83	32.8	32.86	32.99	33.22	33.32	33.27	33.13	32.95	32.88	32.77	32.88
27S	Average of Minimum	32.23	32.3	32.27	32.1	32.37	32.7	32.87	32.9	32.3	32.43	31.6	32.23
27S	Minimum	31.7	32.1	32.1	31.7	32.2	32.1	32.4	32.3	32.2	32	30.3	32
27S	Coefficient of Variation	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.01
27S	Standard Deviation	0.36	0.36	0.35	0.42	0.43	0.51	0.3	0.4	0.48	0.53	0.67	0.36
27S	Variance	0.13	0.13	0.13	0.18	0.18	0.26	0.09	0.16	0.23	0.28	0.45	0.13
29S	N of Cases	65	59	63	64	68	61	67	49	40	47	62	58
29S	Maximum	33.4	33.5	33.7	33.7	34.2	34.5	34.1	33.8	33.8	33.9	33.8	33.8
29S	Average of Maximum	33.2	33.17	33.33	33.57	33.83	33.87	33.67	33.57	33.4	33.27	33.3	33.37
29S	95% Upper Control Limit	32.96	32.91	33.03	33.13	33.41	33.53	33.42	33.33	33.23	33.19	33.09	33.07
29S	Arithmetic Mean	32.87	32.82	32.93	33.01	33.31	33.41	33.34	33.21	33.07	33.04	32.94	32.97
29S	95% Lower Control Limit	32.79	32.72	32.84	32.88	33.2	33.29	33.27	33.09	32.92	32.89	32.79	32.87
29S	Average of Minimum	32.1	32.13	32.1	31.9	32.2	32.83	32.87	32.93	32.25	32.5	32.27	32.23
29S	Minimum	31.9	31.8	31.5	31.4	32	32.5	32.3	32.3	32.1	32.3	31.8	32
29S	Coefficient of Variation	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
29S	Standard Deviation	0.34	0.36	0.38	0.51	0.43	0.47	0.3	0.42	0.49	0.51	0.6	0.39
29S	Variance	0.12	0.13	0.15	0.26	0.19	0.22	0.09	0.18	0.24	0.26	0.35	0.15
39S	N of Cases	65	59	63	64	67	61	67	49	40	47	62	57
39S	Maximum	33.5	33.8	33.7	33.7	34.3	34.5	34.1	33.9	33.8	33.9	33.9	33.8
39S	Average of Maximum	33.3	33.4	33.47	33.6	33.8	33.9	33.7	33.6	33.45	33.23	33.37	33.33
39S	95% Upper Control Limit	33.04	33.03	33.1	33.22	33.44	33.57	33.44	33.37	33.25	33.2	33.12	33.07
39S	Arithmetic Mean	32.95	32.93	33.01	33.09	33.33	33.45	33.36	33.23	33.1	33.04	32.95	32.96
39S	95% Lower Control Limit	32.86	32.84	32.93	32.96	33.22	33.33	33.28	33.09	32.96	32.89	32.78	32.86
39S	Average of Minimum	32.4	32.47	32.37	31.73	32.27	33	32.93	32.6	32.6	32.43	31.8	32.13
39S	Minimum	32	32.2	32.2	31	32	32.6	32.5	31.3	32.5	32.1	30.5	31.8
39S	Coefficient of Variation	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
39S	Standard Deviation	0.35	0.37	0.34	0.5	0.45	0.46	0.32	0.49	0.46	0.53	0.66	0.4
39S	Variance	0.12	0.13	0.11	0.25	0.2	0.21	0.1	0.24	0.21	0.28	0.44	0.16

Table A-2. Quarterly and annual statistics for OCSD surfzone (April 2000 – August 2011) and SCCOOS Newport Pier (January 1925 – December 2010) stations.

Station	*Statistics*	**Temperature**					**Salinity**				
		Winter	*Spring*	*Summer*	*Fall*	*Annual*	*Winter*	*Spring*	*Summer*	*Fall*	*Annual*
39N	N of Cases	669	730	730	658	2787	187	192	156	167	702
39N	Maximum	18.6	22.6	23.4	23	23.4	33.8	34.5	34	33.9	34.5
39N	Average of Maximum	15.42	18.26	20.75	17.26	17.97	33.4	33.71	33.46	33.36	33.48
39N	95.0% Upper Control Limit	13.59	16.41	18.82	15.55	16.12	32.91	33.29	33.19	33.01	33.06
39N	Arithmetic Mean	13.48	16.26	18.69	15.4	16.02	32.8	33.21	33.14	32.94	33.02
39N	95.0% Lower Control Limit	13.37	16.11	18.56	15.25	15.93	32.68	33.14	33.08	32.88	32.98
39N	Average of Minimum	11.37	13.88	16.17	12.94	13.64	30.83	32.13	32.73	32.42	32.01
39N	Minimum	8.4	10.8	13.6	9	8.4	23.7	28.5	32.3	31.5	23.7
39N	Coefficient of Variation	0.11	0.13	0.1	0.13	0.16	0.02	0.02	0.01	0.01	0.02
39N	Standard Deviation	1.46	2.04	1.8	1.97	2.62	0.8	0.56	0.34	0.42	0.59
39N	Variance	2.13	4.16	3.23	3.89	6.89	0.63	0.31	0.11	0.18	0.35
33N	N of Cases	669	733	730	658	2790	187	193	156	167	703
33N	Maximum	18.4	22.4	23.8	23	23.8	33.6	34.5	34.1	33.9	34.5
33N	Average of Maximum	15.35	18.13	20.6	17.32	17.9	33.19	33.67	33.55	33.36	33.44
33N	95.0% Upper Control Limit	13.61	16.33	18.69	15.55	16.07	32.92	33.33	33.28	33.06	33.11
33N	Arithmetic Mean	13.5	16.19	18.56	15.4	15.98	32.84	33.26	33.22	32.99	33.07
33N	95.0% Lower Control Limit	13.39	16.04	18.42	15.25	15.88	32.75	33.18	33.16	32.92	33.03
33N	Average of Minimum	11.5	13.71	15.92	12.96	13.56	31.42	32.26	32.84	32.36	32.2
33N	Minimum	9.4	8.7	13.2	8	8	26.6	29.5	32.4	30.8	26.6
33N	Coefficient of Variation	0.1	0.12	0.1	0.13	0.16	0.02	0.02	0.01	0.01	0.02
33N	Standard Deviation	1.41	2.02	1.8	1.97	2.57	0.58	0.53	0.38	0.46	0.53
33N	Variance	1.98	4.08	3.24	3.89	6.61	0.33	0.28	0.15	0.21	0.28
27N	N of Cases	669	733	729	658	2789	187	193	156	167	703
27N	Maximum	18.4	21.8	24	20.1	24	33.6	34.8	34.1	34.7	34.8
27N	Average of Maximum	15.48	18.05	20.66	17.21	17.9	33.24	33.79	33.53	33.43	33.5
27N	95.0% Upper Control Limit	13.71	16.25	18.52	15.58	16.03	32.92	33.34	33.28	33.06	33.12
27N	Arithmetic Mean	13.6	16.1	18.38	15.43	15.94	32.86	33.26	33.22	32.99	33.08
27N	95.0% Lower Control Limit	13.49	15.96	18.25	15.29	15.85	32.8	33.19	33.16	32.91	33.04
27N	Average of Minimum	11.49	13.59	15.73	12.95	13.48	31.89	32.4	32.76	32.33	32.33
27N	Minimum	9.2	10.2	13.4	9.3	9.2	30.2	30.3	31.7	31.5	30.2
27N	Coefficient of Variation	0.11	0.13	0.1	0.12	0.16	0.01	0.02	0.01	0.01	0.01
27N	Standard Deviation	1.43	2.02	1.86	1.9	2.5	0.42	0.54	0.38	0.48	0.49
27N	Variance	2.05	4.08	3.46	3.62	6.26	0.17	0.29	0.15	0.23	0.24

Table A-2. Quarterly and annual statistics for OCSD surfzone (April 2000 – August 2011) and SCCOOS Newport Pier (January 1925 – December 2010) stations.

Station	*Statistics*	**Temperature**					**Salinity**				
		Winter	*Spring*	*Summer*	*Fall*	*Annual*	*Winter*	*Spring*	*Summer*	*Fall*	*Annual*
21N	N of Cases	669	733	730	658	2790	187	193	155	167	702
21N	Maximum	17	21.8	24.2	20.2	24.2	33.6	34.6	34.1	33.9	34.6
21N	Average of Maximum	15.33	17.99	20.71	17.28	17.87	33.17	33.74	33.54	33.3	33.43
21N	95.0% Upper Control Limit	13.65	16.12	18.46	15.56	15.96	32.91	33.33	33.29	33.03	33.11
21N	Arithmetic Mean	13.54	15.97	18.32	15.41	15.87	32.84	33.25	33.23	32.96	33.07
21N	95.0% Lower Control Limit	13.43	15.83	18.18	15.26	15.78	32.78	33.17	33.17	32.89	33.03
21N	Average of Minimum	11.43	13.43	15.57	12.73	13.33	31.84	32.26	32.75	32.36	32.29
21N	Minimum	8.8	10.6	13	8.3	8.3	30.4	30.1	32	31.7	30.1
21N	Coefficient of Variation	0.1	0.13	0.11	0.13	0.16	0.01	0.02	0.01	0.01	0.02
21N	Standard Deviation	1.42	2.02	1.93	1.93	2.52	0.42	0.56	0.38	0.48	0.5
21N	Variance	2.02	4.08	3.71	3.74	6.33	0.18	0.31	0.14	0.23	0.25
15N	N of Cases	669	732	729	658	2788	187	193	156	167	703
15N	Maximum	17	22.2	24	21.2	24	33.7	34.6	34	33.9	34.6
15N	Average of Maximum	15.26	18.02	20.74	17.1	17.83	33.31	33.8	33.51	33.28	33.47
15N	95.0% Upper Control Limit	13.6	16.08	18.39	15.5	15.91	32.94	33.34	33.29	33.04	33.12
15N	Arithmetic Mean	13.49	15.93	18.24	15.36	15.81	32.88	33.26	33.24	32.97	33.08
15N	95.0% Lower Control Limit	13.38	15.78	18.09	15.21	15.72	32.82	33.18	33.18	32.89	33.05
15N	Average of Minimum	11.46	13.41	15.22	12.94	13.29	31.88	32.44	32.8	32.32	32.35
15N	Minimum	9.3	10.6	12.5	9.2	9.2	30.2	30.7	31.8	31.2	30.2
15N	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.01	0.02	0.01	0.01	0.01
15N	Standard Deviation	1.42	2.09	2.05	1.9	2.54	0.43	0.54	0.37	0.49	0.49
15N	Variance	2.02	4.35	4.22	3.6	6.46	0.18	0.29	0.14	0.24	0.24
9N	N of Cases	673	732	730	658	2793	187	192	156	167	702
9N	Maximum	17.2	22	24.4	19.8	24.4	33.8	34.5	34.1	33.9	34.5
9N	Average of Maximum	15.3	18.03	20.52	17.22	17.81	33.32	33.73	33.55	33.32	33.48
9N	95.0% Upper Control Limit	13.69	16.02	18.28	15.58	15.9	32.96	33.31	33.29	33.07	33.12
9N	Arithmetic Mean	13.58	15.86	18.13	15.44	15.81	32.88	33.22	33.23	32.99	33.08
9N	95.0% Lower Control Limit	13.47	15.71	17.98	15.3	15.71	32.8	33.13	33.17	32.92	33.04
9N	Average of Minimum	11.51	13.09	15.05	13.01	13.19	31.41	32.28	32.84	32.34	32.2
9N	Minimum	8.7	9.4	11.9	9.4	8.7	27.3	30.4	32.3	31.6	27.3
9N	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.02	0.02	0.01	0.01	0.02
9N	Standard Deviation	1.43	2.14	2.07	1.85	2.5	0.58	0.63	0.39	0.49	0.56
9N	Variance	2.06	4.56	4.29	3.43	6.26	0.34	0.39	0.15	0.24	0.31

Table A-2. Quarterly and annual statistics for OCSD surfzone (April 2000 – August 2011) and SCCOOS Newport Pier (January 1925 – December 2010) stations.

Station	*Statistics*	**Temperature**					**Salinity**				
		Winter	*Spring*	*Summer*	*Fall*	*Annual*	*Winter*	*Spring*	*Summer*	*Fall*	*Annual*
6N	N of Cases	672	732	730	658	2792	187	192	156	167	702
6N	Maximum	17.2	22	25	20.3	25	33.7	34.3	34.1	33.9	34.3
6N	Average of Maximum	15.31	18.09	20.57	17.32	17.87	33.29	33.71	33.56	33.33	33.47
6N	95.0% Upper Control Limit	13.69	16.06	18.35	15.59	15.93	32.98	33.28	33.29	33.08	33.11
6N	Arithmetic Mean	13.58	15.91	18.2	15.44	15.84	32.85	33.19	33.23	33	33.06
6N	95.0% Lower Control Limit	13.47	15.75	18.05	15.3	15.74	32.73	33.09	33.17	32.93	33.01
6N	Average of Minimum	11.43	13.33	15.18	12.95	13.25	30.9	32.03	32.88	32.32	32.01
6N	Minimum	8.4	9.8	11.8	9.2	8.4	22.2	29.2	32.2	31.6	22.2
6N	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.03	0.02	0.01	0.01	0.02
6N	Standard Deviation	1.48	2.13	2.09	1.89	2.54	0.87	0.68	0.39	0.49	0.67
6N	Variance	2.2	4.55	4.37	3.58	6.43	0.77	0.46	0.15	0.24	0.44
3N	N of Cases	673	733	730	658	2794	187	193	156	167	703
3N	Maximum	17.4	23	29.6	19.4	29.6	33.7	34.2	34.1	33.9	34.2
3N	Average of Maximum	15.25	18.2	20.96	17.15	17.94	33.34	33.63	33.59	33.34	33.47
3N	95.0% Upper Control Limit	13.7	16.16	18.57	15.59	16.02	32.96	33.18	33.29	33.07	33.07
3N	Arithmetic Mean	13.59	16.01	18.41	15.45	15.92	32.82	33.03	33.22	32.99	33.01
3N	95.0% Lower Control Limit	13.48	15.85	18.26	15.3	15.83	32.68	32.87	33.16	32.91	32.94
3N	Average of Minimum	11.53	13.42	15.41	12.91	13.35	30.79	31.36	32.83	32.21	31.77
3N	Minimum	8.4	10.3	11.9	7.2	7.2	21	25.5	32.1	30	21
3N	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.03	0.03	0.01	0.02	0.03
3N	Standard Deviation	1.47	2.14	2.11	1.89	2.59	0.97	1.08	0.4	0.53	0.83
3N	Variance	2.15	4.57	4.44	3.59	6.71	0.94	1.17	0.16	0.29	0.69
ZERO	N of Cases	668	732	730	658	2788	187	193	156	167	703
ZERO	Maximum	19.2	24.2	25.6	21.4	25.6	33.8	34.8	34.2	34	34.8
ZERO	Average of Maximum	15.44	18.69	21.3	17.34	18.25	33.34	33.8	33.68	33.32	33.53
ZERO	95.0% Upper Control Limit	13.7	16.28	18.74	15.63	16.11	32.44	32.71	33.34	33.06	32.74
ZERO	Arithmetic Mean	13.58	16.12	18.59	15.48	16.01	32.01	32.21	33.27	32.88	32.55
ZERO	95.0% Lower Control Limit	13.46	15.96	18.43	15.33	15.91	31.59	31.71	33.2	32.69	32.36
ZERO	Average of Minimum	11.21	13.23	15.45	12.75	13.2	26.22	27.58	32.81	30.84	29.27
ZERO	Minimum	7.7	8.8	11.5	4.9	7.7	14.5	13	32	19	13
ZERO	Coefficient of Variation	0.11	0.14	0.11	0.13	0.17	0.09	0.11	0.01	0.04	0.08
ZERO	Standard Deviation	1.54	2.23	2.09	1.95	2.66	2.96	3.52	0.44	1.21	2.52
ZERO	Variance	2.36	4.95	4.37	3.82	7.1	8.79	12.4	0.19	1.46	6.36

Table A-2. Quarterly and annual statistics for OCSD surfzone (April 2000 – August 2011) and SCCOOS Newport Pier (January 1925 – December 2010) stations.

Station	*Statistics*	Temperature					Salinity				
		Winter	*Spring*	*Summer*	*Fall*	*Annual*	*Winter*	*Spring*	*Summer*	*Fall*	*Annual*
3S	N of Cases	669	733	731	658	2791	187	193	156	167	703
3S	Maximum	17.2	21.8	23.6	19.9	23.6	33.7	34.3	34.2	34	34.3
3S	Average of Maximum	15.39	18.08	20.68	17.35	17.92	33.28	33.67	33.64	33.4	33.49
3S	95.0% Upper Control Limit	13.6	16.03	18.44	15.59	15.93	32.02	33.36	33.33	33.02	32.81
3S	Arithmetic Mean	13.48	15.88	18.3	15.44	15.84	31.32	33.06	33.26	32.87	32.6
3S	95.0% Lower Control Limit	13.37	15.73	18.15	15.29	15.74	30.63	32.76	33.2	32.71	32.38
3S	Average of Minimum	11.05	13.16	15.23	12.66	13.06	23.11	29.49	32.95	30.82	28.98
3S	Minimum	7.9	10.1	11.8	8.9	7.9	4.3	5.5	32.4	23.7	4.3
3S	Coefficient of Variation	0.11	0.13	0.11	0.13	0.16	0.15	0.06	0.01	0.03	0.09
3S	Standard Deviation	1.47	2.07	2	1.98	2.56	4.82	2.13	0.41	0.99	2.88
3S	Variance	2.16	4.29	4.01	3.92	6.56	23.25	4.52	0.17	0.97	8.27
6S	N of Cases	669	733	730	658	2790	187	193	155	167	702
6S	Maximum	18.2	21.6	24.8	19.5	24.8	33.6	34.7	34.1	34	34.7
6S	Average of Maximum	15.5	18.09	20.66	17.25	17.92	33.19	33.76	33.55	33.37	33.46
6S	95.0% Upper Control Limit	13.8	16.1	18.48	15.72	16.04	32.81	33.34	33.3	33.04	33.07
6S	Arithmetic Mean	13.69	15.95	18.34	15.58	15.95	32.61	33.24	33.24	32.95	33
6S	95.0% Lower Control Limit	13.59	15.79	18.19	15.43	15.85	32.41	33.14	33.18	32.85	32.94
6S	Average of Minimum	11.4	13.36	15.2	13.07	13.29	29.56	31.89	32.74	31.73	31.44
6S	Minimum	8.8	10.4	10.3	9.4	8.8	19.2	26.2	31.8	30.2	19.2
6S	Coefficient of Variation	0.1	0.13	0.11	0.12	0.16	0.04	0.02	0.01	0.02	0.03
6S	Standard Deviation	1.39	2.07	2.04	1.87	2.5	1.38	0.71	0.41	0.62	0.91
6S	Variance	1.93	4.29	4.15	3.5	6.24	1.89	0.5	0.17	0.38	0.84
9S	N of Cases	668	733	731	658	2790	186	193	156	167	702
9S	Maximum	17.8	21.6	24.2	19.6	24.2	33.6	34.5	34.1	34	34.5
9S	Average of Maximum	15.43	17.99	20.77	17.24	17.9	33.22	33.7	33.54	33.34	33.45
9S	95.0% Upper Control Limit	13.81	16.11	18.57	15.76	16.08	32.91	33.34	33.29	33.06	33.11
9S	Arithmetic Mean	13.71	15.96	18.42	15.62	15.99	32.82	33.27	33.23	32.98	33.07
9S	95.0% Lower Control Limit	13.6	15.81	18.27	15.48	15.89	32.72	33.2	33.16	32.9	33.03
9S	Average of Minimum	11.61	13.44	15.15	13.18	13.37	31.68	32.41	32.69	32.16	32.22
9S	Minimum	8.8	11	9.4	7.9	7.9	27.6	30.9	31.5	31.3	27.6
9S	Coefficient of Variation	0.1	0.13	0.11	0.12	0.16	0.02	0.02	0.01	0.02	0.02
9S	Standard Deviation	1.37	2.07	2.02	1.84	2.5	0.63	0.52	0.43	0.52	0.57
9S	Variance	1.88	4.27	4.09	3.4	6.27	0.4	0.27	0.18	0.27	0.32

Table A-2. Quarterly and annual statistics for OCSD surfzone (April 2000 – August 2011) and SCCOOS Newport Pier (January 1925 – December 2010) stations.

Station	*Statistics*	**Temperature**					**Salinity**				
		Winter	*Spring*	*Summer*	*Fall*	*Annual*	*Winter*	*Spring*	*Summer*	*Fall*	*Annual*
Newport Pier	N of Cases	8129	8280	8240	8159	32808	8005	8147	8049	7995	32196
Newport Pier	Maximum	19.52	22.9	25	23.3	25	35.31	34.89	34.68	34.81	35.31
Newport Pier	Average of Maximum	15.28	18.16	21.07	17.72	18.06	33.68	33.83	33.83	33.74	33.77
Newport Pier	95.0% Upper Control Limit	14.19	16.35	18.85	16.39	16.44	33.29	33.55	33.6	33.5	33.48
Newport Pier	Arithmetic Mean	14.16	16.31	18.81	16.35	16.42	33.27	33.54	33.6	33.5	33.48
Newport Pier	95.0% Lower Control Limit	14.14	16.27	18.77	16.31	16.39	33.25	33.53	33.59	33.49	33.47
Newport Pier	Average of Minimum	12.95	14.09	16.12	14.72	14.47	32.4	33.16	33.39	33.2	33.04
Newport Pier	Minimum	9.9	10	12	10.6	9.9	15.96	26.08	26.76	26.71	15.96
Newport Pier	Coefficient of Variation	0.08	0.12	0.1	0.11	0.15	0.03	0.01	0.01	0.01	0.02
Newport Pier	Standard Deviation	1.2	1.96	1.79	1.84	2.38	0.89	0.45	0.21	0.25	0.54
Newport Pier	Variance	1.44	3.85	3.22	3.39	5.68	0.79	0.2	0.04	0.06	0.29
15S	N of Cases	668	733	730	659	2790	187	193	155	167	702
15S	Maximum	17.8	22	23.6	19.7	23.6	33.7	34.5	34.1	34	34.5
15S	Average of Maximum	15.48	18.06	20.71	17.31	17.93	33.3	33.71	33.56	33.33	33.47
15S	95.0% Upper Control Limit	13.78	16.07	18.54	15.75	16.05	32.96	33.36	33.32	33.07	33.14
15S	Arithmetic Mean	13.67	15.92	18.39	15.61	15.96	32.9	33.29	33.26	32.99	33.11
15S	95.0% Lower Control Limit	13.56	15.77	18.24	15.47	15.86	32.83	33.23	33.19	32.91	33.07
15S	Average of Minimum	11.5	13.25	15.24	13.21	13.33	31.94	32.5	32.81	32.17	32.34
15S	Minimum	8.3	9.7	11.3	8.4	8.3	29.1	31.5	32.3	31.1	29.1
15S	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.01	0.01	0.01	0.02	0.02
15S	Standard Deviation	1.47	2.1	2.02	1.86	2.53	0.47	0.47	0.4	0.52	0.5
15S	Variance	2.15	4.41	4.06	3.46	6.38	0.22	0.22	0.16	0.27	0.25
21S	N of Cases	668	733	730	657	2788	186	193	155	167	701
21S	Maximum	17.8	21.4	24	19.9	24	33.7	34.6	34.1	34	34.6
21S	Average of Maximum	15.27	17.97	20.73	17.16	17.83	33.29	33.73	33.56	33.38	33.49
21S	95.0% Upper Control Limit	13.69	16.1	18.69	15.72	16.07	32.98	33.36	33.31	33.08	33.15
21S	Arithmetic Mean	13.58	15.94	18.54	15.58	15.97	32.92	33.29	33.25	33	33.12
21S	95.0% Lower Control Limit	13.47	15.79	18.4	15.43	15.87	32.87	33.23	33.19	32.92	33.08
21S	Average of Minimum	11.41	13.31	15.47	13.2	13.38	32.19	32.39	32.84	32.33	32.43
21S	Minimum	8.3	10	12	8.9	8.3	31.4	31.7	32.1	31.6	31.4
21S	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.01	0.01	0.01	0.02	0.01
21S	Standard Deviation	1.45	2.14	2.02	1.87	2.6	0.38	0.47	0.4	0.51	0.47
21S	Variance	2.12	4.6	4.08	3.48	6.75	0.14	0.23	0.16	0.26	0.22

Table A-2. Quarterly and annual statistics for OCSD surfzone (April 2000 – August 2011) and SCCOOS Newport Pier (January 1925 – December 2010) stations.

Station	*Statistics*	**Temperature**					**Salinity**				
		Winter	*Spring*	*Summer*	*Fall*	*Annual*	*Winter*	*Spring*	*Summer*	*Fall*	*Annual*
27S	N of Cases	669	733	731	658	2791	187	193	156	167	703
27S	Maximum	19	22.6	24.4	20.2	24.4	33.7	34.6	34.1	34	34.6
27S	Average of Maximum	15.3	18.11	20.83	17.28	17.93	33.31	33.73	33.6	33.37	33.5
27S	95.0% Upper Control Limit	13.69	16.11	18.71	15.76	16.09	32.97	33.35	33.32	33.06	33.15
27S	Arithmetic Mean	13.58	15.96	18.56	15.62	15.99	32.92	33.29	33.25	32.98	33.11
27S	95.0% Lower Control Limit	13.47	15.81	18.42	15.48	15.9	32.87	33.22	33.19	32.9	33.07
27S	Average of Minimum	11.55	13.43	15.63	13.32	13.51	32.27	32.39	32.74	32.09	32.36
27S	Minimum	7.2	8.9	11.4	9.3	7.2	31.7	31.7	32.2	30.3	30.3
27S	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.01	0.01	0.01	0.02	0.01
27S	Standard Deviation	1.46	2.11	2.03	1.85	2.59	0.35	0.47	0.39	0.54	0.47
27S	Variance	2.12	4.45	4.13	3.42	6.72	0.13	0.22	0.16	0.29	0.22
29S	N of Cases	669	733	731	658	2791	187	193	156	167	703
29S	Maximum	17.8	21.8	25.4	20	25.4	33.7	34.5	34.1	33.9	34.5
29S	Average of Maximum	15.28	18.27	20.96	17.35	18.02	33.23	33.76	33.56	33.31	33.46
29S	95.0% Upper Control Limit	13.74	16.28	18.78	15.76	16.16	32.93	33.31	33.3	33.05	33.11
29S	Arithmetic Mean	13.63	16.13	18.63	15.62	16.06	32.87	33.24	33.23	32.98	33.08
29S	95.0% Lower Control Limit	13.53	15.97	18.47	15.48	15.97	32.82	33.17	33.17	32.9	33.04
29S	Average of Minimum	11.74	13.61	15.32	13.36	13.54	32.11	32.31	32.74	32.33	32.36
29S	Minimum	7.8	10.1	11.3	10.1	7.8	31.5	31.4	32.1	31.8	31.4
29S	Coefficient of Variation	0.1	0.13	0.12	0.12	0.16	0.01	0.01	0.01	0.02	0.01
29S	Standard Deviation	1.42	2.13	2.14	1.84	2.62	0.36	0.5	0.41	0.51	0.47
29S	Variance	2	4.53	4.59	3.37	6.84	0.13	0.25	0.17	0.26	0.23
39S	N of Cases	666	732	730	658	2786	187	192	156	166	701
39S	Maximum	19.4	21.6	24.6	19.9	24.6	33.8	34.5	34.1	33.9	34.5
39S	Average of Maximum	15.46	18.26	20.99	17.3	18.05	33.39	33.77	33.6	33.31	33.51
39S	95.0% Upper Control Limit	13.74	16.28	18.81	15.78	16.17	33.02	33.36	33.32	33.07	33.16
39S	Arithmetic Mean	13.62	16.12	18.66	15.63	16.08	32.97	33.29	33.26	32.98	33.12
39S	95.0% Lower Control Limit	13.51	15.97	18.51	15.49	15.98	32.92	33.22	33.19	32.9	33.09
39S	Average of Minimum	11.58	13.52	15.58	13.43	13.56	32.41	32.33	32.73	32.12	32.39
39S	Minimum	7.8	9.3	10.6	9.3	7.8	32	31	31.3	30.5	30.5
39S	Coefficient of Variation	0.11	0.13	0.11	0.12	0.16	0.01	0.01	0.01	0.02	0.01
39S	Standard Deviation	1.49	2.1	2.07	1.86	2.62	0.35	0.49	0.43	0.54	0.48
39S	Variance	2.23	4.41	4.27	3.48	6.87	0.12	0.24	0.18	0.3	0.23

Table A-3. **Quarterly and annual statistics for temperature (^{o}C). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95% UCL	Mean	95% LCL	Min	CV	SD	Var
				Winter					
1	20	16.23	15.20	14.82	14.44	13.43	0.06	0.82	0.67
2	20	16.20	15.13	14.76	14.38	13.37	0.05	0.81	0.65
3	20	16.01	15.02	14.66	14.29	13.40	0.05	0.77	0.60
4	20	15.82	14.88	14.54	14.20	13.38	0.05	0.73	0.53
5	20	15.83	14.82	14.47	14.12	13.35	0.05	0.74	0.55
6	20	15.76	14.69	14.35	14.01	13.28	0.05	0.73	0.53
7	20	15.72	14.60	14.27	13.93	13.15	0.05	0.71	0.51
8	20	15.72	14.56	14.22	13.88	13.07	0.05	0.72	0.52
9	20	15.68	14.48	14.15	13.82	13.07	0.05	0.71	0.50
10	20	15.61	14.40	14.07	13.73	13.07	0.05	0.71	0.51
11	20	15.57	14.33	14.00	13.67	13.06	0.05	0.71	0.50
12	20	15.49	14.27	13.93	13.59	13.04	0.05	0.72	0.52
13	19	15.42	14.17	13.83	13.50	13.02	0.05	0.69	0.48
14	17	15.40	14.22	13.85	13.47	13.01	0.05	0.73	0.53
15	8	13.99	13.88	13.61	13.34	13.03	0.02	0.32	0.10
16	1	13.79	13.79	13.79	13.79	13.79			
All	285	16.23	14.36	14.27	14.17	13.01	0.06	0.78	0.61
				Spring					
1	21	20.86	17.37	16.54	15.72	13.27	0.11	1.82	3.32
2	21	20.81	17.27	16.44	15.62	13.28	0.11	1.82	3.32
3	21	20.74	17.15	16.32	15.49	13.27	0.11	1.82	3.31
4	21	20.50	17.02	16.20	15.38	13.25	0.11	1.79	3.22
5	21	19.79	16.80	16.03	15.26	13.21	0.11	1.70	2.88
6	21	19.33	16.58	15.84	15.09	13.19	0.10	1.64	2.70
7	21	18.99	16.39	15.63	14.87	12.97	0.11	1.66	2.77
8	21	18.41	16.16	15.40	14.65	12.75	0.11	1.66	2.76
9	21	18.11	15.85	15.08	14.32	12.72	0.11	1.68	2.82
10	21	17.93	15.55	14.81	14.07	12.48	0.11	1.62	2.63
11	21	17.74	15.26	14.53	13.81	12.34	0.11	1.60	2.55
12	21	17.32	14.98	14.26	13.54	12.22	0.11	1.58	2.49
13	21	16.83	14.67	13.94	13.22	12.05	0.11	1.59	2.54
14	19	16.38	14.50	13.74	12.99	11.75	0.11	1.57	2.47
15	10	15.75	14.40	13.46	12.53	12.23	0.10	1.31	1.71
16	4	14.77	15.37	13.96	12.55	12.73	0.06	0.89	0.78
All	306	20.86	15.49	15.27	15.06	11.75	0.12	1.89	3.59
				Summer					
1	18	23.06	20.48	19.72	18.95	17.32	0.08	1.53	2.35
2	18	22.98	20.34	19.58	18.81	16.98	0.08	1.55	2.39
3	18	22.82	20.09	19.29	18.49	16.38	0.08	1.61	2.59
4	18	22.62	19.77	18.94	18.11	15.85	0.09	1.67	2.77
5	18	22.07	19.45	18.64	17.83	15.55	0.09	1.62	2.63
6	18	21.63	19.25	18.46	17.67	15.48	0.09	1.59	2.52
7	18	21.31	19.02	18.22	17.42	15.46	0.09	1.61	2.58
8	18	21.29	18.80	17.98	17.17	14.87	0.09	1.64	2.68
9	18	21.23	18.56	17.72	16.88	14.57	0.10	1.69	2.85
10	18	20.97	18.34	17.46	16.58	14.37	0.10	1.78	3.15
11	18	20.47	18.10	17.22	16.35	14.24	0.10	1.76	3.09
12	18	20.21	17.81	16.95	16.10	13.96	0.10	1.72	2.94
13	18	20.13	17.44	16.63	15.82	13.82	0.10	1.63	2.64
14	16	19.88	17.22	16.34	15.46	13.69	0.10	1.66	2.74
15	9	19.63	17.71	16.21	14.71	13.25	0.12	1.96	3.83
16	5	17.08	16.97	14.90	12.83	13.26	0.11	1.67	2.78
17	1	13.63	13.63	13.63	13.63	13.63			
All	265	23.06	18.20	17.96	17.71	13.25	0.11	1.99	3.97

Table A-3. Quarterly and annual statistics for temperature (^{o}C). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95% UCL	Mean	95% LCL	Min	CV	SD	Var
Fall									
1	11	19.78	18.48	17.71	16.93	15.97	0.07	1.16	1.34
2	12	19.77	18.33	17.53	16.73	15.64	0.07	1.26	1.60
3	12	19.72	18.25	17.44	16.63	15.54	0.07	1.27	1.62
4	12	19.69	18.09	17.31	16.54	15.52	0.07	1.22	1.50
5	12	19.67	18.03	17.22	16.41	15.29	0.07	1.27	1.62
6	12	19.66	18.00	17.11	16.23	15.00	0.08	1.39	1.94
7	12	19.64	17.93	17.02	16.10	14.75	0.08	1.44	2.07
8	12	19.62	17.89	16.96	16.02	14.71	0.09	1.47	2.15
9	12	19.58	17.81	16.86	15.91	14.60	0.09	1.50	2.24
10	12	19.54	17.77	16.80	15.84	14.51	0.09	1.52	2.31
11	12	19.36	17.69	16.73	15.78	14.48	0.09	1.51	2.27
12	12	19.06	17.51	16.59	15.67	14.46	0.09	1.45	2.11
13	12	18.57	17.21	16.28	15.36	14.29	0.09	1.46	2.14
14	12	17.92	16.94	16.05	15.16	14.28	0.09	1.40	1.96
15	4	17.49	18.00	15.53	13.06	14.12	0.10	1.55	2.42
16	1	13.78	13.78	13.78	13.78	13.78			
17	1	13.68	13.68	13.68	13.68	13.68			
All	173	19.78	17.12	16.90	13.68	16.68	0.09	1.45	2.11
Annual									
1	70	23.06	17.60	17.05	16.50	13.27	0.14	2.32	5.36
2	71	22.98	17.49	16.95	16.40	13.28	0.14	2.29	5.24
3	71	22.82	17.33	16.79	16.26	13.27	0.13	2.25	5.04
4	71	22.62	17.13	16.61	16.10	13.25	0.13	2.17	4.73
5	71	22.07	16.95	16.45	15.96	13.21	0.13	2.09	4.37
6	71	21.63	16.79	16.30	15.81	13.19	0.13	2.07	4.29
7	71	21.31	16.62	16.14	15.65	12.97	0.13	2.05	4.20
8	71	21.29	16.47	15.99	15.51	12.75	0.13	2.02	4.10
9	71	21.23	16.27	15.79	15.31	12.72	0.13	2.01	4.06
10	71	20.97	16.08	15.61	15.13	12.48	0.13	2.00	4.01
11	71	20.47	15.91	15.44	14.97	12.34	0.13	1.98	3.92
12	71	20.21	15.70	15.24	14.79	12.22	0.13	1.93	3.74
13	70	20.13	15.45	15.01	14.56	12.05	0.13	1.89	3.55
14	64	19.88	15.31	14.85	14.40	11.75	0.12	1.82	3.31
15	31	19.63	15.24	14.56	13.89	12.23	0.13	1.84	3.38
16	11	17.08	15.21	14.35	13.50	12.73	0.09	1.27	1.62
17	2	13.68	13.97	13.66	13.34	13.63	0.00	0.04	0.00
All	1,029	23.06	16.09	15.96	15.82	11.75	0.14	2.17	4.72

Table A-4. Quarterly and annual statistics for density (kg/m^3). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	20	25.08	24.69	24.55	24.40	23.93	0.01	0.32	0.10
2	20	25.10	24.73	24.59	24.45	23.94	0.01	0.31	0.09
3	20	25.11	24.78	24.66	24.55	23.94	0.01	0.25	0.06
4	20	25.12	24.82	24.71	24.60	24.08	0.01	0.23	0.05
5	20	25.14	24.84	24.74	24.63	24.04	0.01	0.23	0.05
6	20	25.17	24.88	24.78	24.69	24.31	0.01	0.20	0.04
7	20	25.18	24.89	24.81	24.72	24.51	0.01	0.18	0.03
8	20	25.17	24.91	24.83	24.74	24.52	0.01	0.18	0.03
9	20	25.17	24.94	24.85	24.77	24.52	0.01	0.18	0.03
10	20	25.22	24.96	24.88	24.79	24.52	0.01	0.19	0.03
11	20	25.23	24.98	24.89	24.81	24.52	0.01	0.19	0.03
12	20	25.24	25.00	24.91	24.82	24.52	0.01	0.19	0.04
13	19	25.24	25.02	24.94	24.86	24.58	0.01	0.17	0.03
14	17	25.26	25.04	24.95	24.86	24.58	0.01	0.18	0.03
15	8	25.26	25.17	25.04	24.91	24.75	0.01	0.16	0.02
16	1	24.76	24.76	24.76	24.76	24.76			
All	285	25.26	24.83	24.80	24.77	23.93	0.01	0.25	0.06
Spring									
1	21	25.26	24.70	24.47	24.25	23.33	0.02	0.49	0.24
2	21	25.26	24.72	24.50	24.28	23.35	0.02	0.49	0.24
3	21	25.26	24.75	24.53	24.31	23.37	0.02	0.49	0.24
4	21	25.26	24.77	24.56	24.34	23.43	0.02	0.48	0.23
5	21	25.27	24.81	24.60	24.40	23.65	0.02	0.45	0.20
6	21	25.27	24.85	24.65	24.45	23.78	0.02	0.43	0.19
7	21	25.32	24.89	24.70	24.50	23.83	0.02	0.43	0.19
8	21	25.37	24.94	24.74	24.55	23.89	0.02	0.43	0.18
9	21	25.38	25.02	24.82	24.62	23.94	0.02	0.43	0.19
10	21	25.41	25.07	24.89	24.70	24.12	0.02	0.41	0.17
11	21	25.46	25.12	24.94	24.76	24.16	0.02	0.40	0.16
12	21	25.48	25.18	25.00	24.82	24.22	0.02	0.39	0.15
13	21	25.51	25.24	25.07	24.90	24.45	0.02	0.38	0.14
14	19	25.57	25.29	25.11	24.93	24.48	0.01	0.37	0.14
15	10	25.57	25.41	25.17	24.93	24.68	0.01	0.33	0.11
16	4	25.36	25.46	25.02	24.58	24.71	0.01	0.28	0.08
All	306	25.57	24.82	24.77	24.72	23.33	0.02	0.47	0.23
Summer									
1	18	24.29	23.89	23.69	23.49	22.76	0.02	0.40	0.16
2	18	24.44	23.93	23.73	23.53	22.79	0.02	0.40	0.16
3	18	24.56	23.99	23.80	23.60	22.85	0.02	0.40	0.16
4	18	24.64	24.09	23.89	23.69	22.94	0.02	0.40	0.16
5	18	24.67	24.15	23.96	23.78	23.10	0.02	0.38	0.14
6	18	24.68	24.19	24.01	23.82	23.21	0.02	0.37	0.13
7	18	24.74	24.25	24.06	23.88	23.32	0.02	0.37	0.14
8	18	24.90	24.30	24.12	23.93	23.45	0.02	0.37	0.14
9	18	24.96	24.37	24.18	23.99	23.47	0.02	0.38	0.15
10	18	25.00	24.45	24.25	24.05	23.54	0.02	0.40	0.16
11	18	25.03	24.49	24.30	24.11	23.65	0.02	0.39	0.15
12	18	25.09	24.54	24.36	24.17	23.72	0.02	0.37	0.14
13	18	25.12	24.60	24.43	24.26	23.74	0.01	0.35	0.12
14	16	25.14	24.69	24.50	24.32	23.80	0.01	0.35	0.12
15	9	25.24	24.88	24.56	24.24	23.86	0.02	0.42	0.18
16	5	25.24	25.30	24.84	24.38	24.37	0.01	0.37	0.14
17	1	25.11	25.11	25.11	25.11	25.11			
All	265	25.24	24.18	24.12	24.07	22.76	0.02	0.47	0.22

Table A-4. **Quarterly and annual statistics for density (kg/m^3). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	11	24.49	24.28	24.00	23.73	23.12	0.02	0.40	0.16
2	12	24.68	24.34	24.07	23.79	23.11	0.02	0.43	0.19
3	12	24.70	24.35	24.12	23.89	23.55	0.02	0.36	0.13
4	12	24.71	24.37	24.17	23.97	23.66	0.01	0.32	0.10
5	12	24.71	24.40	24.19	23.99	23.67	0.01	0.32	0.10
6	12	24.71	24.43	24.22	24.00	23.67	0.01	0.34	0.12
7	12	24.73	24.46	24.24	24.02	23.67	0.01	0.35	0.12
8	12	24.73	24.48	24.26	24.03	23.68	0.01	0.36	0.13
9	12	24.74	24.51	24.28	24.05	23.68	0.02	0.36	0.13
10	12	24.75	24.53	24.29	24.06	23.69	0.02	0.37	0.13
11	12	24.75	24.54	24.31	24.08	23.74	0.01	0.36	0.13
12	12	24.76	24.56	24.34	24.12	23.80	0.01	0.35	0.12
13	12	24.85	24.63	24.41	24.19	23.89	0.01	0.35	0.12
14	12	24.88	24.67	24.45	24.24	23.94	0.01	0.34	0.11
15	4	24.95	25.07	24.61	24.14	24.30	0.01	0.29	0.09
16	1	25.01	25.01	25.01	25.01	25.01			
17	1	25.03	25.03	25.03	25.03	25.03			
All	173	25.03	24.32	24.26	24.20	23.11	0.02	0.37	0.14
Annual									
1	70	25.26	24.35	24.22	24.09	22.76	0.02	0.54	0.29
2	71	25.26	24.38	24.26	24.13	22.79	0.02	0.54	0.29
3	71	25.26	24.44	24.31	24.19	22.85	0.02	0.52	0.27
4	71	25.26	24.48	24.37	24.25	22.94	0.02	0.49	0.24
5	71	25.27	24.52	24.41	24.30	23.10	0.02	0.47	0.22
6	71	25.27	24.56	24.45	24.34	23.21	0.02	0.47	0.22
7	71	25.32	24.60	24.49	24.38	23.32	0.02	0.46	0.21
8	71	25.37	24.64	24.53	24.42	23.45	0.02	0.46	0.21
9	71	25.38	24.69	24.58	24.47	23.47	0.02	0.46	0.21
10	71	25.41	24.73	24.62	24.51	23.54	0.02	0.46	0.21
11	71	25.46	24.76	24.66	24.55	23.65	0.02	0.45	0.20
12	71	25.48	24.80	24.70	24.59	23.72	0.02	0.44	0.20
13	70	25.51	24.86	24.76	24.65	23.74	0.02	0.43	0.19
14	64	25.57	24.90	24.79	24.69	23.80	0.02	0.42	0.18
15	31	25.57	25.04	24.89	24.73	23.86	0.02	0.41	0.17
16	11	25.36	25.11	24.91	24.71	24.37	0.01	0.30	0.09
17	2	25.11	25.55	25.07	24.59	25.03	0.00	0.05	0.00
All	1,029	25.57	24.56	24.53	24.49	22.76	0.02	0.51	0.26

Table A-5. **Quarterly and annual statistics for salinity (psu). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	20	33.56	33.28	33.10	32.92	32.32	0.012	0.38	0.15
2	20	33.56	33.30	33.14	32.99	32.53	0.010	0.32	0.11
3	20	33.56	33.33	33.21	33.10	32.65	0.007	0.25	0.06
4	20	33.56	33.34	33.24	33.13	32.75	0.007	0.22	0.05
5	20	33.56	33.35	33.25	33.15	32.73	0.006	0.21	0.05
6	20	33.56	33.37	33.28	33.19	32.90	0.006	0.20	0.04
7	20	33.56	33.37	33.29	33.21	32.98	0.005	0.18	0.03
8	20	33.56	33.38	33.30	33.22	32.99	0.005	0.17	0.03
9	20	33.56	33.39	33.32	33.24	32.99	0.005	0.17	0.03
10	20	33.55	33.40	33.32	33.25	32.99	0.005	0.16	0.03
11	20	33.56	33.40	33.33	33.25	33.02	0.005	0.16	0.03
12	20	33.55	33.40	33.33	33.26	33.04	0.005	0.16	0.02
13	19	33.55	33.42	33.35	33.27	33.06	0.005	0.15	0.02
14	17	33.55	33.44	33.36	33.28	33.07	0.005	0.15	0.02
15	8	33.55	33.56	33.41	33.25	33.09	0.006	0.18	0.03
16	1	33.09	33.09	33.09	33.09	33.09			
All	285	33.56	33.30	33.28	33.25	32.32	0.007	0.22	0.05
Spring									
1	21	33.73	33.60	33.52	33.45	33.05	0.005	0.17	0.03
2	21	33.72	33.60	33.53	33.45	33.05	0.005	0.16	0.03
3	21	33.72	33.60	33.53	33.46	33.05	0.005	0.16	0.03
4	21	33.71	33.60	33.53	33.46	33.05	0.005	0.16	0.02
5	21	33.70	33.60	33.54	33.47	33.06	0.005	0.15	0.02
6	21	33.70	33.61	33.54	33.48	33.06	0.004	0.15	0.02
7	21	33.70	33.61	33.54	33.47	33.06	0.004	0.15	0.02
8	21	33.70	33.61	33.54	33.47	33.07	0.004	0.15	0.02
9	21	33.71	33.61	33.54	33.48	33.08	0.004	0.15	0.02
10	21	33.70	33.61	33.55	33.48	33.08	0.004	0.14	0.02
11	21	33.72	33.61	33.55	33.49	33.10	0.004	0.14	0.02
12	21	33.75	33.61	33.55	33.49	33.13	0.004	0.14	0.02
13	21	33.75	33.61	33.55	33.49	33.19	0.004	0.13	0.02
14	19	33.75	33.61	33.55	33.49	33.22	0.004	0.13	0.02
15	10	33.75	33.67	33.55	33.44	33.27	0.005	0.16	0.02
16	4	33.62	33.81	33.49	33.17	33.19	0.006	0.20	0.04
All	306	33.75	33.56	33.54	33.52	33.05	0.004	0.15	0.02
Summer									
1	17	33.77	33.56	33.49	33.42	33.15	0.004	0.14	0.02
2	18	33.77	33.56	33.50	33.43	33.18	0.004	0.13	0.02
3	18	33.77	33.56	33.50	33.44	33.22	0.004	0.12	0.01
4	18	33.76	33.56	33.51	33.46	33.26	0.003	0.11	0.01
5	18	33.75	33.57	33.51	33.46	33.28	0.003	0.11	0.01
6	18	33.73	33.56	33.51	33.46	33.29	0.003	0.10	0.01
7	18	33.73	33.55	33.50	33.45	33.32	0.003	0.10	0.01
8	18	33.73	33.55	33.50	33.45	33.32	0.003	0.10	0.01
9	18	33.73	33.55	33.50	33.45	33.32	0.003	0.10	0.01
10	18	33.73	33.55	33.51	33.46	33.33	0.003	0.10	0.01
11	18	33.71	33.55	33.50	33.45	33.32	0.003	0.10	0.01
12	18	33.70	33.55	33.50	33.45	33.30	0.003	0.10	0.01
13	18	33.70	33.55	33.49	33.45	33.30	0.003	0.10	0.01
14	16	33.70	33.55	33.51	33.46	33.33	0.003	0.09	0.01
15	9	33.69	33.59	33.54	33.48	33.43	0.002	0.07	0.00
16	5	33.57	33.58	33.52	33.46	33.44	0.001	0.05	0.00
17	1	33.50	33.50	33.50	33.50	33.50			
All	264	33.77	33.52	33.50	33.49	33.15	0.003	0.10	0.01

Table A-5. Quarterly and annual statistics for salinity (psu). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	11	33.53	33.42	33.31	33.20	32.95	0.005	0.17	0.03
2	12	33.54	33.43	33.33	33.23	32.98	0.005	0.16	0.03
3	12	33.53	33.43	33.34	33.25	33.11	0.004	0.14	0.02
4	12	33.54	33.43	33.36	33.28	33.12	0.004	0.12	0.01
5	12	33.55	33.43	33.35	33.28	33.12	0.004	0.12	0.02
6	12	33.55	33.43	33.35	33.27	33.11	0.004	0.12	0.02
7	12	33.55	33.43	33.35	33.27	33.12	0.004	0.13	0.02
8	12	33.56	33.44	33.36	33.28	33.12	0.004	0.13	0.02
9	12	33.56	33.44	33.36	33.28	33.13	0.004	0.13	0.02
10	12	33.56	33.44	33.36	33.28	33.14	0.004	0.13	0.02
11	12	33.57	33.44	33.36	33.28	33.15	0.004	0.12	0.02
12	12	33.56	33.43	33.36	33.28	33.15	0.004	0.12	0.01
13	12	33.57	33.43	33.35	33.28	33.16	0.004	0.12	0.02
14	12	33.57	33.42	33.34	33.26	33.16	0.004	0.12	0.02
15	4	33.57	33.62	33.39	33.16	33.24	0.004	0.15	0.02
16	1	33.42	33.42	33.42	33.42	33.42			
17	1	33.42	33.42	33.42	33.42	33.42			
All	173	33.57	33.37	33.35	33.33	32.95	0.004	0.13	0.02
Annual									
1	69	33.77	33.43	33.36	33.29	32.32	0.009	0.30	0.09
2	71	33.77	33.44	33.38	33.32	32.53	0.008	0.27	0.07
3	71	33.77	33.45	33.40	33.35	32.65	0.007	0.22	0.05
4	71	33.76	33.46	33.41	33.36	32.75	0.006	0.20	0.04
5	71	33.75	33.47	33.42	33.37	32.73	0.006	0.20	0.04
6	71	33.73	33.47	33.43	33.38	32.90	0.006	0.19	0.03
7	71	33.73	33.47	33.43	33.39	32.98	0.005	0.18	0.03
8	71	33.73	33.47	33.43	33.39	32.99	0.005	0.17	0.03
9	71	33.73	33.48	33.44	33.40	32.99	0.005	0.17	0.03
10	71	33.73	33.48	33.44	33.40	32.99	0.005	0.17	0.03
11	71	33.72	33.48	33.44	33.41	33.02	0.005	0.16	0.03
12	71	33.75	33.48	33.44	33.40	33.04	0.005	0.16	0.03
13	70	33.75	33.49	33.45	33.41	33.06	0.005	0.16	0.02
14	64	33.75	33.49	33.45	33.41	33.07	0.005	0.15	0.02
15	31	33.75	33.55	33.49	33.43	33.09	0.005	0.15	0.02
16	11	33.62	33.57	33.46	33.35	33.09	0.005	0.17	0.03
17	2	33.50	34.01	33.46	32.91	33.42	0.002	0.06	0.00
All	1,028	33.77	33.44	33.43	33.41	32.32	0.006	0.20	0.04

Table A-6. **Quarterly and annual statistics for dissolved oxygen (mg/L). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	20	10.16	8.81	8.33	7.85	6.19	0.12	1.03	1.05
2	20	10.17	8.82	8.35	7.87	6.67	0.12	1.02	1.03
3	20	10.15	8.86	8.39	7.93	6.73	0.12	0.99	0.98
4	20	10.20	8.85	8.38	7.90	6.62	0.12	1.01	1.03
5	20	10.32	8.86	8.35	7.85	6.48	0.13	1.08	1.16
6	20	10.34	8.80	8.27	7.74	6.12	0.14	1.13	1.27
7	20	10.10	8.74	8.21	7.67	6.07	0.14	1.14	1.31
8	20	9.90	8.68	8.16	7.64	5.95	0.14	1.11	1.23
9	20	9.67	8.56	8.05	7.54	5.86	0.14	1.09	1.20
10	20	9.27	8.43	7.93	7.43	5.76	0.14	1.08	1.16
11	20	9.20	8.26	7.77	7.27	5.69	0.14	1.06	1.12
12	20	9.32	8.18	7.67	7.16	5.63	0.14	1.09	1.19
13	19	9.32	8.08	7.54	7.01	5.58	0.15	1.11	1.24
14	17	9.25	8.14	7.54	6.94	5.55	0.15	1.16	1.35
15	8	8.53	8.22	7.67	7.13	6.80	0.08	0.65	0.42
16	1	8.44	8.44	8.44	8.44	8.44			
All	285	10.34	8.19	8.07	7.94	5.55	0.14	1.09	1.18
Spring									
1	21	10.77	9.38	9.02	8.67	7.78	0.09	0.78	0.60
2	21	10.69	9.38	9.03	8.68	7.91	0.09	0.77	0.60
3	21	10.70	9.38	9.03	8.68	7.94	0.09	0.77	0.59
4	21	10.75	9.36	8.99	8.63	7.85	0.09	0.80	0.65
5	21	10.93	9.30	8.92	8.54	7.67	0.09	0.83	0.69
6	21	11.04	9.25	8.86	8.47	7.58	0.10	0.86	0.73
7	21	10.88	9.19	8.78	8.38	7.26	0.10	0.89	0.79
8	21	10.33	8.99	8.60	8.21	6.89	0.10	0.86	0.74
9	21	10.02	8.83	8.43	8.02	6.57	0.11	0.89	0.79
10	21	9.67	8.60	8.18	7.77	6.46	0.11	0.91	0.84
11	21	9.51	8.43	7.96	7.49	5.90	0.13	1.03	1.06
12	21	9.53	8.26	7.77	7.28	5.61	0.14	1.08	1.16
13	21	9.60	8.15	7.69	7.23	5.92	0.13	1.01	1.03
14	19	9.68	8.13	7.63	7.12	5.92	0.14	1.05	1.10
15	10	9.70	8.32	7.51	6.70	6.16	0.15	1.13	1.28
16	4	9.47	9.98	8.03	6.07	6.63	0.15	1.23	1.51
All	306	11.04	8.58	8.46	8.34	5.61	0.12	1.04	1.08
Summer									
1	18	12.62	9.15	8.59	8.03	7.54	0.13	1.13	1.27
2	18	12.71	9.15	8.58	8.00	7.51	0.13	1.16	1.34
3	18	12.86	9.22	8.64	8.05	7.56	0.14	1.18	1.39
4	18	13.04	9.33	8.72	8.11	7.57	0.14	1.23	1.51
5	18	12.41	9.27	8.73	8.18	7.65	0.13	1.10	1.21
6	18	11.37	9.11	8.66	8.21	7.66	0.10	0.90	0.82
7	18	10.84	9.04	8.63	8.22	7.66	0.10	0.83	0.69
8	18	10.54	9.00	8.60	8.20	7.34	0.09	0.81	0.66
9	18	10.50	9.00	8.59	8.19	7.29	0.09	0.81	0.66
10	18	10.56	9.01	8.59	8.17	7.32	0.10	0.84	0.70
11	18	10.46	8.98	8.57	8.15	7.30	0.10	0.83	0.69
12	18	10.33	8.96	8.54	8.12	7.16	0.10	0.84	0.71
13	18	10.16	8.90	8.50	8.10	7.22	0.09	0.81	0.65
14	16	9.59	8.72	8.35	7.98	7.28	0.08	0.69	0.48
15	9	9.29	8.83	8.40	7.97	7.76	0.07	0.56	0.32
16	5	8.64	8.58	8.14	7.69	7.76	0.04	0.36	0.13
17	1	8.21	8.21	8.21	8.21	8.21			
All	265	13.04	8.69	8.58	8.47	7.16	0.11	0.92	0.84

Table A-6. Quarterly and annual statistics for dissolved oxygen (mg/L). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	11	10.68	9.04	8.30	7.57	6.00	0.13	1.09	1.20
2	12	10.70	9.00	8.35	7.71	6.17	0.12	1.01	1.02
3	12	11.07	9.06	8.40	7.74	6.46	0.12	1.04	1.08
4	12	11.40	9.13	8.48	7.83	7.15	0.12	1.02	1.05
5	12	11.14	9.05	8.47	7.90	7.64	0.11	0.91	0.83
6	12	10.11	8.81	8.42	8.02	7.78	0.07	0.62	0.38
7	12	9.19	8.59	8.31	8.03	7.76	0.05	0.44	0.20
8	12	9.07	8.52	8.25	7.98	7.71	0.05	0.43	0.18
9	12	9.12	8.46	8.19	7.91	7.68	0.05	0.43	0.18
10	12	9.16	8.40	8.12	7.84	7.60	0.05	0.44	0.20
11	12	9.22	8.35	8.01	7.68	7.07	0.07	0.53	0.28
12	12	9.30	8.31	7.92	7.53	6.65	0.08	0.62	0.38
13	12	9.37	8.31	7.88	7.45	6.53	0.09	0.67	0.45
14	12	8.93	8.21	7.86	7.50	6.86	0.07	0.56	0.31
15	4	8.35	8.47	7.98	7.49	7.63	0.04	0.31	0.09
16	1	7.92	7.92	7.92	7.92	7.92			
17	1	8.01	8.01	8.01	8.01	8.01			
All	173	11.40	8.31	8.20	8.09	6.00	0.09	0.73	0.54
Annual									
1	70	12.62	8.84	8.60	8.36	6.00	0.12	1.02	1.04
2	71	12.71	8.85	8.61	8.37	6.17	0.12	1.01	1.02
3	71	12.86	8.88	8.64	8.40	6.46	0.12	1.01	1.02
4	71	13.04	8.91	8.66	8.42	6.62	0.12	1.03	1.06
5	71	12.41	8.87	8.64	8.40	6.48	0.12	0.99	0.99
6	71	11.37	8.79	8.57	8.35	6.12	0.11	0.93	0.87
7	71	10.88	8.72	8.50	8.28	6.07	0.11	0.92	0.84
8	71	10.54	8.63	8.42	8.21	5.95	0.10	0.88	0.78
9	71	10.50	8.53	8.32	8.11	5.86	0.11	0.89	0.79
10	71	10.56	8.42	8.20	7.99	5.76	0.11	0.90	0.81
11	71	10.46	8.29	8.07	7.84	5.69	0.12	0.95	0.91
12	71	10.33	8.20	7.96	7.73	5.61	0.13	1.00	1.01
13	70	10.16	8.13	7.89	7.65	5.58	0.13	1.00	1.00
14	64	9.68	8.07	7.83	7.59	5.55	0.12	0.96	0.93
15	31	9.70	8.18	7.87	7.56	6.16	0.11	0.84	0.71
16	11	9.47	8.59	8.10	7.62	6.63	0.09	0.72	0.52
17	2	8.21	9.38	8.11	6.84	8.01	0.02	0.14	0.02
All	1,029	13.04	8.40	8.34	8.28	5.55	0.12	1.00	1.00

Table A-7. Quarterly and annual statistics for pH. OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	19	8.34	8.21	8.11	8.00	7.70	0.03	0.21	0.05
2	20	8.34	8.21	8.11	8.01	7.70	0.03	0.21	0.04
3	20	8.34	8.21	8.11	8.01	7.70	0.03	0.21	0.04
4	20	8.33	8.20	8.10	8.01	7.70	0.03	0.20	0.04
5	20	8.33	8.19	8.10	8.01	7.70	0.02	0.20	0.04
6	20	8.33	8.19	8.09	8.00	7.70	0.02	0.20	0.04
7	20	8.32	8.17	8.08	7.99	7.70	0.02	0.19	0.04
8	20	8.29	8.16	8.08	7.99	7.70	0.02	0.19	0.04
9	20	8.29	8.15	8.07	7.98	7.70	0.02	0.19	0.03
10	20	8.28	8.14	8.06	7.97	7.70	0.02	0.18	0.03
11	20	8.28	8.13	8.05	7.96	7.68	0.02	0.18	0.03
12	20	8.28	8.12	8.04	7.95	7.66	0.02	0.18	0.03
13	19	8.26	8.10	8.01	7.93	7.66	0.02	0.18	0.03
14	17	8.26	8.09	8.00	7.90	7.65	0.02	0.19	0.03
15	8	8.07	7.97	7.84	7.71	7.65	0.02	0.16	0.02
16	1	7.83	7.83	7.83	7.83	7.83			
All	284	8.34	8.09	8.06	8.04	7.65	0.02	0.20	0.04
Spring									
1	21	8.51	8.26	8.18	8.10	7.89	0.02	0.18	0.03
2	21	8.51	8.26	8.18	8.10	7.89	0.02	0.18	0.03
3	21	8.51	8.26	8.18	8.10	7.89	0.02	0.18	0.03
4	21	8.52	8.26	8.18	8.10	7.89	0.02	0.18	0.03
5	21	8.52	8.26	8.17	8.09	7.89	0.02	0.18	0.03
6	21	8.50	8.25	8.17	8.09	7.89	0.02	0.18	0.03
7	21	8.46	8.23	8.15	8.07	7.89	0.02	0.18	0.03
8	21	8.40	8.22	8.14	8.06	7.87	0.02	0.17	0.03
9	21	8.40	8.20	8.12	8.04	7.86	0.02	0.18	0.03
10	21	8.39	8.18	8.10	8.01	7.81	0.02	0.18	0.03
11	21	8.39	8.16	8.07	7.99	7.75	0.02	0.19	0.04
12	21	8.39	8.14	8.06	7.97	7.72	0.02	0.19	0.04
13	21	8.38	8.12	8.03	7.94	7.68	0.02	0.19	0.04
14	19	8.37	8.06	7.97	7.88	7.66	0.02	0.19	0.04
15	10	8.14	8.07	7.96	7.84	7.66	0.02	0.16	0.03
16	4	8.12	8.23	8.00	7.76	7.78	0.02	0.15	0.02
All	306	8.52	8.14	8.12	8.09	7.66	0.02	0.19	0.04
Summer									
1	17	8.46	8.25	8.18	8.10	7.91	0.02	0.14	0.02
2	17	8.46	8.25	8.18	8.11	7.91	0.02	0.14	0.02
3	17	8.45	8.25	8.18	8.11	7.91	0.02	0.14	0.02
4	17	8.37	8.24	8.17	8.10	7.91	0.02	0.13	0.02
5	17	8.36	8.22	8.16	8.09	7.91	0.02	0.12	0.02
6	17	8.36	8.21	8.15	8.09	7.91	0.02	0.12	0.02
7	17	8.36	8.21	8.14	8.08	7.91	0.02	0.12	0.02
8	17	8.36	8.20	8.14	8.07	7.91	0.02	0.13	0.02
9	17	8.35	8.20	8.13	8.06	7.89	0.02	0.13	0.02
10	17	8.35	8.19	8.12	8.05	7.86	0.02	0.14	0.02
11	17	8.35	8.19	8.12	8.05	7.87	0.02	0.14	0.02
12	17	8.35	8.19	8.12	8.04	7.86	0.02	0.14	0.02
13	17	8.35	8.18	8.11	8.03	7.83	0.02	0.15	0.02
14	15	8.34	8.17	8.09	8.01	7.81	0.02	0.15	0.02
15	9	8.31	8.19	8.06	7.93	7.78	0.02	0.17	0.03
16	5	8.26	8.21	7.97	7.74	7.75	0.02	0.19	0.04
17	1	7.91	7.91	7.91	7.91	7.91			
All	251	8.46	8.15	8.13	8.12	7.75	0.02	0.14	0.02

Table A-7. Quarterly and annual statistics for pH. OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	11	8.32	8.25	8.18	8.10	8.04	0.01	0.11	0.01
2	12	8.32	8.25	8.18	8.11	8.04	0.01	0.10	0.01
3	12	8.34	8.25	8.18	8.12	8.04	0.01	0.10	0.01
4	12	8.35	8.25	8.18	8.12	8.04	0.01	0.11	0.01
5	12	8.35	8.25	8.18	8.11	8.04	0.01	0.11	0.01
6	12	8.36	8.24	8.17	8.11	8.02	0.01	0.11	0.01
7	12	8.37	8.23	8.16	8.10	8.00	0.01	0.10	0.01
8	12	8.37	8.22	8.16	8.09	7.99	0.01	0.10	0.01
9	12	8.37	8.21	8.15	8.08	7.99	0.01	0.10	0.01
10	12	8.37	8.21	8.14	8.08	7.99	0.01	0.10	0.01
11	12	8.37	8.20	8.14	8.07	7.99	0.01	0.10	0.01
12	12	8.37	8.20	8.13	8.07	7.99	0.01	0.11	0.01
13	12	8.36	8.19	8.12	8.05	7.99	0.01	0.11	0.01
14	12	8.26	8.15	8.09	8.03	7.96	0.01	0.10	0.01
15	4	8.20	8.20	8.15	8.10	8.13	0.00	0.03	0.00
16	1	8.12	8.12	8.12	8.12	8.12			
17	1	8.10	8.10	8.10	8.10	8.10			
All	173	8.37	8.17	8.15	8.14	7.96	0.01	0.10	0.01
Annual									
1	68	8.51	8.20	8.16	8.12	7.70	0.02	0.17	0.03
2	70	8.51	8.20	8.16	8.12	7.70	0.02	0.17	0.03
3	70	8.51	8.20	8.16	8.12	7.70	0.02	0.17	0.03
4	70	8.52	8.20	8.16	8.12	7.70	0.02	0.17	0.03
5	70	8.52	8.19	8.15	8.11	7.70	0.02	0.16	0.03
6	70	8.50	8.18	8.14	8.10	7.70	0.02	0.16	0.03
7	70	8.46	8.17	8.13	8.09	7.70	0.02	0.16	0.03
8	70	8.40	8.16	8.12	8.09	7.70	0.02	0.16	0.03
9	70	8.40	8.15	8.11	8.07	7.70	0.02	0.16	0.03
10	70	8.39	8.14	8.10	8.06	7.70	0.02	0.16	0.03
11	70	8.39	8.13	8.09	8.05	7.68	0.02	0.16	0.03
12	70	8.39	8.12	8.08	8.04	7.66	0.02	0.17	0.03
13	69	8.38	8.10	8.06	8.02	7.66	0.02	0.17	0.03
14	63	8.37	8.07	8.03	7.99	7.65	0.02	0.17	0.03
15	31	8.31	8.05	7.98	7.92	7.65	0.02	0.18	0.03
16	11	8.26	8.09	7.98	7.87	7.75	0.02	0.16	0.03
17	2	8.10	9.21	8.01	6.80	7.91	0.02	0.13	0.02
All	1,014	8.52	8.12	8.11	8.10	7.65	0.02	0.17	0.03

Table A-8. **Quarterly and annual statistics for light transmittance (%). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	20	81.88	73.60	66.49	59.37	24.56	0.23	15.20	231.02
2	20	81.82	73.42	67.39	61.37	37.58	0.19	12.88	165.88
3	20	81.59	73.94	68.40	62.86	39.91	0.17	11.84	140.08
4	20	81.61	74.59	69.75	64.91	45.20	0.15	10.34	106.93
5	20	81.11	74.65	70.35	66.04	45.98	0.13	9.19	84.49
6	20	80.84	74.80	70.79	66.78	50.49	0.12	8.56	73.31
7	20	80.84	75.58	70.91	66.23	41.88	0.14	9.99	99.89
8	20	81.03	75.83	70.74	65.66	38.91	0.15	10.86	117.97
9	20	81.07	75.51	70.50	65.50	41.41	0.15	10.69	114.20
10	20	81.41	75.69	70.38	65.07	42.96	0.16	11.35	128.87
11	20	81.95	75.58	69.90	64.23	44.18	0.17	12.13	147.03
12	20	82.01	74.74	69.23	63.72	45.44	0.17	11.78	138.75
13	19	82.30	74.45	68.27	62.09	39.49	0.19	12.82	164.29
14	17	82.45	75.45	68.03	60.62	36.23	0.21	14.42	208.06
15	8	82.45	78.44	63.59	48.75	34.52	0.28	17.75	315.19
16	1	38.90	38.90	38.90	38.90	38.90			
All	285	82.45	70.49	69.12	67.74	24.56	0.17	11.81	139.46
Spring									
1	20	84.77	77.74	73.99	70.25	57.65	0.11	8.00	64.05
2	21	84.78	77.85	74.41	70.98	58.30	0.10	7.56	57.09
3	21	84.68	77.81	74.43	71.05	58.60	0.10	7.43	55.17
4	21	84.33	77.89	74.57	71.26	58.03	0.10	7.28	53.06
5	21	84.19	77.85	74.69	71.53	57.80	0.09	6.94	48.21
6	21	84.14	77.79	74.68	71.56	56.43	0.09	6.84	46.84
7	21	83.83	77.90	75.01	72.13	59.31	0.08	6.34	40.24
8	21	83.27	77.88	75.39	72.90	64.75	0.07	5.47	29.91
9	21	83.26	77.79	75.44	73.10	64.24	0.07	5.15	26.48
10	21	83.51	77.64	75.10	72.56	64.20	0.07	5.58	31.11
11	21	83.60	77.48	75.01	72.54	64.97	0.07	5.42	29.42
12	21	84.45	77.12	74.71	72.30	64.64	0.07	5.30	28.06
13	21	84.11	76.55	74.24	71.94	63.62	0.07	5.07	25.67
14	19	83.37	75.92	73.12	70.32	61.84	0.08	5.81	33.71
15	10	79.17	76.01	69.23	62.46	49.09	0.14	9.47	89.59
16	4	77.79	86.00	60.99	35.97	44.06	0.26	15.72	247.16
All	305	84.78	75.05	74.29	73.52	44.06	0.09	6.76	45.69
Summer									
1	18	87.26	78.05	74.24	70.44	55.81	0.10	7.65	58.51
2	18	87.25	78.99	76.02	73.06	64.04	0.08	5.96	35.50
3	18	87.32	79.02	76.21	73.41	65.63	0.07	5.64	31.81
4	18	87.42	79.70	77.21	74.74	70.53	0.06	4.99	24.87
5	18	88.25	80.76	78.27	75.78	69.77	0.06	5.02	25.16
6	18	88.01	81.23	78.79	76.34	68.97	0.06	4.92	24.19
7	18	88.42	81.49	78.98	76.47	66.54	0.06	5.05	25.52
8	18	85.27	81.14	78.77	76.40	64.91	0.06	4.76	22.68
9	18	83.72	80.91	78.76	76.60	65.14	0.05	4.33	18.74
10	18	85.59	81.35	79.01	76.66	64.20	0.06	4.71	22.20
11	18	85.29	81.28	78.78	76.28	64.16	0.06	5.02	25.22
12	18	85.69	81.53	79.01	76.50	65.69	0.06	5.05	25.54
13	18	85.81	80.99	78.46	75.93	65.96	0.06	5.09	25.88
14	16	84.20	79.61	76.61	73.61	65.75	0.07	5.63	31.69
15	9	82.77	81.59	78.26	74.93	72.45	0.06	4.33	18.74
16	5	82.55	83.64	77.48	71.32	71.91	0.06	4.96	24.64
17	1	71.59	71.59	71.59	71.59	71.59	1.00		
All	265	88.42	78.44	77.79	77.15	55.81	0.07	5.33	28.41

Table A-8. **Quarterly and annual statistics for light transmittance (%). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	11	85.15	81.95	76.30	70.66	59.19	0.11	8.40	70.60
2	12	85.40	81.67	77.91	74.16	68.16	0.08	5.91	34.94
3	12	85.46	81.36	77.59	73.82	68.38	0.08	5.93	35.18
4	12	85.43	81.08	76.97	72.86	66.31	0.08	6.47	41.89
5	12	85.76	80.80	76.45	72.11	65.86	0.09	6.84	46.74
6	12	85.67	80.97	76.98	73.00	68.76	0.08	6.27	39.32
7	12	85.68	81.43	77.85	74.26	67.51	0.07	5.65	31.89
8	12	85.80	82.19	78.41	74.62	64.15	0.08	5.96	35.48
9	12	86.35	82.35	78.97	75.59	65.31	0.07	5.32	28.30
10	12	86.25	82.26	79.80	77.34	71.45	0.05	3.87	15.01
11	12	86.64	82.48	80.30	78.12	73.44	0.04	3.43	11.78
12	12	86.74	82.51	80.51	78.50	75.37	0.04	3.16	9.98
13	12	84.69	81.96	80.36	78.76	77.19	0.03	2.52	6.34
14	12	84.46	81.02	79.23	77.44	75.15	0.04	2.81	7.92
15	4	84.93	86.42	80.10	73.78	75.46	0.05	3.97	15.79
16	1	74.75	74.75	74.75	74.75	74.75			
17									
All	172	86.74	79.24	78.43	77.63	59.19	0.07	5.36	28.69
Annual									
1	69	87.26	74.90	72.25	69.60	24.56	0.15	11.04	121.83
2	71	87.25	75.70	73.44	71.17	37.58	0.13	9.56	91.33
3	71	87.32	75.83	73.72	71.61	39.91	0.12	8.91	79.43
4	71	87.42	76.21	74.29	72.36	45.20	0.11	8.13	66.15
5	71	88.25	76.49	74.67	72.85	45.98	0.10	7.71	59.38
6	71	88.01	76.77	75.01	73.26	50.49	0.10	7.40	54.79
7	71	88.42	77.17	75.34	73.51	41.88	0.10	7.74	59.95
8	71	85.80	77.32	75.45	73.58	38.91	0.10	7.89	62.31
9	71	86.35	77.31	75.49	73.66	41.41	0.10	7.71	59.48
10	71	86.25	77.47	75.56	73.64	42.96	0.11	8.09	65.48
11	71	86.64	77.43	75.42	73.41	44.18	0.11	8.49	72.02
12	71	86.74	77.25	75.24	73.22	45.44	0.11	8.50	72.26
13	70	85.81	76.87	74.76	72.64	39.49	0.12	8.85	78.40
14	64	84.46	76.13	73.79	71.44	36.23	0.13	9.39	88.13
15	31	84.93	76.28	71.80	67.33	34.52	0.17	12.20	148.86
16	11	82.55	78.09	67.73	57.37	38.90	0.23	15.42	237.76
17	1	71.59	71.59	71.59	71.59	71.59			
All	1,027	88.42	74.99	74.45	73.91	24.56	0.12	8.81	77.68

Table A-9. **Quarterly and annual statistics for color dissolved organic matter (CDOM; µg/L). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	9	4.18	3.22	2.46	1.72	1.37	0.39	0.96	0.93
2	9	4.51	3.18	2.43	1.67	1.4	0.40	0.98	0.96
3	9	4.68	3.07	2.29	1.50	1.42	0.45	1.02	1.05
4	9	4.34	2.89	2.17	1.44	1.37	0.43	0.94	0.88
5	9	3.53	2.53	1.99	1.44	1.14	0.36	0.71	0.50
6	9	2.52	2.10	1.74	1.39	0.96	0.27	0.46	0.22
7	9	2.12	1.81	1.54	1.28	0.87	0.22	0.35	0.12
8	9	2.13	1.78	1.47	1.16	0.80	0.28	0.40	0.16
9	9	2.00	1.74	1.41	1.08	0.78	0.30	0.43	0.18
10	9	1.97	1.74	1.38	1.03	0.73	0.33	0.46	0.21
11	9	1.97	1.73	1.37	1.00	0.66	0.35	0.47	0.23
12	9	2.02	1.75	1.38	1.00	0.65	0.35	0.49	0.24
13	9	2.01	1.77	1.41	1.05	0.75	0.33	0.47	0.22
14	8	2.05	1.86	1.47	1.07	0.83	0.32	0.47	0.22
15	2	1.20	1.79	1.15	0.51	1.10	0.06	0.07	0.00
16	1	1.31	1.31	1.31	1.31	1.31			
All	128	4.68	1.87	1.74	1.61	0.65	0.43	0.75	0.56
Spring									
1	4	1.64	1.88	1.37	0.86	0.91	0.23	0.32	0.10
2	4	1.65	1.89	1.40	0.90	0.95	0.22	0.31	0.10
3	4	1.66	1.91	1.42	0.93	0.99	0.22	0.31	0.09
4	4	1.68	1.92	1.45	0.97	1.04	0.20	0.30	0.09
5	4	1.77	1.95	1.49	1.03	1.10	0.19	0.29	0.08
6	4	1.82	1.99	1.57	1.14	1.19	0.17	0.27	0.07
7	4	1.81	1.97	1.60	1.23	1.28	0.15	0.23	0.05
8	4	1.80	1.97	1.62	1.27	1.34	0.14	0.22	0.05
9	4	1.96	2.10	1.68	1.25	1.39	0.16	0.26	0.07
10	4	2.19	2.35	1.77	1.18	1.45	0.21	0.37	0.13
11	4	2.30	2.50	1.83	1.17	1.46	0.23	0.42	0.17
12	4	2.33	2.55	1.85	1.16	1.44	0.23	0.44	0.19
13	4	2.34	2.61	1.86	1.10	1.41	0.26	0.48	0.23
14	4	2.35	2.69	1.87	1.04	1.41	0.28	0.52	0.27
15	1	2.34	2.34	2.34	2.34	2.34			
16									
All	57	2.35	1.73	1.64	1.54	0.91	0.22	0.36	0.13
Summer									
1	4	2.31	2.49	1.40	0.30	0.66	0.49	0.68	0.47
2	4	2.31	2.47	1.39	0.29	0.69	0.49	0.68	0.46
3	4	2.35	2.49	1.39	0.35	0.72	0.50	0.69	0.48
4	4	2.29	2.44	1.40	0.46	0.75	0.47	0.66	0.43
5	4	2.22	2.40	1.43	0.52	0.81	0.43	0.61	0.37
6	4	2.21	2.42	1.47	0.53	0.86	0.41	0.60	0.35
7	4	2.21	2.42	1.48	0.64	0.86	0.40	0.59	0.35
8	4	2.21	2.42	1.53	0.68	0.91	0.37	0.56	0.31
9	4	2.21	2.40	1.54	0.70	0.98	0.35	0.54	0.29
10	4	2.21	2.44	1.57	0.71	1.02	0.35	0.54	0.30
11	4	2.21	2.53	1.62	0.63	1.03	0.35	0.57	0.33
12	4	2.29	2.75	1.69	0.52	1.01	0.39	0.66	0.44
13	4	2.54	2.98	1.75	-0.43	0.96	0.44	0.77	0.60
14	3	2.77	4.51	2.04	2.49	0.91	0.49	0.99	0.98
15	1	2.49	2.49	2.49	2.49	2.49			
16									
17									
All	56	2.77	1.72	1.56		0.66	0.39	0.60	0.36

Table A-9. **Quarterly and annual statistics for color dissolved organic matter (CDOM; µg/L). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	4	2.88	2.99	1.67	0.35	0.98	0.50	0.83	0.69
2	4	2.87	3.01	1.70	0.40	0.96	0.48	0.82	0.67
3	4	2.87	3.02	1.70	0.37	0.91	0.49	0.83	0.69
4	4	2.80	2.94	1.65	0.35	0.89	0.49	0.81	0.66
5	4	2.59	2.72	1.57	0.42	0.89	0.46	0.72	0.52
6	4	2.18	2.31	1.44	0.57	0.90	0.38	0.55	0.30
7	4	1.89	2.00	1.34	0.67	0.93	0.31	0.42	0.17
8	4	1.84	1.91	1.29	0.68	0.99	0.30	0.39	0.15
9	4	1.88	1.93	1.27	0.61	1.02	0.32	0.41	0.17
10	4	1.93	1.97	1.25	0.53	0.99	0.36	0.45	0.20
11	4	2.01	2.06	1.25	0.44	0.95	0.41	0.51	0.26
12	4	2.01	2.06	1.24	0.42	0.94	0.41	0.51	0.26
13	4	1.91	1.95	1.22	0.49	0.96	0.38	0.46	0.21
14	4	1.90	1.94	1.23	0.52	0.99	0.36	0.45	0.20
15	2	1.04	1.39	1.01	0.63	0.98	0.04	0.04	0.00
16									
17									
All	58	2.88	1.55	1.40	1.26	0.89	0.40	0.56	0.31
Annual									
1	21	4.18	2.31	1.90	1.49	0.66	0.48	0.90	0.82
2	21	4.51	2.30	1.89	1.49	0.69	0.47	0.90	0.81
3	21	4.68	2.24	1.84	1.44	0.72	0.48	0.88	0.78
4	21	4.34	2.15	1.78	1.42	0.75	0.45	0.81	0.65
5	21	3.53	2.00	1.71	1.42	0.81	0.38	0.64	0.41
6	21	2.52	1.81	1.60	1.39	0.86	0.29	0.46	0.21
7	21	2.21	1.67	1.50	1.33	0.86	0.25	0.38	0.14
8	21	2.21	1.65	1.47	1.30	0.80	0.27	0.39	0.15
9	21	2.21	1.65	1.46	1.27	0.78	0.28	0.41	0.17
10	21	2.21	1.68	1.47	1.26	0.73	0.31	0.46	0.21
11	21	2.30	1.71	1.48	1.25	0.66	0.34	0.50	0.25
12	21	2.33	1.74	1.50	1.26	0.65	0.35	0.53	0.28
13	21	2.54	1.77	1.52	1.28	0.75	0.36	0.55	0.30
14	19	2.77	1.88	1.59	1.30	0.83	0.38	0.60	0.36
15	6	2.49	2.25	1.53	0.80	0.98	0.46	0.69	0.48
16	1	1.31	1.31	1.31	1.31	1.31			
17									
All	299	4.68	1.69	1.62	1.55	0.65	0.39	0.64	0.40

Table A-10. Quarterly and annual statistics for ammonia (mg/L). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1									
2									
3									
4									
5									
6									
7									
8									
9					No Samples				
10									
11									
12									
13									
14									
15									
16									
All									
Spring									
1	5	0.02	0.02	0.01	0.00	0.01	0.56	0.01	0.00
2									
3									
4									
5	5	0.09	0.08	0.03	-0.01	0.01	1.14	0.04	0.00
6									
7									
8									
9									
10	5	0.03	0.03	0.01	0.00	0.01	0.70	0.01	0.00
11									
12									
13									
14	2	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.00
15	1	0.01	0.01	0.01	0.01	0.01			
16	3	0.03	0.05	0.02	-0.02	0.01	0.87	0.01	0.00
All	21	0.09	0.03	0.02	0.01	0.01	1.07	0.02	0.00
Summer									
1	6	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
2									
3									
4									
5	6	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
6									
7									
8									
9									
10	6	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
11									
12									
13									
14	2	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
15	3	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
16	2	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
17	1	0.01	0.01	0.01	0.01	0.01			
All	26	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00

Table A-10. Quarterly and annual statistics for ammonia (mg/L). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	No Samples								
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
All									
Annual									
1	11	0.02	0.01	0.01	0.01	0.01	0.44	0.00	0.00
2									
3									
4									
5	11	0.09	0.04	0.02	0.00	0.01	1.42	0.03	0.00
6									
7									
8									
9									
10	11	0.03	0.02	0.01	0.01	0.01	0.69	0.01	0.00
11									
12									
13									
14	4	0.03	0.04	0.02	0.00	0.01	0.69	0.01	0.00
15	4	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
16	5	0.03	0.02	0.01	0.00	0.01	0.84	0.01	0.00
17	1	0.01	0.01	0.01	0.01	0.01			
All	47	0.09	0.02	0.01	0.01	0.01	1.15	0.02	0.00

Table A-11. Quarterly and annual statistics for chlorophyll-*a* (μg/L). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	20	17.81	8.40	6.28	4.16	1.55	0.72	4.53	20.55
2	20	17.79	8.78	6.74	4.69	1.70	0.65	4.37	19.12
3	20	19.47	9.77	7.45	5.12	1.85	0.67	4.96	24.63
4	20	25.32	11.13	8.32	5.51	1.51	0.72	6.01	36.09
5	20	19.95	10.36	8.09	5.82	1.32	0.60	4.85	23.53
6	20	19.91	10.22	7.95	5.68	1.24	0.61	4.85	23.50
7	20	18.81	10.28	7.84	5.41	1.19	0.66	5.20	27.08
8	20	20.52	10.15	7.71	5.26	1.41	0.68	5.23	27.33
9	20	19.08	9.74	7.47	5.20	1.77	0.65	4.85	23.49
10	20	17.94	9.40	7.35	5.29	2.12	0.60	4.39	19.29
11	20	18.28	9.22	7.19	5.15	1.99	0.61	4.35	18.92
12	20	18.71	9.07	7.00	4.93	1.97	0.63	4.42	19.58
13	19	17.31	8.92	6.89	4.86	2.57	0.61	4.22	17.78
14	17	16.57	8.93	6.73	4.53	1.90	0.64	4.28	18.34
15	8	16.29	12.00	8.24	4.47	3.77	0.55	4.50	20.27
16	1	16.11	16.11	16.11	16.11	16.11			
All	285	25.32	7.97	7.42	6.87	1.19	0.64	4.71	22.20
Spring									
1	21	47.12	10.27	5.87	1.46	1.46	1.65	9.68	93.70
2	21	44.81	10.37	6.18	1.98	1.55	1.49	9.22	84.95
3	21	41.83	10.64	6.68	2.73	1.67	1.30	8.69	75.59
4	21	35.68	10.44	7.03	3.62	1.83	1.07	7.50	56.20
5	21	30.02	10.85	7.70	4.55	1.98	0.90	6.92	47.91
6	21	26.98	10.92	8.04	5.16	2.24	0.79	6.33	40.13
7	21	28.70	11.87	8.78	5.68	2.48	0.77	6.80	46.21
8	21	34.15	13.25	9.68	6.11	2.64	0.81	7.84	61.43
9	21	40.50	14.93	10.75	6.57	2.84	0.85	9.18	84.22
10	21	42.59	16.47	11.82	7.17	2.87	0.86	10.22	104.36
11	21	38.99	16.51	12.21	7.90	2.95	0.78	9.46	89.51
12	21	34.69	16.13	12.22	8.32	3.41	0.70	8.58	73.62
13	21	33.47	15.75	11.97	8.19	3.88	0.69	8.31	69.02
14	19	29.20	13.97	10.57	7.18	3.49	0.67	7.05	49.71
15	10	35.22	16.99	10.42	3.84	3.26	0.88	9.19	84.44
16	4	16.38	16.89	8.45	0.00	5.33	0.63	5.31	28.20
All	306	47.12	10.22	9.27	8.32	1.46	0.91	8.46	71.50
Summer									
1	18	18.58	5.45	3.48	1.50	0.83	1.14	3.97	15.77
2	18	20.07	5.68	3.56	1.43	0.87	1.20	4.27	18.27
3	18	21.45	6.01	3.74	1.48	0.97	1.22	4.56	20.79
4	18	24.01	6.67	4.11	1.55	1.12	1.25	5.15	26.55
5	18	23.49	6.95	4.39	1.83	1.30	1.17	5.15	26.52
6	18	14.07	5.98	4.20	2.41	1.36	0.85	3.59	12.85
7	18	14.51	5.89	4.30	2.71	1.47	0.74	3.20	10.23
8	18	17.31	6.54	4.71	2.89	1.62	0.78	3.67	13.44
9	18	19.40	7.12	5.11	3.10	1.73	0.79	4.04	16.31
10	18	21.11	7.92	5.72	3.52	1.84	0.77	4.42	19.56
11	18	22.42	8.45	6.12	3.80	2.11	0.76	4.67	21.84
12	18	24.83	9.15	6.57	3.99	2.53	0.79	5.19	26.94
13	18	28.34	10.18	7.25	4.32	2.43	0.81	5.89	34.67
14	16	28.62	10.87	7.57	4.28	2.48	0.82	6.18	38.22
15	9	12.47	8.59	6.44	4.30	2.85	0.43	2.79	7.79
16	5	10.33	10.77	7.25	3.72	4.15	0.39	2.84	8.07
17	1	7.63	7.63	7.63	7.63	7.63			
All	265	28.62	5.70	5.14	4.58	0.83	0.90	4.62	21.30

Table A-11. **Quarterly and annual statistics for chlorophyll-*a* (µg/L). OCSD Station 2202, July 1998–May 2011.**

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1	11	21.16	10.68	6.21	1.73	1.41	1.07	6.66	44.38
2	12	20.12	10.97	6.79	2.61	1.58	0.97	6.58	43.27
3	12	31.73	14.40	8.59	2.79	1.61	1.06	9.13	83.41
4	12	34.51	16.45	9.97	3.48	1.77	1.02	10.21	104.19
5	12	26.05	14.71	9.41	4.11	1.99	0.89	8.34	69.59
6	12	17.97	12.82	8.60	4.38	2.25	0.77	6.64	44.06
7	12	18.96	11.54	7.93	4.33	2.60	0.72	5.68	32.23
8	12	17.36	10.19	7.20	4.22	2.85	0.65	4.70	22.09
9	12	16.10	9.22	6.69	4.16	2.96	0.60	3.98	15.87
10	12	17.21	8.95	6.40	3.84	2.86	0.63	4.02	16.13
11	12	17.18	8.53	6.07	3.60	2.65	0.64	3.88	15.07
12	12	17.47	8.34	5.87	3.40	2.50	0.66	3.88	15.06
13	12	15.92	7.71	5.49	3.27	2.39	0.64	3.50	12.22
14	12	13.51	6.92	5.08	3.23	2.27	0.57	2.90	8.40
15	4	6.15	6.84	4.72	2.60	3.24	0.28	1.33	1.78
16	1	6.26	6.26	6.26	6.26	6.26			
17	1	6.45	6.45	6.45	6.45	6.45			
All	173	34.51	8.00	7.10	6.21	1.41	0.84	5.97	35.61
Annual									
1	70	47.12	7.01	5.42	3.83	0.83	1.23	6.67	44.50
2	71	44.81	7.32	5.77	4.23	0.87	1.13	6.52	42.46
3	71	41.83	8.14	6.48	4.81	0.97	1.09	7.03	49.41
4	71	35.68	8.87	7.15	5.43	1.12	1.02	7.27	52.81
5	71	30.02	8.77	7.26	5.75	1.30	0.88	6.37	40.61
6	71	26.98	8.45	7.14	5.82	1.24	0.78	5.56	30.92
7	71	28.70	8.56	7.23	5.91	1.19	0.77	5.59	31.22
8	71	34.15	8.85	7.45	6.04	1.41	0.80	5.93	35.15
9	71	40.50	9.23	7.71	6.18	1.73	0.84	6.45	41.60
10	71	42.59	9.75	8.10	6.45	1.84	0.86	6.97	48.61
11	71	38.99	9.81	8.21	6.62	1.99	0.82	6.74	45.38
12	71	34.69	9.78	8.24	6.71	1.97	0.79	6.49	42.14
13	70	33.47	9.80	8.27	6.73	2.39	0.78	6.44	41.45
14	64	29.20	9.22	7.77	6.33	1.90	0.74	5.79	33.48
15	31	35.22	10.18	7.97	5.75	2.85	0.76	6.04	36.44
16	11	16.38	11.31	8.40	5.49	4.15	0.52	4.33	18.76
17	2	7.63	14.54	7.04	-0.46	6.45	0.12	0.83	0.70
All	1,029	47.12	7.72	7.33	6.94	0.83	0.88	6.41	41.14

Table A-12. Quarterly and annual statistics for total coliform bacteria (MPN). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	6	223.0	190.7	96.3	2.0	10.0	0.9	89.9	8,082.3
2									
3									
4									
5	1	20.0	20.0	20.0	20.0	20.0			
6									
7	1	20.0	20.0	20.0	20.0	20.0			
8	1	20.0	20.0	20.0	20.0	20.0			
9									
10	1	7.5	7.5	7.5	7.5	7.5			
11									
12									
13									
14									
15	2	203.0	1,274.1	111.5	-1,051.1	20.0	1.2	129.4	16,744.5
16									
All	12	223.0	125.2	72.4	19.5	7.5	1.1	83.2	6,918.1
Spring									
1	5	10.0	9.4		6.6		9.4	1.1	1.3
2									
3									
4									
5	5	10.0	9.4	8.0	6.6		9.4	1.1	1.3
6									
7									
8									
9									
10	5	10.0	9.4	8.0	6.6		9.4	1.1	1.3
11									
12									
13									
14	2	10.0	24.6	8.8	-7.1		24.6	1.8	3.1
15	1	10.0		10.0					
16	3	10.0	11.9	8.3	4.7		11.9	1.4	2.1
All	21	10.0	8.7	8.2	7.7		8.7	1.2	1.3
Summer									
1	6	20.0	15.2	10.0	4.8	7.5	0.5	5.0	25.0
2									
3									
4									
5	6	10.0	9.0	7.9	6.8	7.5	0.1	1.0	1.0
6									
7									
8									
9									
10	6	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
11									
12									
13									
14	2	10.0	24.6	8.8	-7.1	7.5	0.2	1.8	3.1
15	3	10.0	12.8	9.2	5.6	7.5	0.2	1.4	2.1
16	2	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
17	1	20.0	20.0	20.0	20.0	20.0			
All	26	20.0	10.3	8.9	7.6	7.5	0.4	3.4	11.6

Table A-12. Quarterly and annual statistics for total coliform bacteria (MPN). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1				No Samples					
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
All									
Annual									
1	17	223.0	73.9	39.9	5.8	7.5	1.7	66.2	4,381.4
2									
3									
4									
5	12	20.0	11.3	9.0	6.7	7.5	0.4	3.6	13.0
6									
7	1	20.0		20.0		20.0			
8	1	20.0		20.0		20.0			
9									
10	12	10.0	8.2	7.7	7.2	7.5	0.1	0.7	0.5
11									
12									
13									
14	4	10.0	11.0	8.8	6.5	7.5	0.2	1.4	2.1
15	6	203.0	125.6	43.4	-38.8	7.5	1.8	78.3	6,131.0
16	5	10.0	9.4	8.0	6.6	7.5	0.1	1.1	1.3
17	1	20.0		20.0		20.0			
All	59	223.0	33.2	21.6	10.0	7.5	2.1	44.6	1,987.6

Table A-13. Quarterly and annual statistics for fecal coliform bacteria (MPN). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	6	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
2									
3									
4									
5	1	7.5	7.5	7.5	7.5	7.5	1.0		
6									
7	1	11.0		11.0		11.0			
8	1	7.5	7.5	7.5	7.5	7.5	1.0		
9									
10	1	7.5		7.5		7.5			
11									
12									
13									
14									
15	2	45.0	244.0	28.0	-188.0	11.0	0.9	24.0	578.0
16			7.5		7.5				
All	12	45.0	18.0	11.2	4.4	7.5	1.0	10.7	115.1
Spring									
1	5	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
2									
3									
4									
5	5	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
6									
7									
8									
9									
10	5	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
11									
12									
13									
14	2	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
15	1	7.5		7.5		7.5			
16	3	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
All	21	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
Summer									
1	6	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
2									
3									
4									
5	6	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
6									
7									
8									
9									
10	6	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
11									
12									
13									
14	2	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
15	3	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
16	2	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
17	1	7.5		7.5		7.5			
All	26	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0

Table A-13. Quarterly and annual statistics for fecal coliform bacteria (MPN). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1					No Samples				
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
All									
Annual									
1	17	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
2									
3									
4									
5	12	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
6									
7	1	11.0		11.0		11.0			
8	1	7.5		7.5		7.5			
9									
10	12	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
11									
12									
13									
14	4	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
15	6	45.0	30.2	14.3	-1.5	7.5	1.1	15.1	227.7
16	5	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
17	1	7.5	7.5	7.5	7.5	7.5	1.0		
All	59	45.0	9.5	8.3	7.0	7.5	0.6	4.9	24.1

Table A-14. Quarterly and annual statistics for enterococcus bacteria (MPN). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Winter									
1	4	31.0	32.1	13.4	-5.3	7.5	0.9	11.8	138.1
2									
3									
4									
5	1	7.5		7.5		7.5	1.0		
6									
7									
8									
9									
10	1	10.0		10.0		10.0	1.0		
11									
12									
13									
14									
15									
16									
All	6	31.0	21.7	11.8	1.9	7.5	0.8	9.4	89.2
Spring									
1	1	7.5	7.5	7.5	7.5	7.5	1.0		
2									
3									
4									
5	2	10.0	24.6	8.8	-7.1	7.5	0.2	1.8	3.1
6									
7									
8									
9									
10	1	7.5		7.5		7.5			
11			7.5		7.5				
12			7.5		7.5				
13			7.5		7.5				
14			7.5		7.5				
15	1	7.5		7.5		7.5			
16	2	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
All	7	10.0	8.7	7.9	7.0	7.5	0.1	0.9	0.9
Summer									
1	4	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
2									
3									
4									
5	4	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
6									
7									
8									
9									
10	4	10.0	10.1	8.1	6.1	7.5	0.2	1.3	1.6
11									
12									
13									
14									
15	3	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
16	2	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
17	1	7.5		7.5		7.5			
All	18	10.0	7.9	7.6	7.3	7.5	0.1	0.6	0.3

Table A-14. Quarterly and annual statistics for enterococcus bacteria (MPN). OCSD Station 2202, July 1998–May 2011.

Depth	N	Max	95%UCL	Mean	95%LCL	Min	CV	SD	Var
Fall									
1					No Samples				
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
All									
Annual									
1	9	31.0	16.1	10.1	4.1	7.5	0.8	7.8	61.4
2									
3									
4									
5	7	10.0	8.7	7.9	7.0	7.5	0.1	0.9	0.9
6									
7									
8									
9									
10	6	10.0	9.7	8.3	7.0	7.5	0.2	1.3	1.7
11									
12									
13									
14									
15	4	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
16	4	7.5	7.5	7.5	7.5	7.5	0.0	0.0	0.0
17	1	7.5		7.5		7.5			
All	31	31.0	10.1	8.5	6.9	7.5	0.5	4.2	18.0

Receiving Water Quality in the Vicinity of the Orange County Sanitation District's 78-inch Ocean Outfall

Appendix B – Supporting Figures

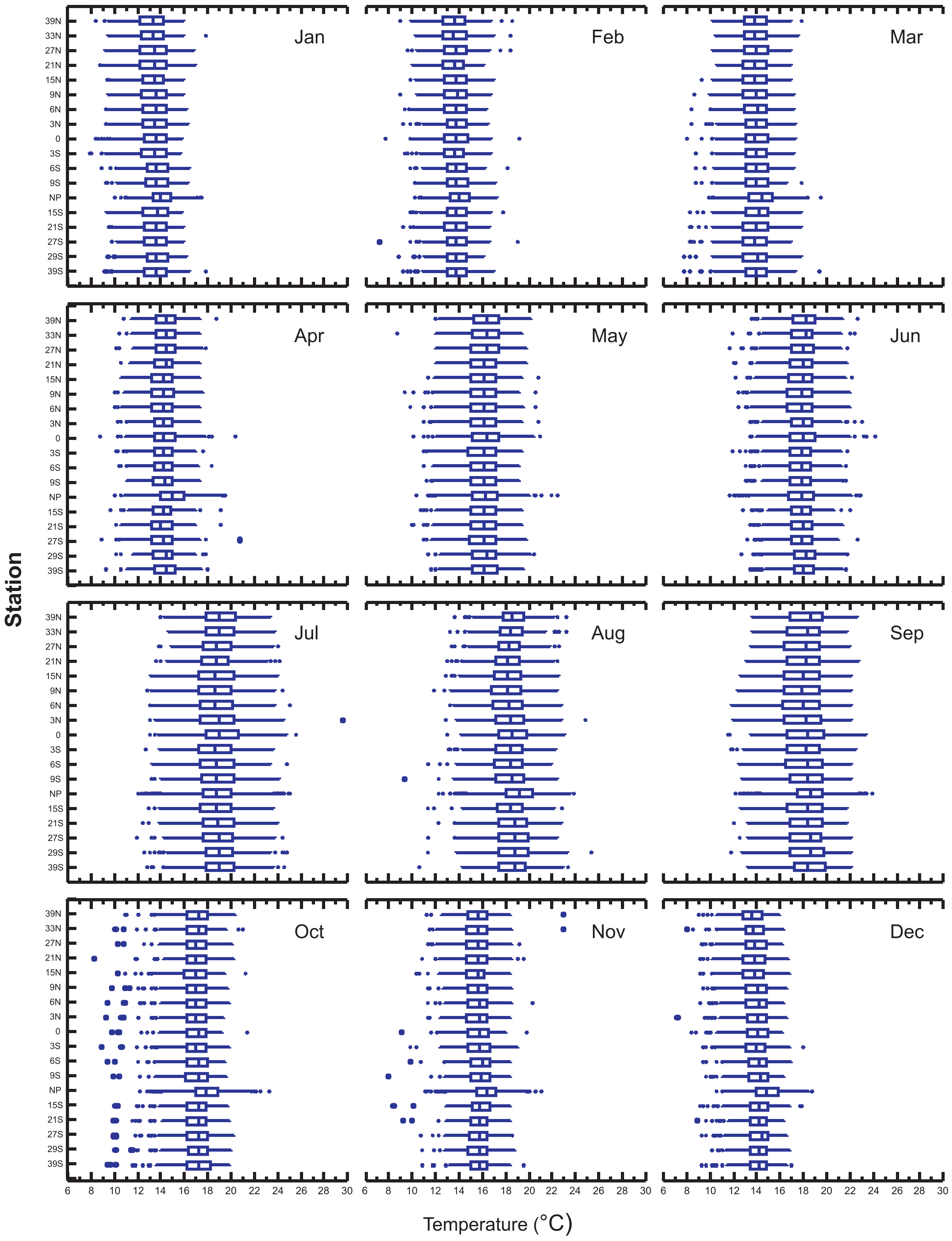

Figure B-1. Monthly temperature box plots for OCSD surf zone (April 2000 - August 2011) and SCCOOS Newport Pier (NP; January 1925 - December 2010) stations.

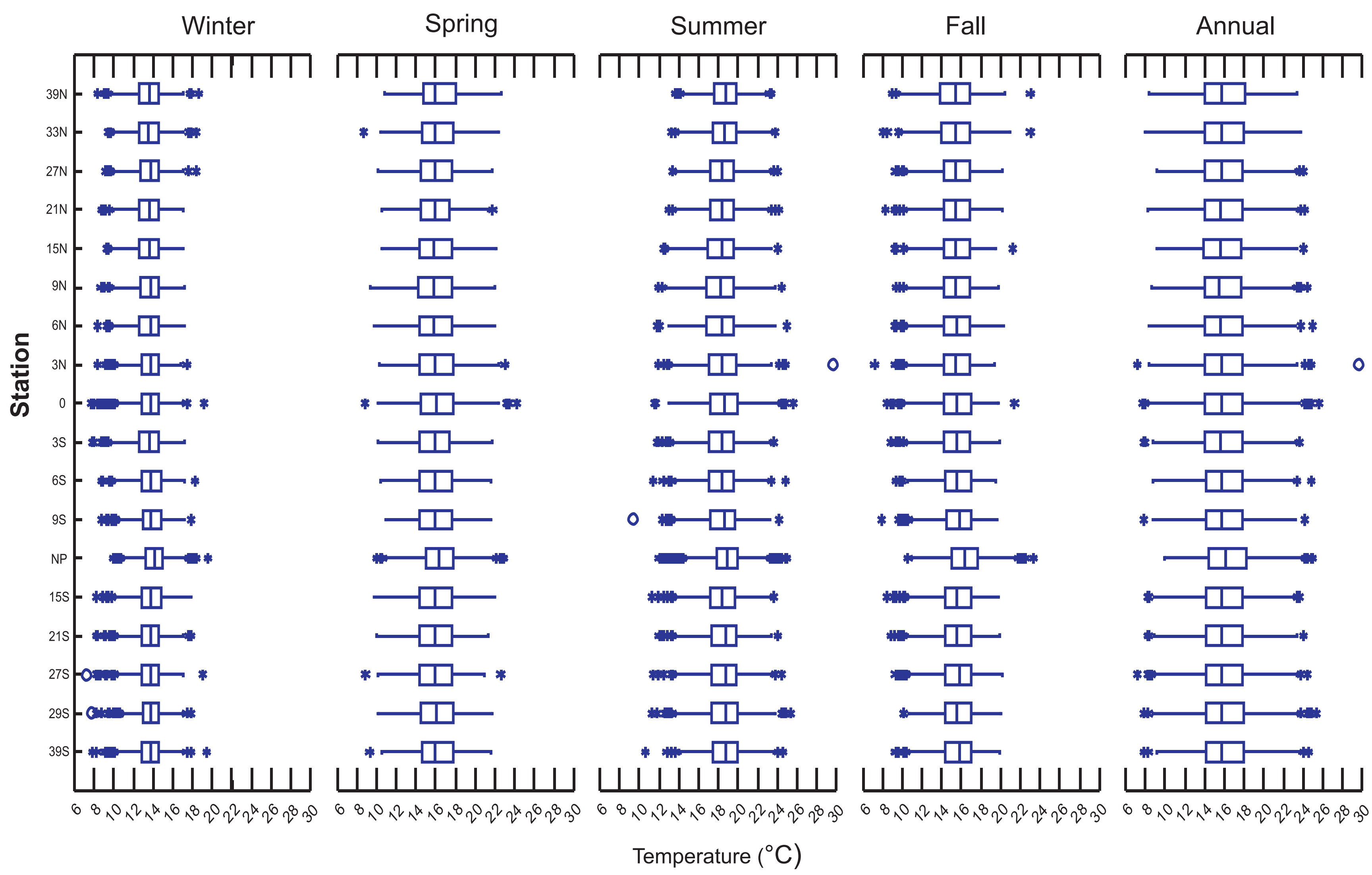

Figure B-2. Seasonal and annual temperature box plots for OCSD surf zone (April 2000 - August 2011) and SCCOOS Newport Pier (NP; January 1925 - December 2010) stations.

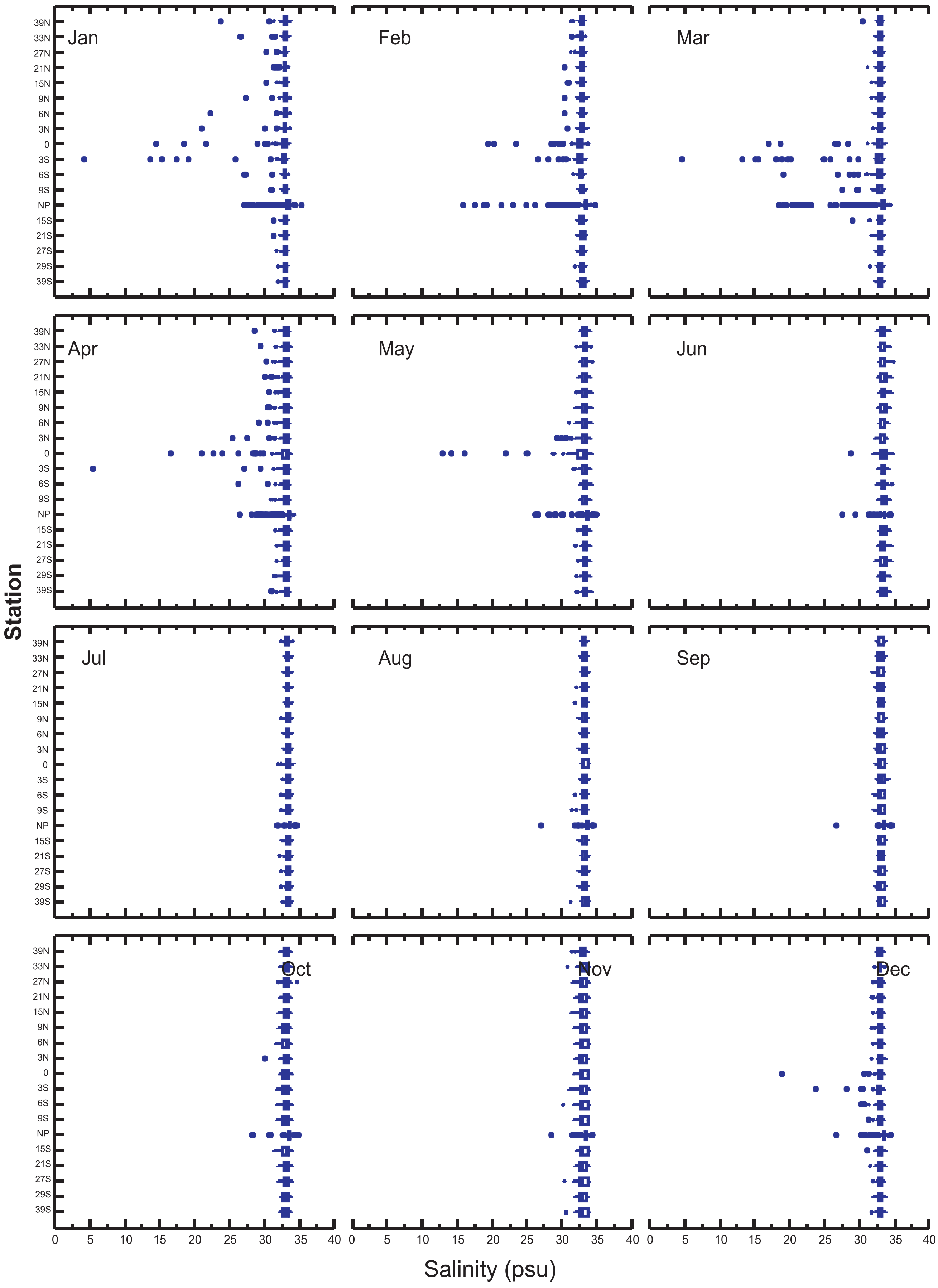

Figure B-3a. **Monthly salinity box plots for OCSD surf zone (April 2000 - August 2011) and SCCOOS Newport Pier (NP; January 1925 - December 2010) stations. Full range.**

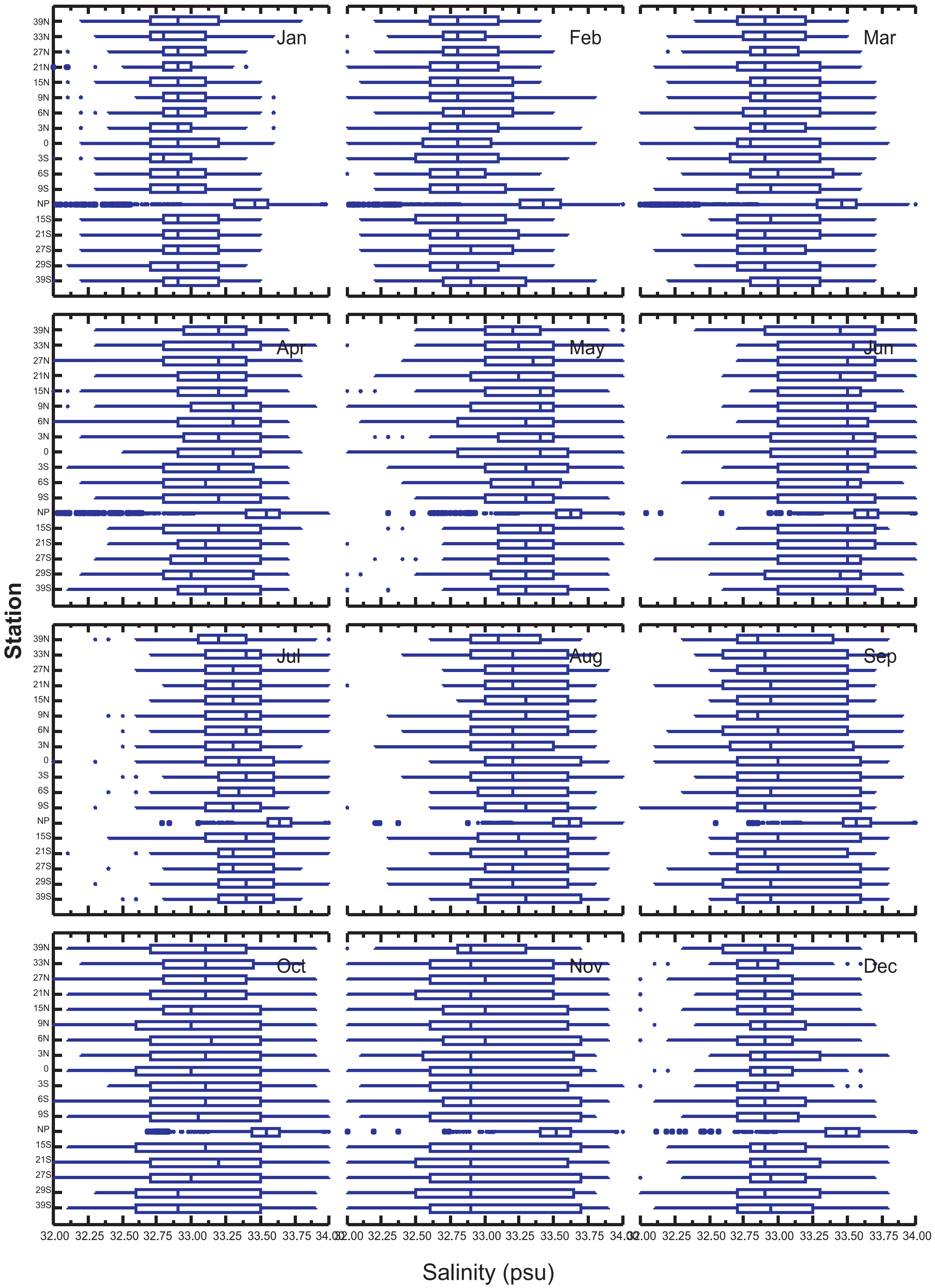

Figure B-3b. **Monthly salinity box plots for OCSD surf zone (April 2000 - August 2011) and SCCOOS Newport Pier (NP; January 1925 - December 2010) stations. Reduced scale to reveal median and 75 percentiles.**

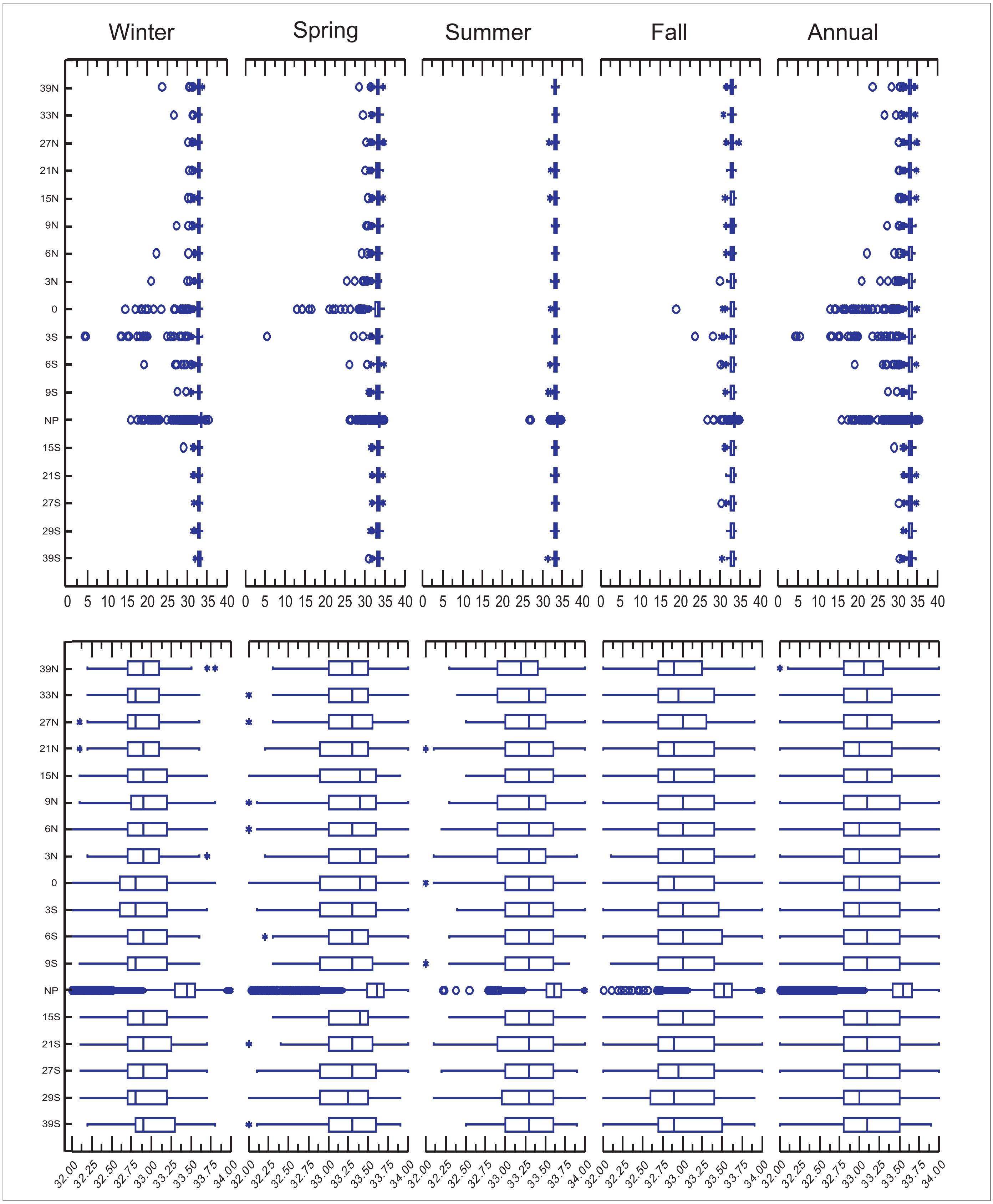

Figure B-4. Seasonal and annual salinity box plots for OCSD surf zone (April 2000 – August 2011) and SCCOOS Newport Pier (NP; January 1925 – December 2010) stations. Upper figure contains complete salinity range. Lower figure contains only values between 32 and 34 psu to reveal median and 75 percentiles

Orange County Sanitation District, California.

Anticipated Biological Response to Extended Discharge from a Nearshore, Shallow Outfall

Submitted to:

Orange County Sanitation District
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October 10, 2011

Introduction

This report outlines the potential biological consequences that may result from an extended (60-day) discharge from the Orange County Sanitation District's nearshore 78-inch ocean outfall. The content of this report derives from our experience with ocean outfalls, coastal oceanographic processes and phytoplankton ecology in the coastal ocean of southern California and elsewhere.

The report is presented in two sections. The first section addresses likely characteristics of the effluent plume including anticipated plume size and dynamics, and the extent and concentrations of nutrients important for phytoplankton growth. The second section addresses potential phytoplankton response to the discharge, the accumulation of biomass, possible shifts in species composition due to the nutrient loading, and the potential environmental and/or public health effects.

Background

The analysis that follows is based on fundamental assumptions provided by the Orange County Sanitation District and direct observations from the Hyperion Treatment Plant nearshore discharge in November, 2006. Assumptions used in this analysis include the following:

1. The daily average discharge rate from the OCSD sewage treatment plants is 145 million gallons per day (6.4 m^3/s).
2. We base our understanding of the plume characteristics from shallow discharge of POTW effluent on observations that were obtained during the City of Los Angeles Hyperion Treatment Plant (HTP) nearshore diversion in November 2006, described in a recent Ph.D. dissertation by Kristen Reifel at USC [*Reifel*, 2009].
    a. Measurements of the surfacing plume thickness range between 3 meters and 5.5 meters (Table 1.1). So for the analysis that follows, a thickness of 4.25 meters has been used.
    b. Average plume dilutions range between 25:1 and 42:1 (Table 1.1). Minimum observed dilutions are as low as 12:1, and these were observed at the surface. The vertical distribution of salinity and colored dissolved organic matter (CDOM) indicated a very steep slope from the base of the plume layer to the surface.
    c. Because of the freshwater induced stratification, the water column will continue to remain stratified unless there is significant wind forcing that will mix the surface layer with the water beneath.
3. The ammonium nitrogen concentrations in the treated effluent are based on historical data where the average concentration in the effluent was approximately 1.4 mmol/L (approximately 24 mg/L ammonia). With a median initial dilution of

33:1, the expected ambient ammonium nitrogen concentration the effluent plume would be about 42 μmol/L. The N:P ratios for domestic effluent are often on the order of 10:1 (http://www.fao.org/docrep/T0551E/t0551e03.htm#1.2%20characteristics%20of%20wastewaters), giving an effluent phosphate concentration 4.2 μmol/L.

Table 1.1 Summary of results from the City of Los Angeles Hyperion Treatment Plant nearshore discharge.

Example	Volume ratio (effluent to ambient water for minimum dilution)	Volume ratio (effluent to ambient water for average dilution)	Dilution (minimum)	Dilution (average)	Plume Thickness (m)
1	0.087	0.042	12.5:1	25.1:1	3.0
2	0.05	0.025	20.8:1	41.6:1	5.5
Midrange Values			16.65:1	33.35:1	4.25

Estimated plume area and volume

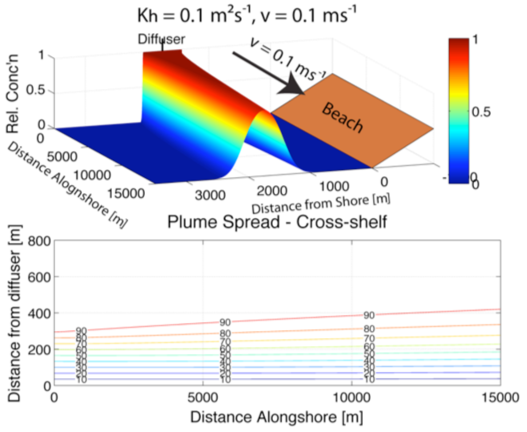
Based on an initial plume depth (dz) of 4.25 meters and a discharge rate (Q) of 5.52x10^5 m^3 per day, the plume area (Q/dz) should expand at a rate of ~1.3x10^5 m^2·day^{-1}, or approximately 0.13 km^2 per day. Under most conditions the nearshore currents are oriented alongshore [*Hamilton et al.*, 2006] with maximal speeds of ~20 cm·s^{-1}. The mean nearshore speeds are typically 5-10 cm·s^{-1} downcoast, corresponding to a mean alongshore transport of 4.3-8.6 km/day. Like submerged plumes, the net alongshore current is likely to affect the plume initial dilution and the horizontal mixing scales during the discharge event.

The initial plume width, given a discharge rate of 6.4 m^3·s^{-1}, at the maximum initial dilution in the Hyperion observations (41.6:1), plume depth of 4.25 m, and alongshore velocity of 0.5-0.1 m·s^{-1}, is expected to be 625 at 0.1 m·s^{-1} to 1250 meters wide at 0.5 m·s^{-1}.

Initial Nutrient Concentrations

Based on a median initial dilution of 33:1, we estimate an average initial ammonium concentration of 42 μM. The expected phosphate concentration is 4.2 μM after initial dilution, assuming an effluent ammonium concentration of 1.4 mM and an N:P ratio in the effluent of 10:1.

With homogeneous alongshore currents one can estimate the width of the plume "downstream" based on characteristic horizontal diffusion rates (K_h). We make these estimates based on characteristic scales [*Okubo*, 1971]. Given the width of the plume, the characteristic horizontal diffusion rates can range from 100 to 500 cm^2/s, or 0.1 to 0.5 m^2/s. Examples of the alongshelf scale of horizontal spreading of the plume in a simple homogenous flow field are shown in Figure 1.1. At the point of discharge with a homogeneous field, 90% of the plume mass is contained within a width of 590 m at the origin of the discharge. Downcurrent from the discharge, the plume width expands to 840 m at 15000 meters (15 km) with a horizontal mixing rage of 0.1 m^2/s, or to 1420 meters at 15000 meters with a horizontal mixing rate of 0.5 m^2/s. Correspondingly, the centerline concentrations (relative) at 15000 meters are 0.94 (39.5 μM NH_4) for K_h=0.1 m^2/s, and 0.60 (25.2 μM NH_4) at K_h=0.5 m^2/s. These centerline concentrations assume no biological uptake. The transit time from the point of discharge to 15000 meters at 0.1 m/s is 1.74 days (42 hours).



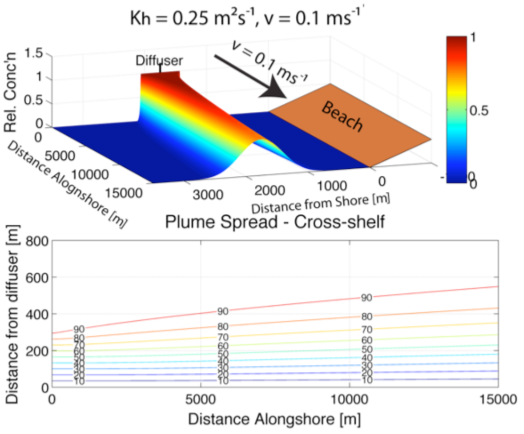


Figure 1.1 Examples of plume spreading during alongshore advection at 0.1 m/s. The horizontal eddy diffusion rates (K_h) range from 0.1 m^2/s to 0.5 m^2/s based on estimates of the plume scale and characteristic rates of K_h based on Okubo's diffusion diagram [*Lemmin*, 1989; *Okubo*, 1971]. The concentration is relative concentration. The contours indicate the percentage of total mass in the plume relative to the plume axis on the shoreward side of the diffuser. Thus plume width is twice the distance from the diffuser.

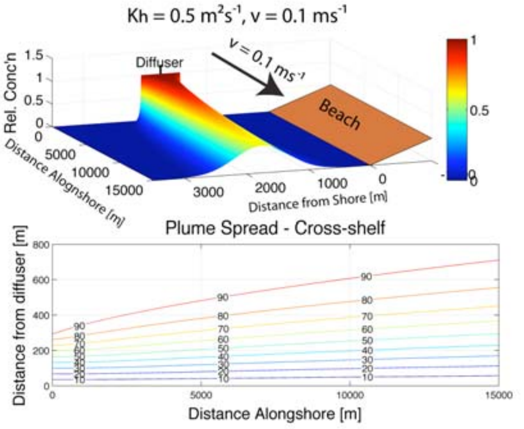


Table 1.2 Plume widths downstream of diffuser based on the contour of 90% of the total mass of the plume. The centerline (maximum) relative concentration of the plume is indicated in the right hand column for each horizontal eddy diffusion rate.

	$K_h = 0.1$ m^2·s^{-1}		$K_h = 0.25$ m^2·s^{-1}		$K_h = 0.5$ m^2·s^{-1}	
Distance [m]	Width [m]	Conc'n	Width [m]	Conc'n	Width [m]	Conc'n
0	590	1.00	590	1.00	590	1.00
5000	686	1.00	806	.96	960	.85
10000	766	.98	960	.85	1210	.70
15000	840	.94	1096	.76	1420	.60

With a slower speed of 0.5 m·s^{-1}, the initial plume width will be 1003 meters, using an initial dilution of 33.4 and a plume thickness of 4.25 meters. Because of the initial dilution assumption, the concentration of ammonium and phosphate in the plume remain the same, but the alongshore spreading as a function of distance expands for the same cross-shelf diffusion rates.

The analysis above assumes a simple, steady, homogenous alongshore current. However, coastal currents close to shore are strongly modulated by tidal motions. Tidal currents can modulate at ± 0.15 m·s^{-1} alongshore (Moffett and Nichol data from May, 2000). Using a mean downcoast velocity of -0.10 m·s^{-1}, the velocity thus ranges from +0.05 m·s^{-1} (upcoast) to -0.25 m·s^{-1} (downcoast). The effect of this oscillation is that during periods of the upcoast (toward the left) oscillation, "old" plume, i.e. plume previously discharged, is transported over the outfall again, injecting "old" plume water with fresh plume water. In addition, during periods when the alongshore currents have slowed and are changing direction the plume will widen due to a slower alongshore advection rate, changing the characteristics of the plume. The effect of these oscillations should act to create patchiness in the nutrient concentrations, plume width, plume thickness and plume dilution. A simple one-dimensional advection-diffusion model demonstrates the effect of the tidal modulation of the flow field (Figure 1.2a,b). For a simple pulse input, the plume moves downcurrent from the discharge with the tidally modulated flow (Figure 1.2a). After 42 hours the plume has moved more than 15 km from the source, beyond the extent of the model domain. For a continuous discharge (Figure 1.2b), there are intensified regions of plume concentration, because the outfall is continuously discharging into the surface, which experiences tidal modulation, slowing and reversal of flow. In this example the intensive concentrations are more than 10-fold the concentrations between the peaks.

The nutrient (plume concentration) patchiness should result in phytoplankton biomass patchiness (Figure 1.2b). Stratification will also be affected along with the concentration distribution. Additionally, there is potential for extremely high phytoplankton as the plume moves downstream with high nutrient concentrations (nitrogen and phosphorus) that are converted into phytoplankton biomass.

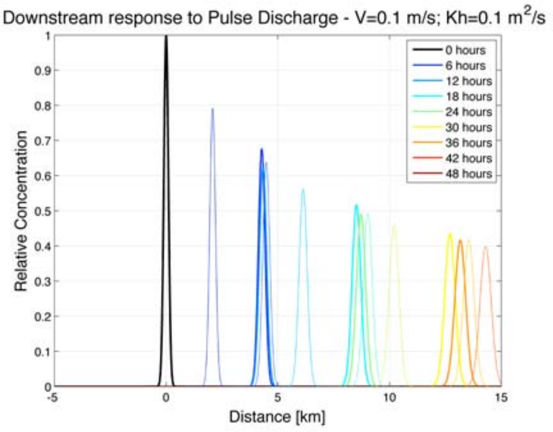


Figure 1.2a Downcurrent distribution from a single pulse discharge from a source at 0 km. The color indicates the time since discharge in hours (lines are plotted at 3-hour intervals). The example assumes a mean current of 0.1 $m\cdot s^{-1}$ and a tidal modulation of ± 0.15 $m\cdot s^{-1}$ for an M2 tidal component (12.42 hour period). A horizontal eddy diffusion coefficient of 0.1 $m^2\cdot s^{-1}$ was used.

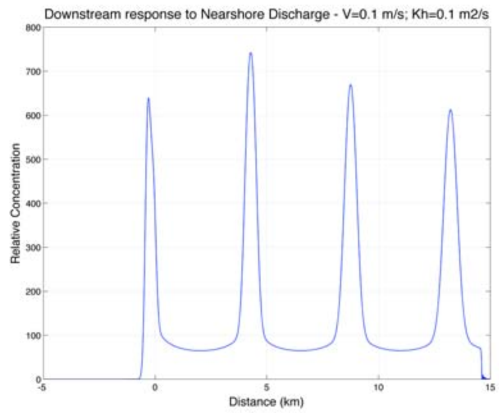


Figure 1.2b. Downcurrent distribution from a continuous source at 0 km. The distribution shown is the result of 48 hours of continuous discharge. Currents and diffusion coefficient are the same as in Figure 1.2a. The relative concentrations are distinct between the two plots.

Biological Response

The conditions described above – a shallow plume with a thickness of 4-5 meters, ammonium concentrations of 42 µmol/L and phosphate concentrates of 4.2 µmol/L – should elicit a response from the phytoplankton community. The integrated ammonium-N for the thickness of the plume, (summed ammonium in the water column between the surface and 4.25 m, is 178.5 $mmol/m^2$ based on the estimations provided above. The importance of this concentration is that nitrogen sets the upper bound for the maximum phytoplankton concentration that might be observed, without mixing, grazing, sinking, nitrogen fixation (which would add fixed nitrogen to the system), or other processes. As a rule of thumb, 1 $mmol/m^3$ (= 1 µmol/L) of N can yield approximately 1 mg/m^3 of phytoplankton chlorophyll. This value assumes Redfield Ratio proportions among major elements (C:N:P = 106:16:1), and a carbon:chlorophyll ratio that is consistent with coastal phytoplankton (40-80). Therefore, the maximum integrated chlorophyll within the upper 4.25 meters of the water column could reach ~180 mg/m^2 chlorophyll from the plume alone. If this amount of chlorophyll is equally distributed throughout the top 4.25 meters of the water column, the average concentration would be approximately 42 mg/m^3. That chlorophyll concentration is more than 4-fold higher than median high values observed routinely in the region (Figure 1.3), and at least as great as the highest value observed for more than three years of weekly observations off Newport Beach pier (Figure 1.3).

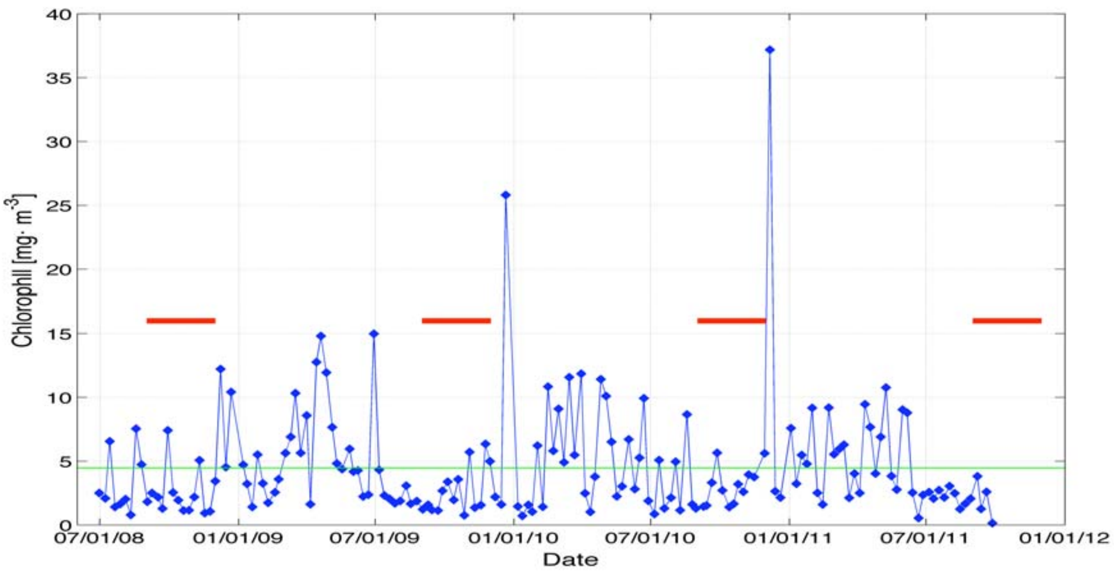


Figure 1.3. Chlorophyll concentrations observed weekly in surface samples collected off the Newport Beach pier. Horizontal red bars indicate the Fall time (September 1 – December 1) frame in each year identified for the 2012 diversion event. The green line indicates the average chlorophyll concentration.

An accumulation of 180 mg/m^2 chlorophyll would constitute microalgal biomass that could be sufficient to essentially attenuate all of the light within the upper few meters of the water column. Given that nutrient loading will not be uniform because of tidal modulation and variations in dilution as described above, and that variations in chlorophyll content of the phytoplankton resulting from differences in species composition, behavior and physiology may occur, chlorophyll values significantly higher than 42 mg/m^3 may occur in patches of water.

The time scale for the phytoplankton growth within the plume will depend on the size and taxonomic composition of the ambient phytoplankton population present at discharge. Assuming that the upper layer chlorophyll concentration is 4.0 mg chlorophyll/m^3 (4.0 mg/m^3 is the average of chlorophyll concentration observed in surface samples collected off Newport Beach pier during the Fall 2008-2011; Figure 1.3), with approximately equal proportions of diatoms growing at 1 doubling/day and dinoflagellates growing at 1 doubling/2 days, then the nutrients within the plume layer would be consumed within 4 days, and a euphotic depth of less than 10 meters would occur within 2.25 days (Figure 1.4). This example does not account for dinoflagellate vertical migration and the ability of the dinoflagellates to aggregate near the surface where they can maximize light absorption and reduce light transmission to nonmotile phytoplankton below them in the water column. If this occurs, the balance between diatoms and dinoflagellates would likely be shifted substantially in favor of dinoflagellates. The shallow stratification, high nitrogen and phosphorus concentrations, low silicon concentration, and low N:P ratio in the shallow surface plume are expected to ultimately select for domination of the phytoplankton assemblage by non-diatom species.

Phytoplankton response: Two aspects of the phytoplankton community response to the nutrient discharge are important; the overall increase in biomass of the phytoplankton (standing stock), and the species composition of the phytoplankton assemblage. The details of both aspects will affect the fate and potential consequences of the phytoplankton biomass produced.

Estimated increase of phytoplankton biomass: As noted above, chlorophyll concentrations could reach 180 mg/m^2 in the plume. Assuming this biomass is distributed evenly across 4-5 m depth, values of 40-50 mg chlorophyll/m^3 could result. Based on weekly sampling off Newport Beach pier, values exceeding 15 mg chlorophyll/m^3 are rare in this region (Figure 1.3). Only two such events have been recorded in three years of observations; a red tide of the dinoflagellate *Lingulodinium polyedrum*, and a bloom of the diatom genus *Pseudo-nitzschia*. Both blooms were recorded late in the year (December, 2009 and December 2010; http://www.sccoos.org/data/habs/index.php). Therefore, median values for the plume could attain 4X the phytoplankton biomass maximally observed during bloom situations in these coastal waters, assuming that the nutrients in the discharge are fully consumed.

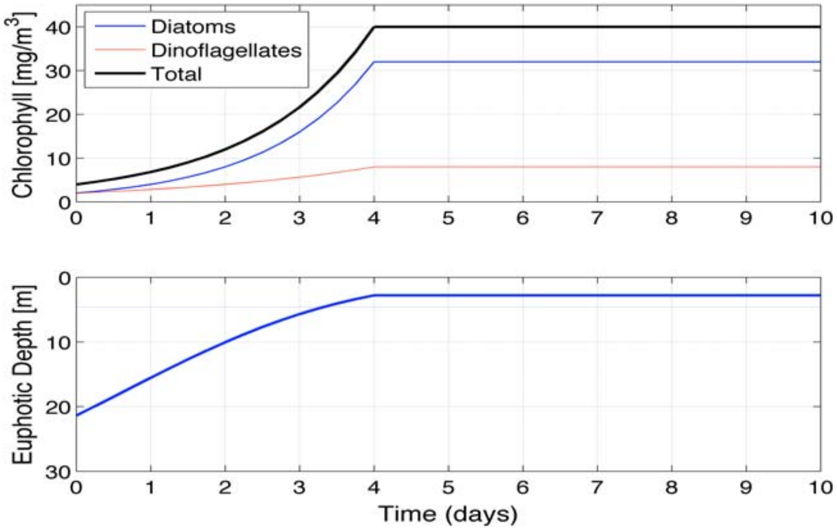


Figure 1.4. Simple phytoplankton growth model (top panel) and light attenuation based on chlorophyll concentration (bottom panel). The light attenuation is expressed as the depth of the euphotic zone, defined here as the 1% light level for photosynthetically available radiation (PAR). Calculation of attenuation was based on the results from Morel [1988].

One potential consequence from highly increased phytoplankton biomass is a ‘boom and bust’ situation in which rapid and prolific growth of the phytoplankton assemblage is followed by death and decomposition, leading to rapid removal of dissolved oxygen in the water column or at the sediment surface following the sinking of the bloom. This situation is unlikely to be of major concern in open coastal waters, but may result in increased oxygen demand in some areas if tidal mixing moves a significant component of the nutrient-rich plume, or a resulting phytoplankton bloom, into protected waters with restricted water exchange, such as Newport Bay. The next flux of nutrients or phytoplankton biomass into the Bay is dependent on the specific path of the plume along the coast, i.e. proximity to the Bay opening, the magnitude and timing of the corresponding tidal cycle, and the degree of retention of plume water within the Bay. It is not anticipated that this situation would result in a major impact on the oxygenation of Newport Bay waters, but sampling to monitor plume/algal movement into the Bay is recommended.

Species composition: Anticipated species composition of the phytoplankton assemblage responding to the nutrient inputs will be a consequence of taxonomic composition of the community at the time of discharge, competition for uptake and rapid growth at high nutrient concentrations, and the susceptibility of the responding species to planktonic consumers as the phytoplankton increase in abundance and biomass. Specifically, the response of harmful algal species to the nutrients in the discharge plume should be monitored and studied. A clear relationship has been established between anthropogenically-derived nutrients and the increased frequency and severity of harmful algal blooms nationally and globally [*Anderson et al. 2008; Kudela et al. 2008*]. The phytoplankton community composition in this region is typically dominated by diatoms and dinoflagellates (http://www.sccoos.org/data/habs/index.php). The diatom assemblage includes harmful species that can disrupt food web structure and function in the coastal ocean. Species within the genus, *Pseudo-nitzschia*, produce the powerful neurotoxin domoic acid [*Schnetzer et al.*, 2007]. Adverse impacts of domoic acid on marine animal populations are well documented [*Kudela et al.*, 2005], and this toxin causes amnesic shellfish poisoning (ASP) in humans.

Two major taxonomic groups of *Pseudo-nitzschia* species (seriata group and delicatissima group) have been monitored in weekly samples collected off the Newport Beach pier since mid-2008 (Figure 1.5). For reference, abundances of these species in excess of approximately 10,000/Liter can result in measurable domoic acid in the plankton (values >0.2 µg/L), and abundances in excess of approximately 100,000/Liter constitute bloom conditions. Individuals within the seriata group generally are more toxic than the delicatissima group, but toxin production in *Pseudo-nitzschia* is not constituitive. It is induced by environmental conditions are that not yet completely understood.

The growth of *Pseudo-nitzschia* species and the production of domoic acid in response to the diversion event should be monitored during the diversion event. *Pseudo-nitzschia* species are typically present in the coastal plankton of the region (Figure 1.5), and massive coastal blooms of *Pseudo-nitzschia* and the appearance of high concentrations of domoic acid very close to the coastline have been documented in the vicinity of the Los Angeles – Long Beach harbor region during recent years. The frequency and severity of these events has increased during the past decade (Schnetzer et al., 2007; Caron, unpublished). The specific cause for the appearance of these toxic blooms within the past decade is not clear, but enriched nutrient concentrations due to the diversion event could enhance the growth of endemic *Pseudo-nitzschia* populations. Toxic events in the region have thus far been relegated primarily to Spring, but significant population abundances of these species are not uncommon in Fall.

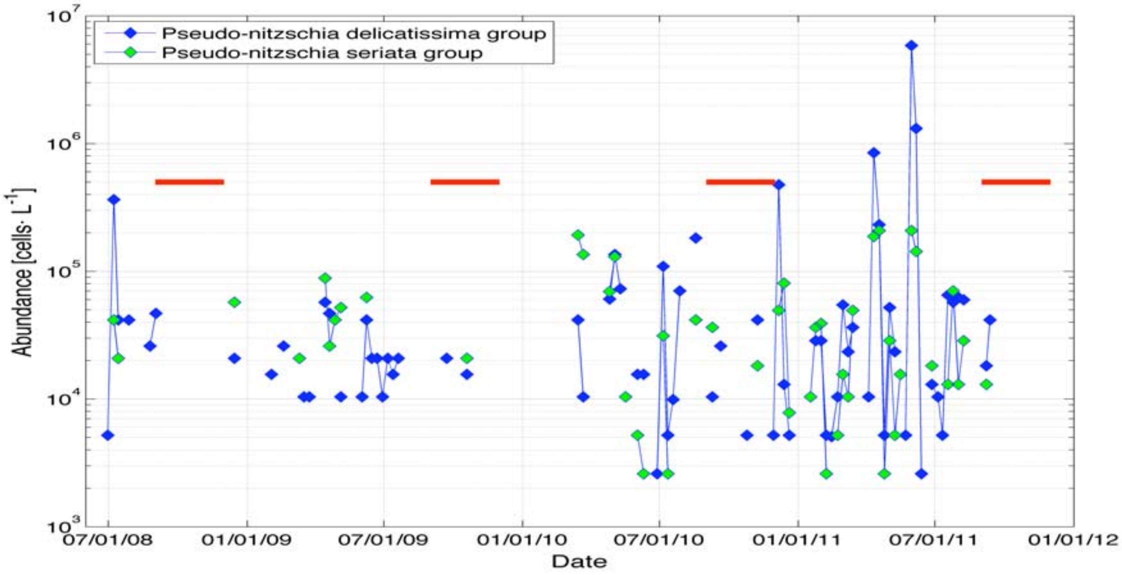


Figure 1.5. Abundances of two groups of *Pseudo-nitzschia* species (delicatissima and seriata) observed weekly in surface samples collected off the Newport Beach pier. Horizontal red bars indicate the Fall time frame (September 1 – December 1) in each year identified for the 2012 diversion event. Note the log scale for cell abundance.

Diatoms can grow rapidly (>1-2 doublings/day) under favorable growth conditions during spring and fall in the region, and are particularly responsive to high nitrogen and phosphorus concentrations. On the other hand, high cellular requirements for silicon (to produce siliceous structure that typify diatoms) could substantially reduce the response of these species to plume discharge because of the relatively low concentrations of silicon expected in the discharge water.

If diatom species do not dominate the phytoplankton community during or following the diversion, dinoflagellates might be expected to be highly successful species. The dinoflagellates include species that are relatively large (up to 50 µm or more) and actively motile (swimming speed in excess of 1m/hr). Their swimming behaviors are responsive to light and nutrient conditions, and many species vertically migrate several meters per day in order to attain optimal growth conditions. Given these abilities, it is probable that dinoflagellate taxa will be responsive to nutrient enrichment within the plume, and may exploit their motility to migrate within the upper water column to maximize light and nutrient acquisition. For this reason, the average chlorophyll concentration of 40-50 mg/m^3 noted above for the upper 4-5 meters of the water column may significantly underestimate chlorophyll concentrations attained in patches of migrating or aggregating dinoflagellates.

One feature that might limit dinoflagellate response to the diversion event is that the growth rates for these species rarely exceed one doubling/day, and might be expected to double not more than once every two days in mid-late fall, given the shorter daylight period and lower temperatures at this time of year. If abundances of dinoflagellate species at the time of the diversion are low, these populations may respond relatively slowly, thus allowing sufficient dilution of nutrients in the plume prior to a major bloom event. Additionally, slower intrinsic growth rates of these species could enable herbivorous zooplankton capable of consuming dinoflagellates to keep pace with dinoflagellate population growth. However, the migratory behavior of these taxa and the tendency of dinoflagellate to thrive at the seasonally high temperatures that characterize surface waters in early Fall, make it very difficult to predict their response.

Dinoflagellate taxa within the Southern California Bight include powerful toxin-producing species such as *Alexandrium catanella*. This species produces a class of compounds called saxitoxins, which are responsible for paralytic shellfish poisoning (PSP) in humans. *Alexandrium* cells are observed consistently, albeit typically at very low abundance, in the region [*Garneau et al.*, In press]. Alexandrium has attained ecologically significant abundances in samples collected off the Newport Beach pier only occasionally (Figure 1.6). None of these samples were collected during the period of the year identified for the diversion event, but this species (along with *Pseudo-nitzschia* species) is a major human health concern and its abundance should be monitored throughout the diversion event.

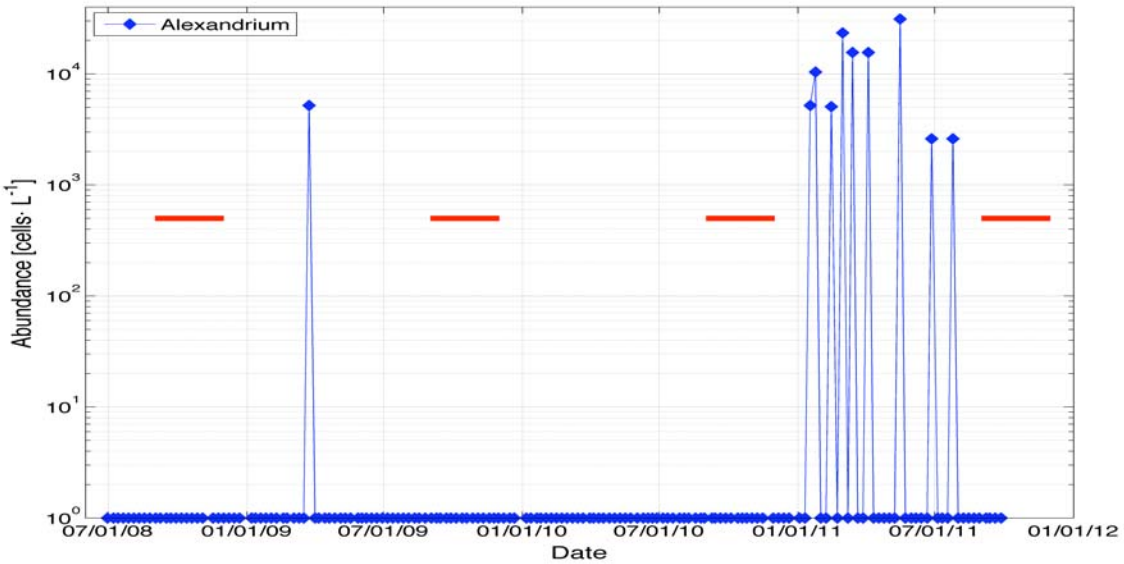


Figure 1.6. Abundances of the PSP-producing dinoflagellate *Alexandrium* spp. observed weekly in surface samples collected off the Newport Beach pier. Horizontal red bars indicate the Fall time frame in each year identified for the 2012 diversion event. Note the log scale for cell abundance.

Other toxic species of the dinoflagellates that are endemic within the region include *Dinophysis*, which causes diarrhetic shellfish poisoning (DSP) in humans. More recently, blooms of *Cochlodinium fulvescens* (the cause of fish kills in some parts of the world) have appeared within the coastal waters of central and southern California [*Howard et al.*, In press; *Jessup et al.*, 2009; *Kudela et al.*, 2008]. The latter species was noted to appear in sporadic, but high abundance, patches following the Hyperion Wastewater Treatment Plant diversion event in 2006 [*Reifel*, 2009]. The dinoflagellate *Akashiwo sanguinea* also warrants study, as this species has been shown to produce a surfactant that can cause mortality in sea birds due to feather wetting and consequent loss of thermal insulation [*Jessup et al.*, 2009]. The growth of toxin-producing dinoflagellates should be monitored with respect to their potential response to nutrients discharged in the plume.

Other species of dinoflagellates that are common in the region and may respond to nutrients in the discharged plume include *Lingulodinium polyedrum* and *Prorocentrum* spp. (Figure 1.7). These species are common red tide forming species in the region that often reach bloom abundances in the Fall.

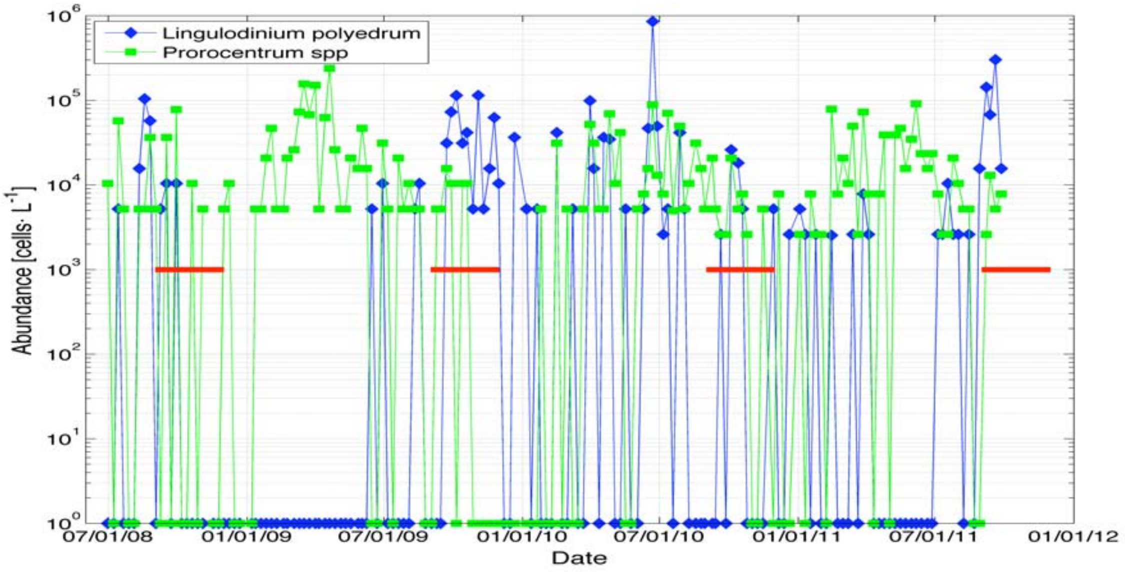


Figure 1.7. Abundances of *Lingulodinium polyedrum* and *Prorocentrum* spp. in weekly surface samples collected off the Newport Beach pier. Horizontal red bars indicate the Fall. Note the log scale for cell abundance.

A variety of other phytoplankton taxa can also be expected to respond to some degree to nutrients in the discharge plume. These include raphidophyte algae (e.g. *Heterosigma akashiwo*, which has been the cause fish kills in some regions), the haptophyte alga, *Phaeocystis globosa* (which can cause massive 'sea foams' and disrupt marine food webs), minute chlorophyte algae (which caused 'sea scums' locally during the summers of 2009, 2010 and 2011), and various chrysophyte algae which can cause odor problems. The latter species are often successful because many of them are mixotrophic; that is, they can both photosynthesize and eat small prey such as bacteria. It is anticipated that overall bacterial abundance in the plume will increase because of the greater availability of dissolved and particulate organic matter due to phytoplankton growth.

The exact composition of the phytoplankton assemblage resulting from the discharge is difficult to predict. Several factors will affect the absolute and qualitative response of the phytoplankton.

1) While N and P will be present at high concentrations in the plume, other nutrients such as silicon will be present in the discharge water in relatively low supply. Silicon is specifically required for diatom growth. At the very least, this factor can be anticipated to limit the success of diatom species to some degree. Moreover, the potential exists for micronutrient limitations (vitamins, trace metals) to temper or limit the response of the phytoplankton assemblage. While these limitations would not be expected to limit long-term utilization of plume nutrients, but they may be sufficient to slow the rate of phytoplankton growth until substantial dilution of plume nutrients has taken place.

2) Light attenuation, or reduced photoperiod due to the time of year, could limit rate and/or maximal amount of primary productivity, allowing dilution to dissipate nutrient concentrations prior to the establishment of a major phytoplankton bloom. If light limitation is important, the success of low-light adapted species or mixotrophic species (i.e. species that can supplement their nutrition through heterotrophy, such as many chrysophyte algae) could be anticipated. It is not anticipated that temperature will be a fundamental limitation on the response of the phytoplankton community.

3) Low initial biomass of the phytoplankton assemblage would lengthen the time required for a dramatic response of the phytoplankton assemblage to nutrient enrichment. Such a situation would particularly disadvantage the slow-growing taxa (e.g. many dinoflagellates), and potentially allow dilution (or grazer response; see 4) to reduce overall nutrient concentrations in the water.

4) Responsiveness of the consumer assemblage, particularly microzooplankton consumers, could keep pace with phytoplankton growth, preventing a dramatic increase in phytoplankton biomass. An active grazer community could prevent a ‘boom and bust’ situation, which might avoid or alleviate localized oxygen depletion and the onset of hypoxic/anoxic conditions. Herbivorous zooplankton responding during fall should be primarily microzooplanktonic species. Microzooplankton species such as oligotrichous ciliates are important consumers of small phytoplankton in coastal plankton ecosystems, and are capable of rapid growth rates (1-2 doublings/day). Heterotrophic dinoflagellates may also play an important role because these species are important consumers of diatoms. It is unlikely that dramatic increases in the crustacean zooplankton will occur in response to the rapid input of nutrients and anticipated growth of the phytoplankton community. Life histories of most of these species are relatively long (weeks-to-months) and probably will not be as responsive as microzooplankton taxa. However, some rapidly growing metazoan taxa that are effective consumers of small phytoplankton, such as appendicularia, may respond positively to dramatic increases in the abundances of small phytoplankton species.

Table 1.3. Summary of possible species that could may respond to the enriched nutrient conditions resulting from the nearshore effluent discharge.

Species	Group & Toxin	Anticipated Risk	Effect	Comment
Pseudo-nitzschia (several species)	Diatom Domoic acid	High: common & responsive	Amnesic Shellfish Poisoning (ASP)	[*Kudela et al.*, 2005; *Schnetzer et al.*, 2007]
Alexandrium catanella	Dinoflagellate Saxitoxins	High: not common, but highly toxic	Paralytic Shellfish Poisoning (PSP)	
Dinophysis (several species)	Dinoflagellate Okadaic Acid Dinophysins	Unknown	Diarrhetic Shellfish Poisoning (DSP)	Heterotrophic. Consume ciliates and algae
Cochlodinium fulvescens	Dinoflagellate Multiple toxic mechanisms	High: this species appeared to have responded to the Hyperion diversion event	Fin fish and shellfish mortality, fouling of desalination systems	Mixotrophic. Observed in Hyperion nearshore discharge plume (Reifel, 2009),[*Richlen et al.*, 2010]
Akashiwo sanguinea	Dinoflagellate	Moderate: cause of seabird mortality at bloom levels	Bird mortality due to surfactant effect on feathers	Jessup et al., 2010
Raphidophyte algae	e.g. *Heterosigma akashiwo*	Low: endemic but no known blooms in coastal waters	Fin fish mortality, effects on invertebrates	
Phaeocystis globosa	Haptophyte	Low: noxious but not a common bloom forming species in region	massive 'sea foams' and disruption of marine food webs	
chlorophyte algae		Low: Annoyance level	Sea scums (2009-2011)	
Chrysophyte algae		Unknown	Odor problems	
Large blooms in general		High: high nutrient levels could induce major bloom	Harboring pathogenic bacteria, low oxygen	[*Honner et al.*, 2010]

Discussion and Summary:

The planned discharge from OCSD's nearshore ocean outfall is likely to result in a significant phytoplankton bloom along the coast of Orange County. The full extent of this bloom will depend on the discharge rates, ambient oceanographic conditions affecting dilution/retention in the region, and the specific assemblage of phytoplankton species present in the ambient ocean at the time of discharge.

We have generated some simple models of alongcoast distributions of the plume based on initial plume characteristics observed during the Hyperion Treatment Plant nearshore diversion in November 2006, and relatively simple advection/diffusion modeling of the transport along the coast. These results show some expected results that include horizontal mixing and diffusion as the surface plume advects along the coast, but with significant nutrient concentrations present 15 km away from the outfall. In this case, 15 km represents the extent of the modeling, not the potential extent of the plume. In reality, the mixing will be more complex as complex horizontal currents including eddies, may cause additional cross-shelf transport in either direction, and vertical mixing processes could expand the depth range of the plume. A more extensive three-dimensional model will provide increased detail characterization of the likely distributions, including both spatial and temporal patterns that would likely result from a nearshore discharge. That is beyond the scope of this report, but based on results from other regions (McWilliams, personal communications), the results presented here provide a reasonable preliminary perspective of expected conditions.

Typical maximal chlorophyll concentrations from the Newport Beach Pier are approximately 15 mg/m^3 (based on >3yrs of weekly samples). The modeling results indicate that phytoplankton biomass could easily attain 3 times that concentration as the result of the nearshore continuous discharge. Taking into account the tidal modulation of the currents, and/or the vertical migratory behavior of dinoflagellate populations, these concentrations could easily increase by a factor of 4 or more. Moreover, natural assemblages of phytoplankton in the ocean exhibit a great deal patchiness, and thus we expect considerable patchiness in the assemblage responding to nutrients in the diluted discharge plume. These high phytoplankton biomass conditions can create an environment where bacterial populations are at the least sustained, and in some conditions may increase.

While it is impossible to predict which particular species will dominate a bloom response to the nearshore discharge nutrient input, high nutrient concentrations such as the ones expected from the discharge often result in dominance by a single or small number of species. Given the presence of several potentially toxic species in the southern California coastal ocean it is possible that the discharge plume may result in the stimulation of toxic algal species (Table 1.3) that could affect other organisms in the ecosystem, have health effects on recreational bathers, and/or have human toxic affects through ingestion of seafoods that have consumed the toxic algae.

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Orange County Sanitation Districts

J-112 Effluent Bacteria Reduction Demonstration Project

July 25, 2011 – August 15, 2011

Purpose

The purpose of the July-August 2011 effluent bacteria reduction demonstration study was to operate Orange County Sanitation District (OCSD) Plant No's 1 & 2 to reduce fecal indicator bacteria (FIB) in the final effluent to levels at or near the geometric mean standards for beach water quality (**Table 1**). The bacterial reductions were achieved through a combination of increased bleach disinfection, operation of the secondary treatment processes without disruption, and manipulation of flow splits between the secondary treatment processes as necessary.

Table 1. OCSD Final Effluent Target Bacteriological Values Relative to AB411 Bacteriological Standards. Counts expressed as MPN/100 mL.

	Final Effluent		AB411 Standards	
Parameter	Standard Operational Targets	Demonstration Plan Targets	Single Sample Maximums	30-day Geometric Mean Standards
Total coliforms	250,000	1,000	10,000	1,000
Fecal coliforms	50,000	200	400	200
Enterococci	8,750	35	104	35

Facility Operation

OCSD Treatment Plant Nos. 1 and 2 were operated to achieve the highest practical effluent water quality for 22 days starting July 25, 2011 and ending August 15, 2011. Plant No. 1 treated an average daily influent flow of 96 million gallons per day (MGD) with a daily peak of 105 MGD. The air activated sludge plant treated 81 MGD, including some recycle flows, and the trickling filters treated 30 MGD. The Ground Water Replenishment System (GWRS) received an average 85 MGD of the combined Plant No. 1 secondary effluent for tertiary treatment. Plant No. 1 disinfected effluent was conveyed to Plant No 2 ocean outfall pump station, with a detention time slightly more than one-hour.

Plant No. 2 treated an average daily influent flow of 108 MGD with an average daily peak flow of 150 MGD. The oxygen activated sludge (OAS) plant treated an average 50 MGD and the new trickling filters with solids contact (TFSC) treated an average of 58 MGD.

OCSD has operated at full secondary since Plant No. 2 commissioned the TFSC on May 19, 2011. In addition, Plant No. 2 has partially commissioned the new Headwork's D facility. The start-up of both facilities challenged flow controls to Plant No. 2 operations during the demonstration. Influent flow control for the TFSC was designed to operate with the new headwork's D; however, both the old Headwork's C and the new Headwork's D were operating simultaneously creating some flow control limitations to the primary clarifiers which then impact flow to the OAS. When flow increases to Plant No. 2 the larger Headwork's C plant influent pumps produce a flow surge to the primary clarifiers which then impacts flows to the OAS and TFSC influent pump stations. The TFSC and OAS influent pump stations are hydraulically connected through the primary effluent distribution box. The cycling of the TFSC influent pumps impacts the Primary Effluent Pumps Station (PEPS) wet well which provides flow to the OAS facility. OCSD system programmers have been adjusting the operating control strategies to dampen the impact of the influent surges. These events affect disinfection practices because OAS bleach dosing is based on the PEPS flow meter while the TFSC bleach dosing is based on the TFSC effluent flow meter.

Bacteria Reduction Operational Guidelines

Bleach disinfection dose rates were increased to reduce final effluent bacteria to meet stated demonstration plan targets. **Table 2** provides the disinfection operating guidelines used during the demonstration test. The flows are approximate and GWRS was treating an average of 85 million gallons a day (MGD).

Table 2. Disinfection Operation Guidelines

Process	**Flow** MGD	**Initial Dose Rate** mg/L	**Minimum Cl_2 residual** mg/L	**Cl_2 residual sample location**	**Chemical Use gal/day**
P1 Effluent	30	5.5	**1.0**	120" @ OOBS	1,100
P2 TFSC	25–90	9.0	**1.2**	TFSC @ OOBS	3,200
P2 AS	25–60	6.0	**2.5**	PWDB	2,300
Sodium Bisulfite	140	2.0	**<0.2**	Final sampler	950

Operations staff adjusted bleach pumping rates to achieve target chlorine (Cl_2) residual at the four sample locations listed in Table 2. Chlorine residuals were monitored at each sample point during operator rounds.

Detention time for the Plant No. 2 TESC effluent was increased by using the Effluent Pump Station Annex (EPSA) instead of the Ocean Outfall Booster Station (OOBS) (**Table 3**). Field and lab tests were conducted to determine the dose rates required to achieve the target bacteria reduction.

Table 3. Bleach Disinfection Detention Times for Different Pump Stations

	Effluent Quality				
Process	**TSS mg/L**	**BOD** mg/L	**Peak Flow** MGD	**OOBS** minutes	**EPSA** minutes
OAS	7.5	4.7	50	26	11
TFSC (Clarifier D)	15.0	8.0	90	11	28

Results and Discussion of Bacteriological Samples

Three final effluent samples were collected daily and analyzed for chlorine residual and bacteria. **Table 4** summarizes the final effluent microbiology results against the various standards, with and without the impact of initial dilution. An initial dilution of 36:1 was applied to the results in order to determine the level of bacteria that would reach the receiving waters after exiting the 1-mile outfall diffuser. The 36:1 is based upon the Moffatt and Nichol modeling work and represents the average fall dilution estimated to occur within 200 meters of the outfall diffuser, absent the additional dilution of ocean currents and any continued die-off that would occur during the transit through the 1-mile discharge pipe.

The following formula was used to calculate the adjusted 36:1 FIB result:

Adjusted 36:1 FIB result = ((MPN result x 1) + (10 x 36)) / (36 + 1)

Definitions:

MPN result = (result to be converted)

10 = (depth-averaged background bacteria concentrations, MPN)

1 and 36 = (dilution preparation on a per parts basis)

Table 4. Percentage (%) of Final Effluent Microbiology Samples Meeting Demonstration Project Targets and Bacteriological Standards and Number (#)of 65 Total Samples Exceeding Targets Before and After Initial Dilution.

Parameter	**Total Coliforms** MPN/100mL	**Fecal Coliforms** MPN/100mL	**Enterococci** MPN/100mL
Final effluent			
Demonstration Plant Target	75% (16)	60% (26)	82% (12)
% 30-day geometric mean standard	80% (13)	37 (41)	65% (23)
% AB411 standards	94% (4)	83% (11)	89% (7)
Following initial dilution (36:1)			
% demonstration plan	98% (1)	95% (3)	98% (1)
% 30-day geometric mean standard	100% (0)	100% (0)	100% (0)
% AB411 standards	98% (1)	98% (1)	100% (0)

The target total coliform bacteria of 1000 MPN/100 mL was met 77% of the time, while the enterococci bacteria target of 35 MPN/100 mL was met 82% of the time (Table 4). The occasional high bacterial counts occurred during low flow transition and when flow surging occurred at the Plant No. 2 OAS facility. The OAS bleach dosing was based on the OAS influent flow meter at PEPS because there was no secondary effluent flow meter for the OAS. During the flow transitions, there is a delayed response in the bleach dose at the OAS plant relative to changes in PEPS flow (**Chart 1**).

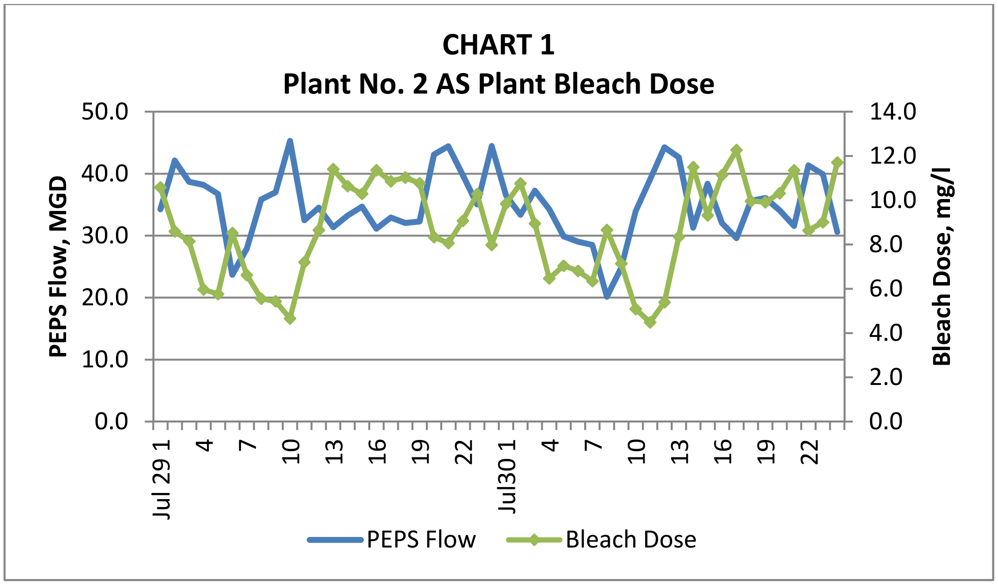

Chart 1. A typical hourly trend of the bleach dosage with the PEPS flow over a 48-hour period.

In addition, the bleach dose was not met during the transition from low to high flows (**Chart 2**). For example, an OAS effluent sample collected on August 10, 2011 during the transition time had total coliform bacteria results of 80,000 MPN/100 mL. Similar results occurred on other days during this transitional period.

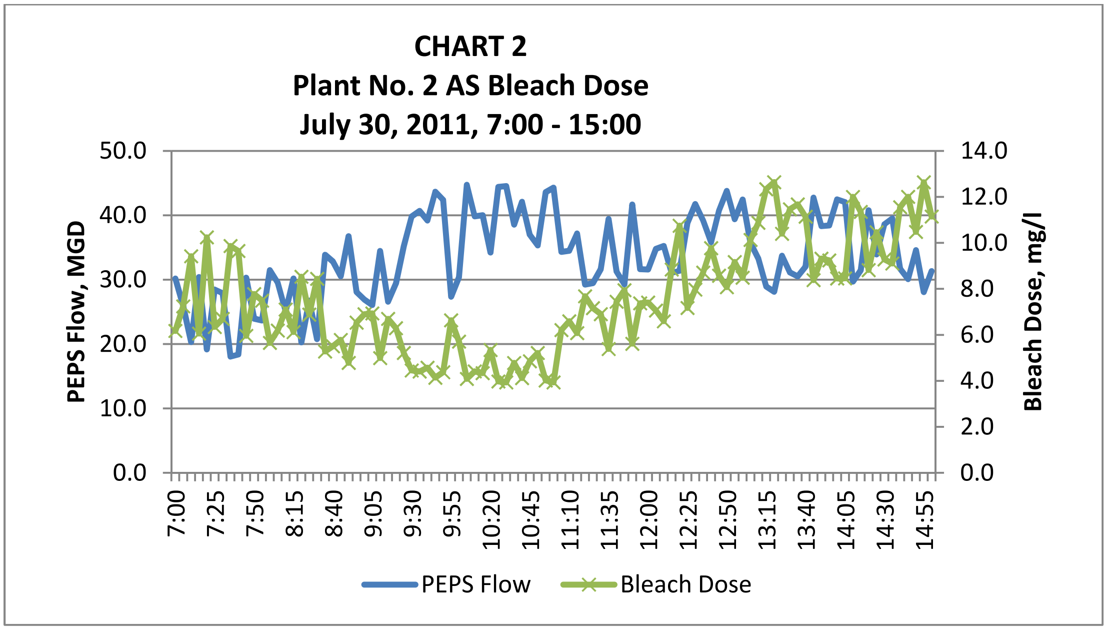

Chart 2. The bleach dose trend at 5 minute intervals over 8 hours on July 30, 2011.

Plant No. 2 influent flow typically changes from 45 MGD at 8:00 am to 155 MGD at 1:00 pm. The final effluent flow changes from 80 MGD to 150 MGD during that time. Samples were collected for the disinfection at 8:00 am, 11:00 am and 1:30 pm to represent low flow and high flow conditions (**Chart 3**).

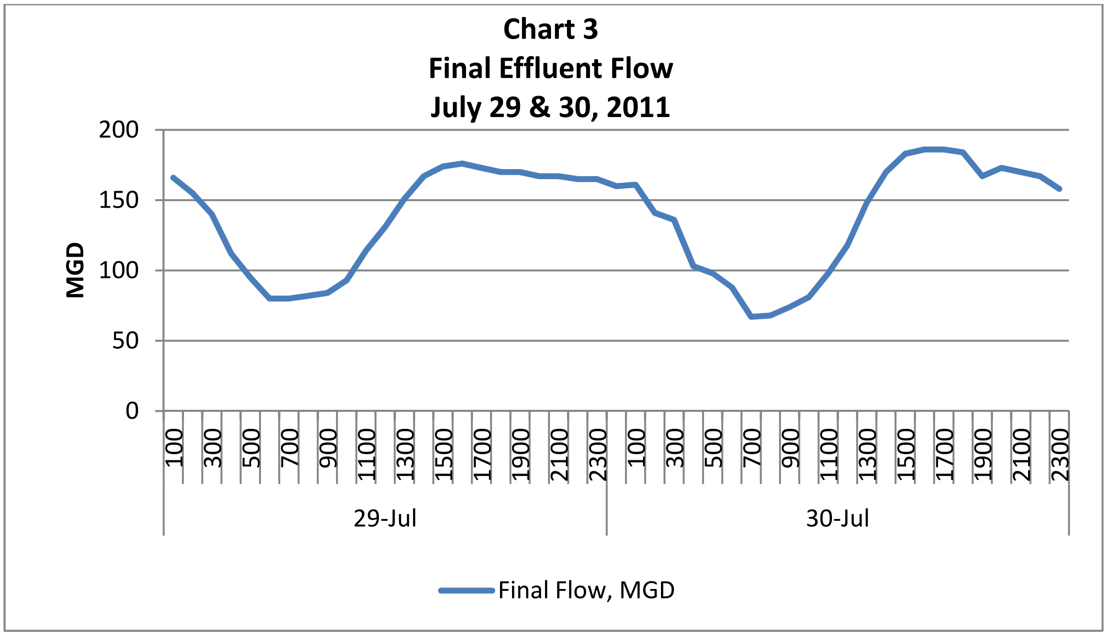

Chart 3. The final effluent diurnal flow curve for July 29 and July 30, 2011.

Conclusion

Many samples with higher microbiology values appear to have been due to insufficient OAS bleach dosing at specific flow transition periods, while others may be due to potential sloughing which could occur in the outfall pipe as flows increase. As a result of this demonstration, the bleach dosing strategy was evaluated and will be improved.

Based on the evaluation of the microbiological results presented herein and an improved bleach dosing strategy, Staff believes that OCSD can meet the stringent bacteriological standards referenced in Table 1 once process testing on the new TFSC is complete and the new Headwork's D is further commissioned. Additional factors that will mitigate public health threats include the dilution factor of 36:1, continued bacteria reductions in transit from Plant No 2 to the receiving waters through the 1-mile outfall pipe, and the further dilution and transport by ocean currents. Additional testing is recommended following the completion of the TFSC process testing and the commissioning of Headwork's D and prior to the use of the 1-mile outfall.