ADAPTIVE PLUME TRACKING PILOT STUDY FOR THE SAN DIEGO OCEAN OUTFALL MONITORING REGIONS

Prepared by

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

Date 01/16/2020

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

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

U.S. IBWC South Bay International Wastewater Treatment Plant
(NPDES CA0108928; Order No. R9-2014-0009
as amended by Order Nos. R9-2014-0094, R9-2017-0024, and R9-2019-0012)

Ryan M. Kempster (rkempster@sandiego.gov)
Adriano Feit (afeit@sandiego.gov)
Ami Latker (alatker@sandiego.gov)

Environmental Monitoring and Technical Services
2392 Kincaid Road, San Diego, CA 92101
Tel (619) 758-2300 Fax (619) 758-2309

INTRODUCTION

In March 2018, a Plume Tracking Monitoring Plan (PTMP; City of San Diego 2018) was 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), which approved the PTMP on April 25, 2018. The PTMP includes three main components designed to develop new and effective procedures for enhanced water quality monitoring and adaptive plume tracking. These components include: (a) real-time oceanographic mooring systems (RTOMS) located near the terminal diffuser wye structures of the PLOO and SBOO; (b) static ADCP and thermistor moorings; (c) deployment and testing of a remotely operated towed vehicle (ROTV). This Adaptive Plume Tracking Pilot Study is intended to address the third PTMP component by outlining a schedule and work plan to evaluate the City's ScanFish III ROTV (Figure 1) to determine the efficacy of using it in conjunction with the real-time mooring systems to enhance the collection of water quality data in order to provide higher resolution maps of plume dispersion and location.

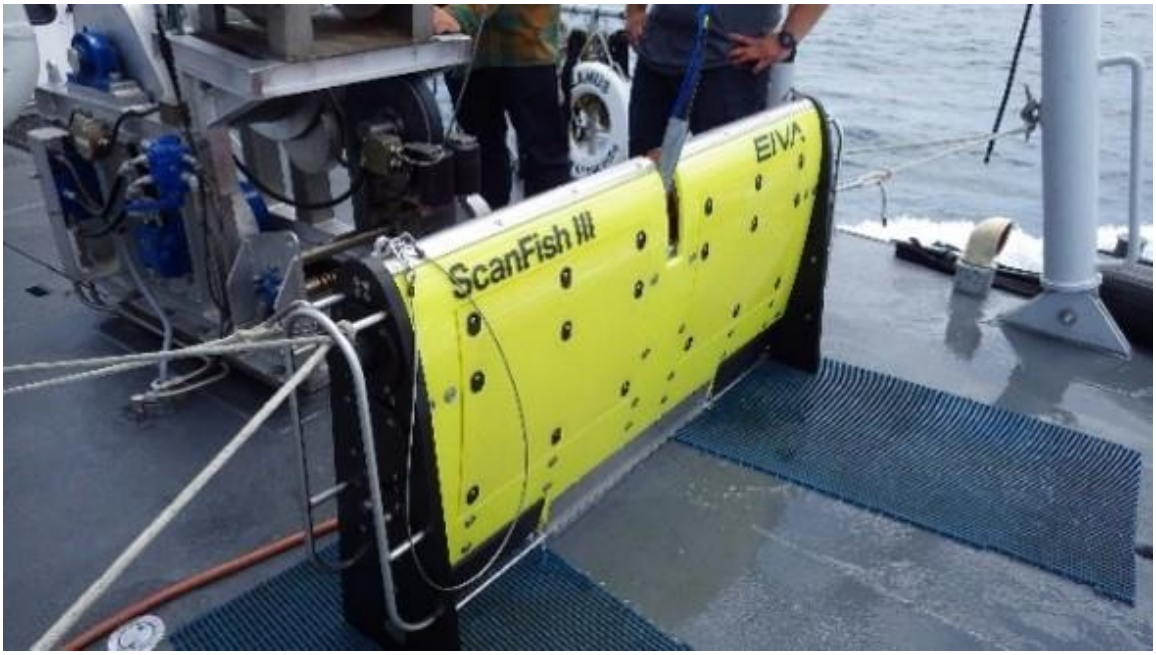

Figure 1.

The ScanFish III is a high performance ROTV, fitted with a CTD and a range of other sensors to aid in the understanding of physical and biological oceanographic processes.

MATERIALS & METHODS

Remotely Operated Towed Vehicle (ROTV) - ScanFish III

The ScanFish III is a high performance ROTV (Figure 1), fitted with a CTD and a range of other sensors to aid in the understanding of physical and biological oceanographic processes. It is towed behind a vessel at approximately 8 knots and undulates from the near surface (~4 m) to within a few meters (~5 m) of the sea bed, down to a maximum water depth of 150 m. The vertical ascent/descent rate can be controlled to ensure that each undulation covers a predetermined horizontal distance, regardless of water depth. Undulating profile data (including temperature, conductivity, and dissolved oxygen) are collected in real time and sent to the vessel via a conductive cable that feeds data and parameters back to proprietary 'NaviPac Software', which is operated by an onboard technician.

City staff have been working closely 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. Furthermore, City staff have participated 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. These trainings ensure that City scientists are fully prepared to control the movement of the ScanFish while underway, and to display and store the data from each sensor in real-time.

Study Design

City staff will deploy, operate, and evaluate the ScanFish III ROTV to determine its effectiveness in tracking wastewater plume dispersion in the San Diego outfall regions. The primary objective of this pilot study is to compare towed CTD measurements from the Scanfish to traditional fixed grid vertical-profile CTD-based water quality monitoring. This will involve deployment of the ScanFish III ROTV in parallel with the deployment of traditional CTD casts, to ensure comparable conditions are sampled.

During each quarterly sampling in 2020 (i.e., February, May, August, November), one City vessel will conduct standard vertical casts using a Sea-Bird SBE 25-Plus outfitted with a conductivity, temperature, and depth instrument (CTD) at 33 PLOO stations (F04-F36) over three consecutive days (Figure 2). All stations located along the 100 m depth contour (stations F26-F36) will be sampled on the first day; all stations located along the 60 m depth contours (F04-F14) will be sampled on the second day; and all stations located along the 80 m depth contour (F15-F25) will be sampled on the third day (Figure 2; see also City of San Diego 2019). The order of sampling is predetermined by existing commitments to the Bight '18 water quality sampling regime.

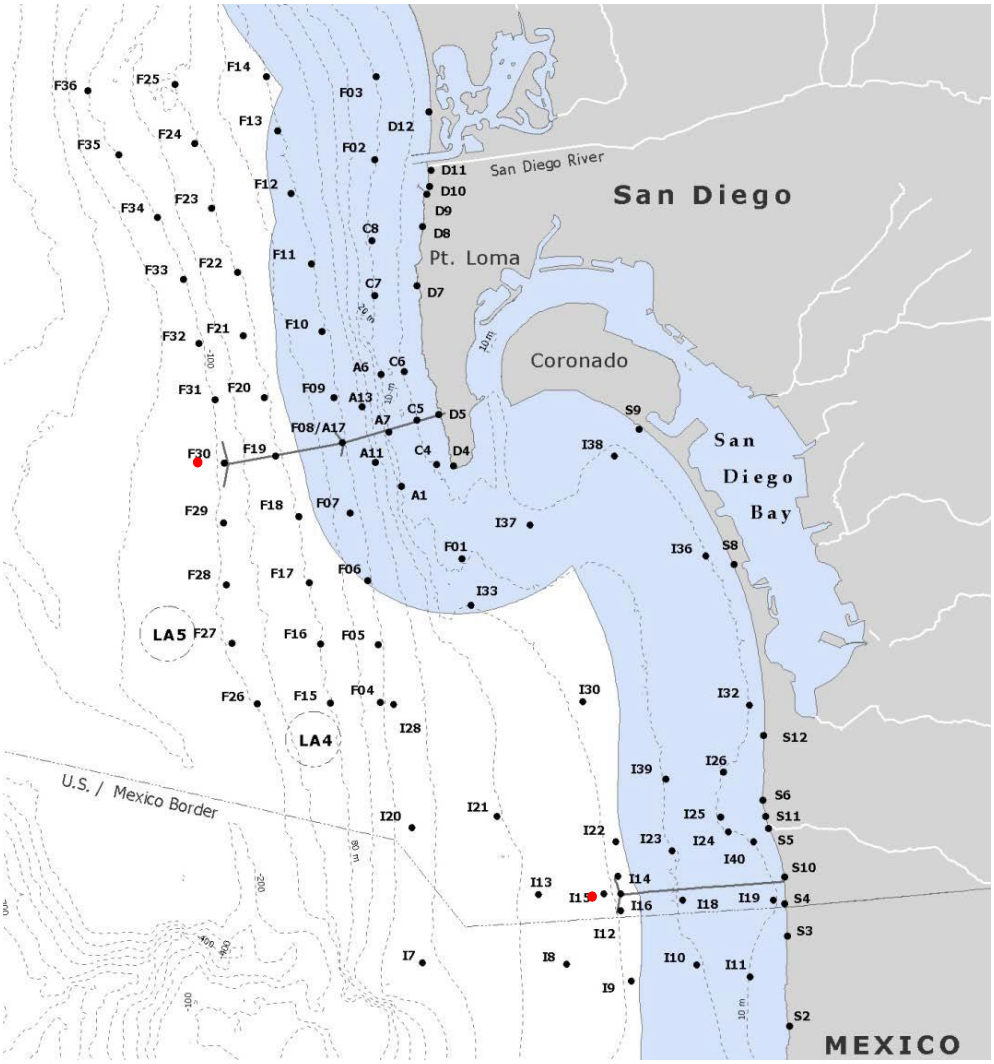

Figure 2.

Map showing approximate locations of Point Loma Ocean Outfall (PLOO) and South Bay Ocean Outfall (SBOO) real-time moorings (red circle) along with regular water quality monitoring stations for both regions (black circles). 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.

The CTD will be lowered through the water column at each station to collect continuous measurements of water temperature, conductivity (used to calculate salinity), pressure (used to calculate depth), dissolved oxygen (DO), pH, transmissivity (a proxy for water clarity), chlorophyll a fluorescence (a proxy for phytoplankton), and colored dissolved organic material (CDOM; a potential plume tracer). This is the current approach being employed to assess plume dispersion around the Point Loma and South Bay Outfalls (Figure 3).

In conjunction with the first quarterly sampling event described above, a second vessel fitted with the ScanFish III will survey the entire PLOO region along 100, 90, 80, 70, and 60 m transects. Initial testing will limit the ScanFish to a maximum depth of 60 m to ensure safe operation. A greater range of depths may be surveyed in subsequent trials, based on positive results from prior testing (see Table 1). Transects will start and end at locations parallel to fixed grid station locations (Figure 2). Upon assessing the outcome of the first quarter ROTV testing, the City's Ocean Monitoring Team will reevaluate the number of transects necessary for subsequent surveys in 2020 (Table 1). Additionally, upon evaluation of the ROTV operations along the shallower depth contours, the City's team will determine the practicality and safety of conducting a comparable sampling regime in the SBOO region in May 2020.

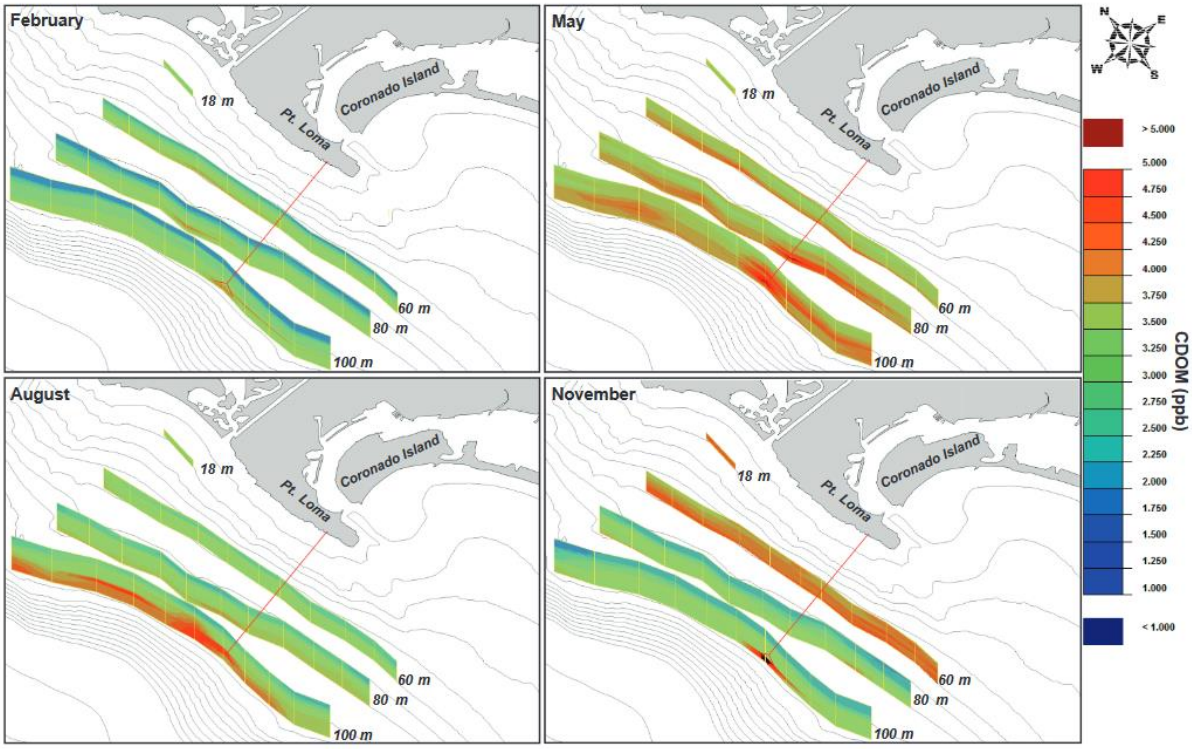

Figure 3.

CDOM values from traditional CTD casts recorded in the PLOO region during 2015. Data were collected over 3–5 days during each of these surveys.

Data Analysis

Data will be downloaded from the ScanFish III and visualized in the NaviModel software. NaviModel offers high-performance digital models in 2D and 3D to visualize datasets. The software makes it possible to compare data both spatially and temporally. All data collected will be subject to the same QA/QC controls currently being utilized for data collected via traditional CTD casts. Using NaviModel software, the resultant plume map produced will be compared with that produced from data collected by traditional CTD casts. Maps will be compared to assess how accurately and precisely they predict plume dispersion. Furthermore, data collected from ScanFish transects at different depths will be compared to one another to assess changes in plume dispersion across depth gradients to determine the appropriate distance at which future transects should be conducted from one another. Final data analyses will focus on identifying the major differences in how the data obtained from the ScanFish III compares with that of traditional CTD casts and, thus, how effectively these two methods can predict wastewater plume dispersion.

If the results of the above studies highlighted here indicate that the PLOO and SBOO wastewater plumes can be detected more consistently and with greater accuracy using the ScanFish III 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 work 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 wastewater plumes. If such triggers can be identified, the ScanFish III may then be used to quickly survey the area of concern in order to more effectively track and monitor plume behavior and dispersion during such events.

PROJECT SCHEDULE

A projected schedule of key activities for this pilot study is given below in Table 1. Sampling will be conducted on a quarterly basis, and the specifics of the sampling strategy will be amended according the outcomes of each quarterly testing cycle. Specific attention will be paid to the practicality of deploying the ScanFish equipment in shallow waters to assess feasibility for conducting sampling in the SBOO region from May onwards.

Table 1.

Tentative schedule for ScanFish III Transects in the PLOO and SBOO regions during 2020.

<table>
<tr><th>Date</th><th>PLOO</th><th>SBOO</th></tr>
<tr><td>February 2020</td><td>100m ScanFish Transect
90m ScanFish Transect
80m ScanFish Transect
70m ScanFish Transect
60m ScanFish Transect

Aim to conduct all transects shown above in a single day, and repeat over 3 days, while CTD casts are conducted in the same area.</td><td>No Sampling</td></tr>
<tr><td>May 2020</td><td rowspan="3">Repeat all or portion of February sampling each quarter depending on results of initial plume analysis.</td><td>Begin testing in SBOO region, if results from PLOO transects are successful and can be safely replicated.</td></tr>
<tr><td>August 2020</td><td rowspan="2">Further testing to be determined by the outcome of SBOO transects in May.</td></tr>
<tr><td>November 2020</td></tr>
</table>

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

City of San Diego. 2018. Plume Tracking Monitoring Plan for the Point Loma and South Bay Ocean Outfall Regions, San Diego, California. Submitted by the City of San Diego Public Utilities Department to the San Diego Water Board and USEPA, Region IX, March 28, 2018 (approved 4/25/2018).

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

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), or Dr. Ryan Kempster (RKempster@sandiego.gov) / City of San Diego Ocean Monitoring Program, Public Utilities Department, 2392 Kincaid Road, San Diego, CA 92101