Plume Tracking Monitoring Plan for the Point Loma and South Bay Ocean Outfall Regions, San Diego, California

Submitted by

City of San Diego Public Utilities Department
Environmental Monitoring & Technical Services Division

March 28, 2018

(Revised April 20, 2018; Approved April 25, 2018)

City of San Diego Point Loma Wastewater Treatment Plant
(Order No. R9-2017-0007; NPDES CA0107409)

City of San Diego South Bay Water Reclamation Plant
(Order No. R9-2013-0006 as amended by Order Nos. R9-2014-0071 and R9-2017-0023; NPDES CA0109045)

U.S. IBWC South Bay International Wastewater Treatment Plant
(Order No. R9-2014-0009 as amended by Order Nos. R9-2014-0094 and R9-2017-0024; NPDES CA0108928)

INTRODUCTION

This Plume Tracking Monitoring Plan (PTMP) is submitted pursuant to the above referenced orders and NPDES permits issued to the City of San Diego (City) and the U.S. Section of the International Boundary and Water Commission (USIBWC) to govern the discharge of wastewater to the Pacific Ocean from: (a) the City's Point Loma Wastewater Treatment Plant (PLWTP) via the Point Loma Ocean Outfall (PLOO); (b) the City's South Bay Water Reclamation Plant (SBWRP) via the South Bay Ocean Outfall (SBOO); and (c) the USIBWC's South Bay International Wastewater Treatment Plant (SBIWTP) via the SBOO. These ocean discharges fall under the jurisdiction of the California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) and the U.S. Environmental Protection Agency, Region IX (USEPA). Accordingly, the PTMP summarizes steps the City, USIBWC, San Diego Water Board and USEPA intend to implement in order to address new plume tracking and other advanced ocean monitoring requirements for the San Diego coastal ocean.

The need to develop an improved understanding of physical circulation and current movement patterns in the coastal waters off San Diego and how they may affect wastewater plume dispersion

was first recognized as part of an external evaluation of the City's Ocean Monitoring Program conducted by the Scripps Institute of Oceanography (SIO 2004). Consequently, the City's ocean monitoring program staff began to collaborate with Scripps scientists on several studies in order to form a long-term plan for enhanced coastal water quality monitoring off San Diego. This included a pilot study initiated in 2006 using moored temperature loggers (thermistor strings) and Acoustic Doppler Current Profilers (ADCPs) to obtain an initial characterization of the thermocline structure and current regime in the area surrounding the PLOO discharge site (see Storms et al. 2006). The use of these thermistor and ADCP moorings was later expanded to include both the PLOO and SBOO regions where the resultant data have been a valuable part of the City's annual monitoring and assessment reports (e.g., City of San Diego 2015a, b). Additionally, the USIBWC and the City commissioned subsequent studies of the fate and behavior of wastewater discharged to the ocean via the SBOO (Terrill et al. 2009) and the PLOO (Rogowski et al. 2012a, 2012b, 2013). The findings of both of these studies included recommendations to use real-time oceanographic moorings and advanced sampling technologies to better monitor and understand near-shore coastal water quality and the impacts of local ocean currents and tidal fluxes on effluent plume dynamics.

Based on the above recommendations and subsequent discussions between the City, USIBWC, San Diego Water Board and USEPA, agreement was reached that initial plume tracking requirements for the PLOO and SBOO regions should include, but not be limited to, the following main elements:

1. Design and installation of permanent, real-time oceanographic mooring systems located near the terminal diffuser wye structures of the PLOO and SBOO.
2. Development of a schedule and work plan (e.g., pilot study) for implementation and testing of the PLOO and SBOO real-time mooring systems, including data acquisition and processing.
3. Networking the PLOO and SBOO real-time mooring systems to be fully compatible with each other, as well as with a third system operated by the Ocean Time Series Group of the Scripps Institution of Oceanography (Scripps) in the coastal waters off the City of Del Mar.
4. Development of a schedule and work plan (e.g., pilot study) for utilizing advanced oceanographic sampling instrumentation and technologies such as an autonomous underwater vehicle (AUV) or remotely operated towed vehicle (ROTV) in conjunction with the real-time mooring systems to enhance the collection water quality data in order to provide higher resolution maps of plume dispersion and location.

Although the requirement to develop the PTMP did not go into effect until October 1, 2017 for the PLOO region and December 13, 2017 for the SBOO region, work began about two years earlier with Scripps to design, build and initiate field testing of two customized real-time mooring systems capable of being deployed from City research vessels. Consequently, some of the dates in the enclosed schedule predate this monitoring plan.

GENERAL APPROACH

The PTMP for the San Diego ocean outfall regions includes three main components that will be conducted in multiple phases and/or on an adaptive cycle as deemed appropriate via mutual agreement of all parties (i.e., City, UISBWC, San Diego Water Board, and USEPA). The first two components include the following different types of moored systems: (a) Real-Time Ocean Observing System, which represents the new real-time oceanographic moorings for the PLOO and SBOO that are presently being designed, deployed and tested by the City and Scripps; (b) Static ADCP and Thermistor Moorings, which represent existing moorings used by the City since 2006 to characterize thermocline structure and current patterns at various locations (see Storms et al. 2006, City of San Diego 2015a, b). Implementation of both of these components is already underway. The third component will involve deployment and testing by the City of a recently acquired ROTV (i.e., a ScanFish III) in order to develop new and effective procedures for enhanced water quality monitoring and adaptive plume tracking. The first main activity associated with this component will be a pilot study designed to compare ROTV survey results to traditional fixed grid CTD-based water quality monitoring. Additional future pilot studies may include side-by-side comparisons of ROTV vs. AUV sampling technologies for nearshore coastal water quality monitoring, as well as testing the feasibility of using drone technology to augment ROTV operations.

Design, acquisition, deployment, and initial testing of the PLOO and SBOO real-time moorings was completed under a previous contractual agreement between the City and Scripps, with the SBOO mooring being first deployed on December 21, 2016 and the PLOO mooring being first deployed in March 1, 2018. All other work in terms of ongoing operations and support of these new real-time moorings as part of this monitoring plan, including networking with the third Del Mar system, will be done as part of a subsequent multi-year collaborative agreement between the City and Scripps that runs through June 30, 2022.

STUDY DESIGN

Real-Time Ocean Observing System

This part of the PTMP involves deploying, operating and evaluating the City of San Diego Real-Time Ocean Observing System for a period of five years (July 1, 2017 – June 30, 2022). The City system is comprised of two oceanographic moorings and real-time data systems placed near the offshore discharge sites of the PLOO and SBOO (**Figure 1**). The primary goal of this part of the program is to enable the City to provide a continuous set of enhanced environmental monitoring data that can be used to better evaluate oceanographic conditions in the San Diego region and address emerging issue related to climate change or other factors.

The City's two new real-time moorings are being deployed near an active diffuser leg of their respective outfalls, yet far enough from the diffuser ports to be outside the area of active plume rise.

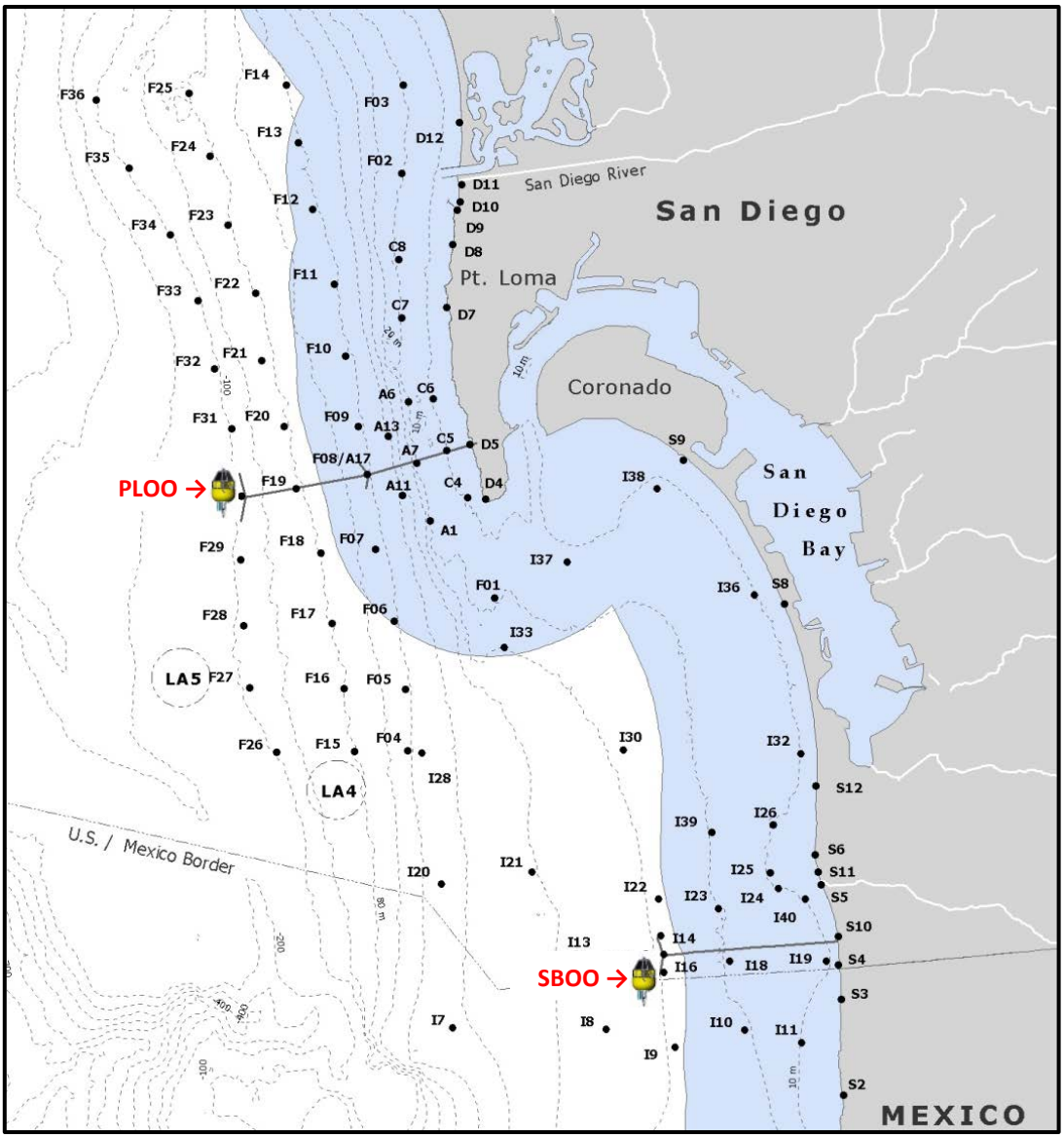

Figure 1

Map showing approximate locations of new Point Loma Ocean Outfall (PLOO) and South Bay Ocean Outfall (SBOO) real-time moorings along with regular water quality monitoring stations for both regions. Not shown is the 3rd real-time mooring system operated by the Scripps Institution of Oceanography that is located farther north and west of the City of Del Mar. Blue shading represents the 3-nm boundary representative of California state waters north of the border.

Each mooring will be operated in those locations for deployment periods of approximately 12 months, during which time Scripps will closely monitor and evaluate technical performance of the component sensors and supporting hardware to certify overall system functionality. If any issues are detected that cannot be corrected remotely, City staff will be engaged to assist with a site visit to repair the problem. At the end of each 12-month deployment, City and Scripps staff

will retrieve the respective mooring and replace it with a similar back-up mooring to minimize any interruption of data production.

The PLOO mooring is being anchored at a depth of about 100 m just west of the outfall's northern diffuser leg, while the SBOO mooring is being anchored at a depth of about 30 m to the west of its southern diffuser leg terminus. Each mooring will be outfitted initially with a series of instruments or sensors as indicated in **Table 1** and illustrated in **Figure 2**. Critical parameters that will be measured on a real-time basis by both systems will include, but may not be limited to, temperature, conductivity, pH, dissolved oxygen, pCO_2, nitrogen (nitrate), chlorophyll *a*, colored dissolved organic matter (CDOM), BOD, and current direction.

Table 1

Sensor configuration for the PLOO and SBOO real-time oceanographic moorings.

Sensor Depth		
PLOO (~100 m)	**SBOO** (~30 m)	**Parameters Measured (Initial Sensor Types)**
1 m (surface)	1 m (surface)	• Temperature, conductivity, pH, dissolved oxygen (Sea-Bird SeapHOx) • Ocean currents (RDI 300kHz ADCP) • Partial pressure of carbon dioxide (Pro-Oceanus pCO_2 System) • Chlorophyll *a*, CDOM (2 Turner Cyclops C7) • Nitrate (Satlantic SUNA V2)
10 m	10 m	• Temperature, conductivity (Sea-Bird MicroCAT)
	15 m	• Temperature, conductivity, dissolved oxygen (Sea-Bird MicroCAT ODO) • Chlorophyll *a*, CDOM (2 Turner Cyclops C7)
20 m		• Temperature, conductivity (Sea-Bird MicroCAT)
	24 m (cage)	• Temperature, conductivity, pH, dissolved oxygen (Sea-Bird SeapHOx) • Chlorophyll *a*, CDOM (2 Turner Cyclops C7) • Nitrate (Satlantic SUNA V2) • BOD (Chelsea UviLux)
30 m (cage-1)		• Temperature, conductivity, pH, dissolved oxygen (Sea-Bird SeapHOx) • Chlorophyll *a*, CDOM (2 Turner Cyclops C7) • BOD (Chelsea UviLux)
45 m		• Temperature, conductivity (Sea-Bird MicroCAT)
60 m		• Temperature, conductivity (Sea-Bird MicroCAT)
75 m		• Temperature, conductivity (Sea-Bird MicroCAT)
90 m (cage-2)		• Temperature, conductivity, pH, dissolved oxygen (Sea-Bird Deep SeapHOx) • Chlorophyll *a*, CDOM (2 Turner Cyclops C7) • Nitrate (Satlantic SUNA V2) • BOD (Chelsea UviLux)

Scripps will be responsible for providing real-time data management and integration support during the course of this 5-year PTMP. This will include, but may not be limited to, maintaining the data management system (e.g., servers and modems), conducting preliminary data processing and verification, hosting real-time data and posting data to an accessible website, and providing ongoing technical support and training for real-time mooring technology to City staff.

Scripps will also oversee networking the PLOO and SBOO real-time moorings with their existing Del Mar mooring to form a comprehensive state-of-the-art ocean observing system for the San Diego region. Such a system will provide valuable information regarding regional oceanographic conditions and the dynamics of emerging issues such as ocean acidification, hypoxia, nutrient inputs, and algal blooms, as well as in helping to predict plume behavior and movement.

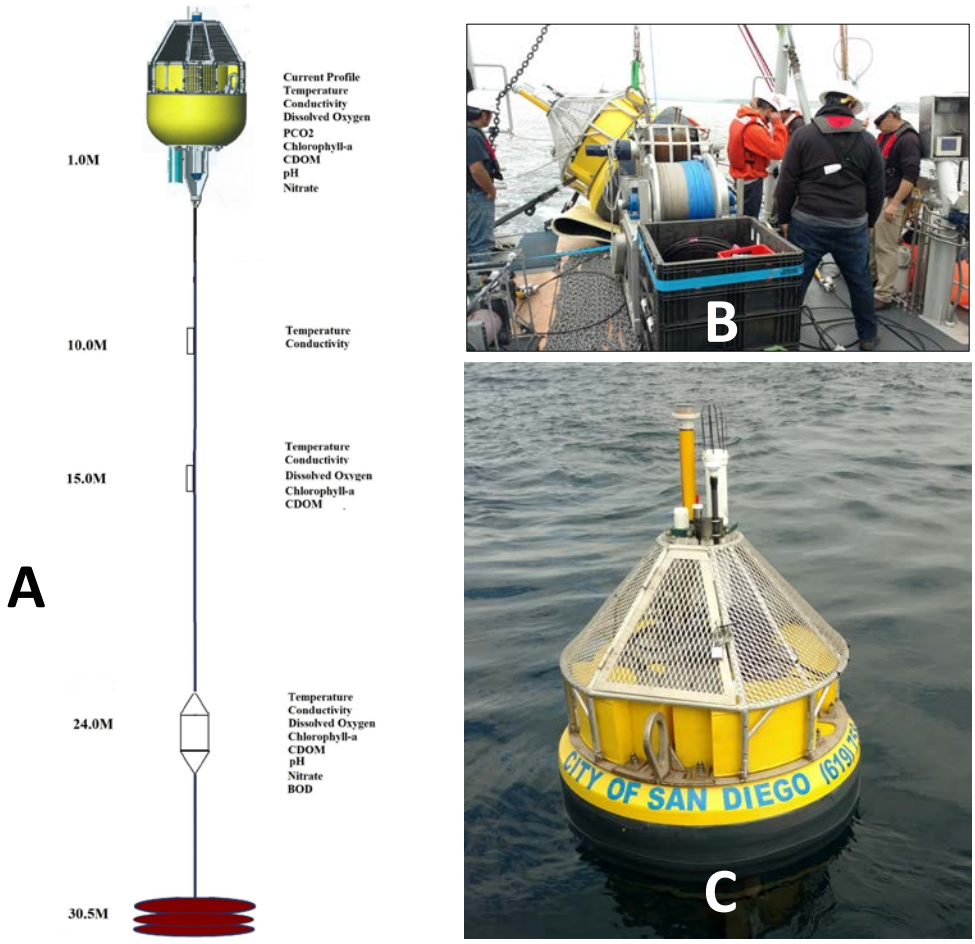

Figure 2
(A) Diagram of SBOO real-time mooring system showing general sensor configuration. See Table 1 for details and comparison with the deeper PLOO mooring. (B) SBOO mooring being readied for first deployment aboard City research vessel. (C) SBOO mooring surface buoy following successful deployment in December 2016.

Static ADCP and Thermistor Moorings

The static ADCP and thermistor moorings deployed near the PLOO and SBOO as part of the original Moored Observation System Pilot Study will be relocated in order to verify real-time data system accuracy and to expand the coverage of the continuous data collecting systems currently being operated in the region. For example, Scripps scientists presently deploy a series of thermistors within the Point Loma Kelp Forest north of the PLOO. The information from these moorings was used to capture the nearshore dynamics of the physical forcing that influences movement of the wastewater plume. In subsequent phases, such measurements will be used to help develop an effective model of plume behavior. Consequently, City staff will continue to consult with the Scripps research team operating their kelp bed moorings to strategize where best to relocate the City's static moorings to complement the data produced by the real-time systems.

ROTV Operations

This component of the PTMP will be devoted to evaluating the City's ScanFish III ROTV to determine the efficacy of using it as an enhanced water quality monitoring instrument and a plume tracking tool. The wing-shaped ScanFish (**Figure 3**) is a highly flexible multi-purpose platform that can be programmed to automatically track at a fixed depth in the water column, move in an undulating pattern from surface to seabed, or move in a terrain-following mode while being towed by a vessel at normal cruising speeds. A wide variety of sensors can be integrated in the ROTV that can be configured to collect and transmit continuous data in real-time, thereby providing in-motion profile information about the water column through which it is being towed.

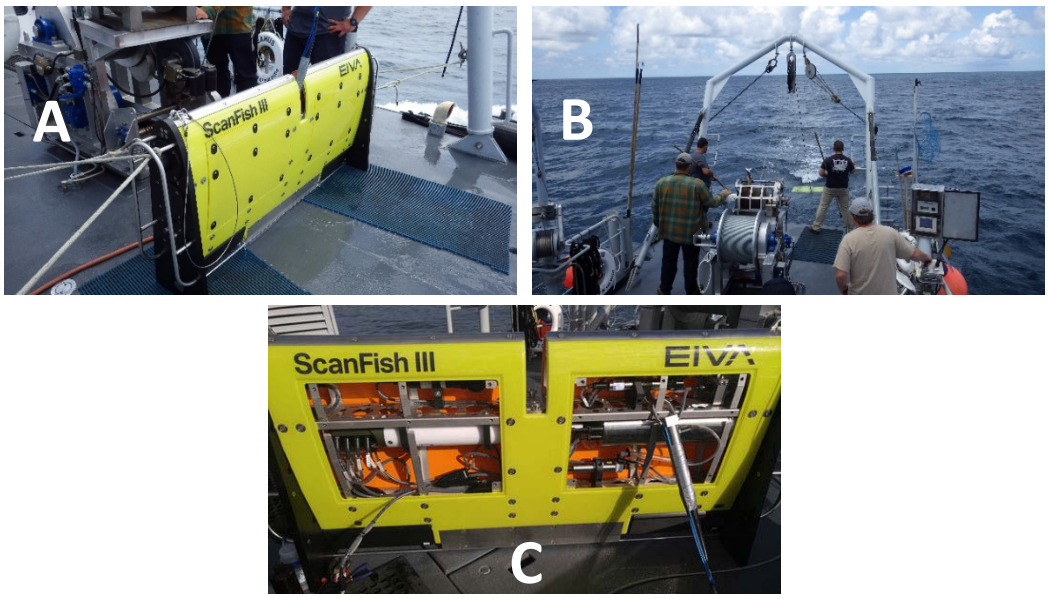

Figure 3
ScanFish III Remotely Operated Towed Vehicle. (A-B) ROTV training and testing aboard City of San Diego research vessel, *Oceanus*. (C) ScanFish with main compartment covers removed to highlight location of CTD unit and other sensors.

City staff will initialize the process by collaborating with U.S. representatives of EIVA Marine Survey Solutions, the European manufacturer of the City's ScanFish, to ensure that the incorporated CTD sensor package is fully integrated and operating correctly. This package includes a Sea-Bird SBE-25 Plus CTD with temperature, conductivity and dissolved oxygen sensors, a Turner Designs CDOM probe, and Tryptophan and Optical Brightener sensors. Once completed successfully, City staff will enroll in a series of classroom and field training courses offered by EIVA covering their NaviPac, NaviEdit and NaviModel flight control and data visualization software modules. This training will enable City scientists to fully control the movement of the ScanFish while underway, and to display and store the data from each sensor in real-time.

The next step in the process will be to conduct a series of quarterly side-by-side field exercises designed to compare the results of using traditional CTD casts (e.g., using a Sea-Bird Carousel CTD) with the results from ScanFish surveys over the same area. Although a more specific work plan will be developed prior to commencement of this pilot study, it's expected that one City vessel will conduct the traditional grid sampling using the carousel CTD, and that a second vessel using the ScanFish will follow soon thereafter collecting a continuous stream of data while being towed over the same transects. The results from these near simultaneous sampling runs will allow City scientists to verify the accuracy of the ScanFish data and to assess the value of this new sampling method for water quality monitoring.

If the results of the above studies indicate that the PLOO and SBOO wastewater plumes can be detected more consistently and with greater accuracy using the ScanFish than with traditional CTD casts, this ROTV method of sampling may be highly useful in developing a more adaptive sampling strategy. Consequently, City staff will be working with their Scripps counterparts in analyzing data collected from the real-time moorings in an effort to identify information that may be reliably used to indicate potential shoreward movement of the plumes. If such triggers can be identified, the ScanFish may then be used to quickly survey the area of concern in order to more effectively track and monitor plume behavior and dispersion.

REPORTS & MEETINGS

Short (1-3 page) annual progress reports shall be submitted by the City to the San Diego Water Board, USEPA and USIBWC within 60 days of completion of all PTMP work for calendar years 2018–2021. Each report will summarize any significant findings for the past year, issues with mooring sensors and how such issues were resolved, and provide updates on new work plans that have been developed or are under development. The expected due dates of these reports are:

- CY 2018 Progress Report due March 1, 2019
- CY 2019 Progress Report due March 1, 2020
- CY 2020 Progress Report due March 1, 2021
- CY 2021 Progress Report due March 1, 2022

Additionally, the City shall report on the results of the real-time ocean observing system project every two years in accordance with the schedule for the combined Biennial Receiving Waters Monitoring and Assessment Report as specified in the orders and permits for the PLWTP, SBWRP and SBIWTP. These reports shall include in-depth evaluations, interpretations, discussions and conclusions concerning the state of the local receiving waters and the estimated location of the PLOO and SBOO plumes throughout the reporting period. The due dates for the two biennial reports covered by this PTMP are:

- CY 2018-2019 Biennial Monitoring & Assessment Report due July 1, 2020
- CY 2020-2021 Biennial Monitoring & Assessment Report due July 1, 2022

City staff will be available to meet with San Diego Water Board, USEPA or USIBWC staff at any time during the project to discuss results and interpretations, while data for the project will be made available as appropriate. If requested by the above parties, the City will give or organize summary presentations to appropriate groups. Informal meetings between the City and all parties may be scheduled as desired throughout the project.

PROJECT SCHEDULE

A tentative schedule of key activities for the PTMP is given below in **Table 2**, including prior mooring design phase and initial deployment.

Table 2

Plume Tracking Monitoring Plan implementation schedule, 2016-2022.

Calendar Year	Activities
2016	• January-December 2016: Real-time mooring design phase • December 2016: Initial SBOO mooring system deployment
2017	• January-December 2017: Initial SBOO field testing • December 2017: First SBOO mooring system retrieval
2018	• March 2018: Initial PLOO mooring system deployment • March-December 2018: Initial PLOO field testing • May-June 2018: SBOO mooring system first re-deployment • December 2018: First PLOO mooring system retrieval and re-deployment
2019	• January-December 2019: ROTV/CTD Quarterly Survey Pilot Study (work plan TBD) • March 2019: CY18 Progress Report due • May 2019: SBOO mooring system retrieval and re-deployment • December 2019: PLOO mooring system retrieval and re-deployment
2020	• March 2020: CY19 Progress Report due • May 2020: SBOO mooring system retrieval and re-deployment • December 2020: PLOO mooring system retrieval and re-deployment
2021	• March 2021: CY20 Progress Report due • May 2021: SBOO mooring system retrieval and re-deployment • December 2021: PLOO mooring system retrieval and re-deployment
2022	• March 2022: CY21 Progress Report due

LITERATURE CITED

City of San Diego. 2015a. Point Loma Ocean Outfall Annual Receiving Waters Monitoring and Assessment Report, 2014. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring & Technical Services Division, San Diego, CA

City of San Diego. 2015b. South Bay Ocean Outfall Annual Receiving Waters Monitoring and Assessment Report, 2014. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring & Technical Services Division, San Diego, CA

Rogowski, P., E. Terrill, M. Otero, L. Hazard, S.Y. Kim, P.E. Parnell, and P. Dayton. 2012a. Final Report: Point Loma Ocean Outfall Plume Behavior Study. Prepared for City of San Diego Public Utilities Department by Scripps Institution of Oceanography, University of California, San Diego, CA

Rogowski, P., E. Terrill, M. Otero, L. Hazard, and W. Middleton. 2012b. Mapping ocean outfall plumes and their mixing using Autonomous Underwater Vehicles. Journal of Geophysical Research, 117: C07016

Rogowski, P., E. Terrill, M. Otero, L. Hazard, and W. Middleton. 2013. Ocean outfall plume characterization using an Autonomous Underwater Vehicle. Water Science & Technology, 67(4): 925–933

Scripps Institution of Oceanography [SIO]. 2004. Point Loma Outfall Project, Final Report, September 2004. Scripps Institution of Oceanography, University of California, La Jolla, CA

Storms, W.E., T.D. Stebbins, and P.E. Parnell. 2006. San Diego Moored Observation System Pilot Study. Workplan for Pilot Study of Thermocline and Current Structure off Point Loma, San Diego, California. City of San Diego, Metropolitan Wastewater Department, Environmental Monitoring & Technical Services Division, and Scripps Institution of Oceanography. 8 pp.

Terrill, E., K. Sung Yong, L. Hazard, and M. Otero. 2009. Final Report. Coastal Observations and Monitoring in South Bay San Diego. IBWC / Surfrider Consent Decree. Scripps Institution of Oceanography, University of California, San Diego, CA

CONTACT INFORMATION

For additional information regarding this Plume Tracking Monitoring Plan, please contact Adriano Feit (AFeit@sandiego.gov), Mike Kelly (MKelly@sandiego.gov), or Tim Stebbins (TStebbins@sandiego.gov) / City of San Diego Ocean Monitoring Program, Public Utilities Department, 2392 Kincaid Road, San Diego, CA 92101