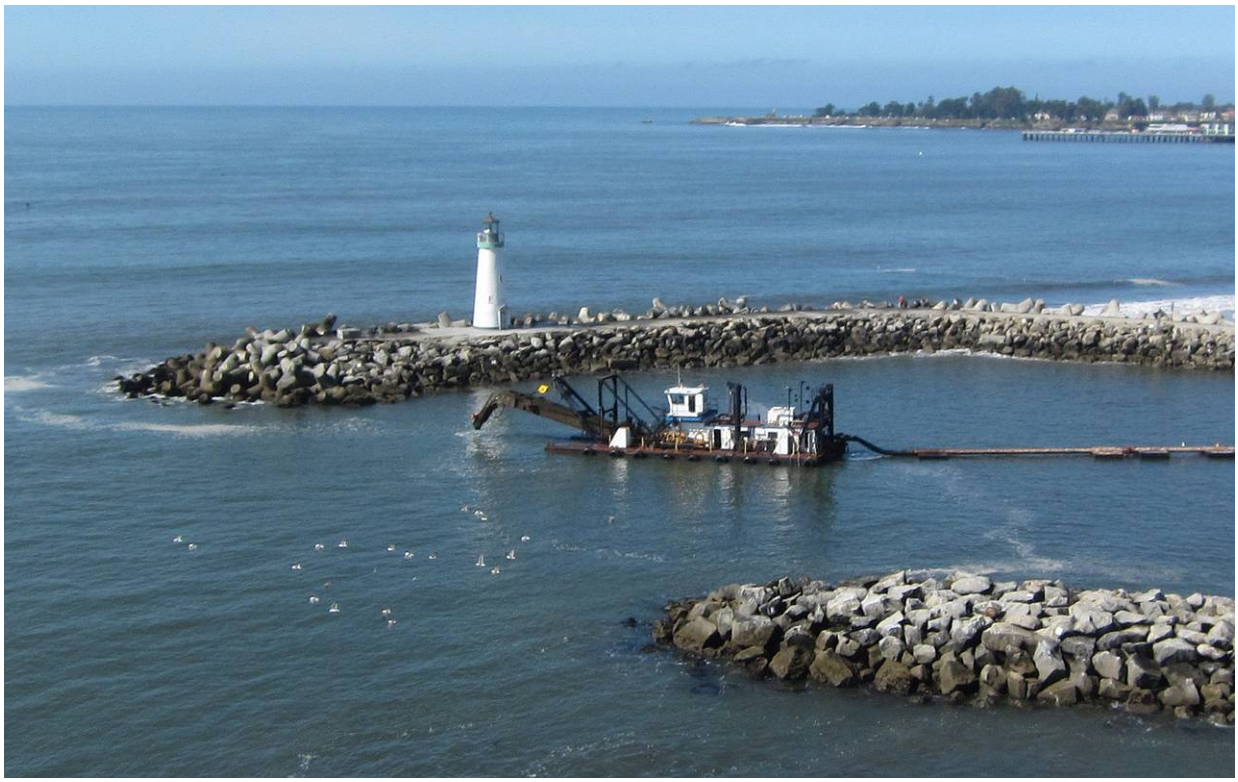
SANTA CRUZ HARBOR

DREDGING & DISPOSAL OPTIONS STUDY (Phases 1 & 2)



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December 2011

M&N Job No: 7394

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December 21, 2011

Marian Olin
Santa Cruz Port District
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Subj: Final Report
Dredging and Disposal Options Study – Phases 1 & 2
M&N File No: 7394

Dear Ms. Olin:

We are pleased to provide you with the Final Report for the subject study. It has been a pleasure working with you and the District on this project, and we appreciate the opportunity to provide our services to the Port District.

We look forward to assisting the District on this or other projects in the future. Should you have any questions on the report, please contact me.

Sincerely,

MOFFATT & NICHOL

Dilip Trivedi, Dr.Eng., P.E
Principal / Project Manager

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1. INTRODUCTION

1.1 Background

This report provides a review of the current dredging/disposal practices at Santa Cruz Harbor, a survey of other harbors with similar characteristics as Santa Cruz Harbor, and an assessment of other potential options that could be implemented to augment or modify current practices. The objective of this study is to determine whether feasible and cost effective alternatives exist to maintain the Federal entrance channel and berths to its design and optimum navigable depths, while minimizing odorous sulfide releases and equipment operations and infrastructure on the east beach. A key aspect of the overall study was to gather information on the dredging and disposal practices at other similar harbors/marinas and compare them to those at Santa Cruz, and determine if viable options exist..

Santa Cruz Harbor is located at the northern end of Monterey Bay as presented in Figure 1. The Harbor has been in operation since 1964; the US Army Corps of Engineers maintained navigation via frequent dredging, but high sedimentation rates prevented year-round navigation access. In 1986, dredging practices changed, with the Port District maintaining year round access using its own dredge acquired in a joint venture between the Port District and U.S. Army Corps of Engineers. Due to the high rate of longshore transport from west to east, sand moves around the tip of the west jetty and deposits within the harbor entrance. The Santa Cruz Port District (District) dredges the channel and places material in the specified disposal zone east of the harbor on the beach or in adjacent nearshore and offshore areas, where the sand would have deposited in the absence of the harbor. This annual dredging is typically referred to as *bypassing,* which is a means to restore natural sand transport around an inlet. This is not unlike many other marinas, harbors or ports around the world, including several along the California coastline.

The District uses its two dredges to maintain the inner harbor and the entrance channel. However, the entrance channel sediment frequently contains decomposing organic material that can emit hydrogen sulfide (H_2S) gas, which has led to challenging issues related to nuisance odor. Local odor complaints resulted in a Health Consultation by the U.S. Department of Health and Human Services (2007), which found that there were no associated health risks. In response to complaints, however, the Monterey Bay Unified Air Pollution Control District issued a Hydrogen Sulfide Nuisance Prevention Protocol permit. The Port District's operational practices for placing sand directly on the east beach have been impacted by this permit protocol. The Santa Cruz Port District must now operate under strict emission limitations imposed by the Monterey Bay Unified Air Pollution Control District permit.

These limitations due to H_2S nuisance-level odor have significantly influenced operational practices and costs for by-passing sediments dredged from the harbor entrance. A method to dispose material in the nearshore (surf zone) minimizes H_2S emissions. The District has devised methods to address this issue by disposing material in the nearshore environment, below the tide line, because H_2S is water soluble. However, this requires anchoring operations by the Port workboat in the surf zone which can be risky depending upon surf conditions. This practice also does not place the sand immediately on the beach, which is optimal for beach replenishment. The District's operational practice is to place materials that are lower in sulfides directly on the beach, and to switch to offshore disposal when excessive sulfide emissions occur. Thus the District needs to carefully monitor air emissions during the dredging operations. In practice, air monitoring requires additional personnel and costs for the dredging operations and also results in frequent shutdowns of beach disposal for all day as required by the permits. Dredging operations thus are less efficient.

These methods have been implemented over the past several years with regulatory approvals for the dredging and disposal practices. At the same time, year-round safe passage for vessels in the entrance channel has been maintained for the most part. However, in light of the sensitive marine resources and public use of the beach, the State Coastal Commission asked the Port District to have its dredging and disposal practices evaluated by external experts, particularly the issues related to disposal practices associated with annual dredging. The District has also prepared several monitoring and marine resource evaluation studies to demonstrate that ongoing practices are not detrimental to the environment, and has also substantially modified its disposal strategy in recent years.

1.2 Purpose

The primary objectives of this study are to review the District's current entrance channel dredging and disposal practices, compare them to an industry standard by surveying other similar harbors, evaluate the benefits and potential adverse effects of its current practices, and explore potential alternatives to District's dredging/disposal practices.

1.3 Scope of Work

The Scope of Work for this study includes the following tasks:

1. *Review Santa Cruz Port District's Current Practices.* This task includes a review and assessment of current dredging/disposal practices at the harbor and regulatory requirements (dredging costs, regulatory oversight, and impacts on public use of beach and on marine resources).
2. *Survey and Review Dredging/Disposal Practices near Urbanized Areas for Other Harbors.* This task included conducting a survey of dredging/disposal practices at other harbors or marinas in an urban setting that have oceanographic conditions similar to Santa Cruz Harbor, and objectively compare Santa Cruz's current dredging and disposal practices to the other surveyed harbors.
3. *Identify and Evaluate Potential Modification Options to Current Practices.* This task includes identifying and evaluating potential modifications to current practices to reduce adverse effects on recreational and marine resources, and to improve efficiency and performance.

2. SUMMARY OF EXISTING CONDITIONS

The objective of this task is to review the dredging and disposal practices at Santa Cruz Harbor by meeting with District staff to summarize operational conditions, the location and occurrence of kelp and other fine grained material, and operational challenges associated with timing and location of dredging and disposal. In addition, dredging permit conditions from various agencies for Santa Cruz Harbor were reviewed and are summarized in this section.

One of the first steps to accomplishing the review is to understand the physical processes that drive the movement of sediments by using local knowledge and prior studies, and to evaluate the distribution and transport mechanism by which the source organics (kelp) enters the entrance channel sediment.

2.1 Physical Setting

Santa Cruz Harbor is located at the northern end of Monterey Bay, about 70 miles south of San Francisco. Due to its orientation, shoreline locations are exposed to varying degrees to waves arriving from several directions. The harbor is situated in an area of relatively high net littoral transport (between 300,000 and 500,000 cubic yards per year from west to east). This transport is the primary contributor of sand to the harbor entrance (USACE 1992).

The Harbor is designated by the State of California and by the federal government as a "harbor of refuge," which means it serves mariners needing to find safe haven from storms or from other emergency circumstances they experience at sea. Therefore, its mission is to provide a year round, useable and safe channel for transit in and out of the harbor for recreational, commercial traffic, and marine rescue service purposes.

The harbor, including the jetties and harbor entrance channel, was constructed in 1963 as a partnership between the US Army Corps of Engineers and the Port District. Since jetty construction, sand accumulates annually west of the west jetty (forming Seabright Beach), effectively becoming a sand trap area (see Figure 2). The downcoast beach (Twin Lakes Beach, see Figure 3) does not receive the sand that would otherwise move there, and annual bypassing is performed by the District. The sediment is allowed to come into the entrance channel and then dredged by the District's hydraulic dredge. Bypassing of the harbor entrance is essential to the maintenance of harbor facilities, as well as for the protection of the adjacent Twin Lakes State Beach, County roads and residential properties from damage by beach erosion.

The Inner harbor is also dredged periodically, but the sediment source is primarily upland from the local watersheds (Arana Gulch), and as such consists of a higher percentage of fine-grained sediment compared to the entrance channel. The San Lorenzo River, which is upcoast (west of harbor entrance), also contributes a significant amount of sediment including organics and debris to the entrance channel that affects the ability to bypass sand to the downcoast beaches.

Offshore, the Monterey Bay coast is a mix of sand and rocky habitats, including major kelp beds. The Santa Cruz Harbor is located adjacent to the Monterey Bay National Marine Sanctuary, which includes expansive kelp forests (see Figure 4). Although some individual kelp can persist for up to three years, the overall structure of the kelp forest is very dynamic. Kelp canopy cover varies seasonally. It is thickest in late summer and thins or disappears in winter when large swells and old age combine to remove weakened adults. Some of this kelp is then washed up along the shoreline, including within the harbor entrance and thus becomes the source of kelp detritus in the dredged material. During the following spring, the next

generation of kelp takes advantage of the thin canopy cover and increase in available light to grow rapidly.

Observations of terrestrial and marine organic debris from the river, in the coastal waters, and on nearby beaches were made during a major storm on March 24-25, 2011, including material that was transported downcoast from the sediment trap area (Seabright Beach). A more detailed summary of these observations are included in Appendix A. This storm raised the stage of the San Lorenzo River from a base flow of less than 70 cubic feet/sec to 10,000 cubic feet/sec and was discharging water laden with sediment, trees, timber, brush and other terrestrial debris into the coastal waters. The storm was accompanied by high surf which transported both terrestrial and marine organic matter along the beaches and presumably into the harbor entrance. The waves also cut a considerable amount of sand from the downcoast beach, most notably from immediately downcoast of the east jetty. Materials thrown over the breakwater from the upcoast sand trap area were predominantly of marine origin heavy with sea grasses and algae. The debris on the downcoast beach also was heavily of marine origin, containing a lot of kelp and other marine algae. Presumably, these observations are indicative of the organic materials that entered the harbor entrance along with sand from the upcoast area.

2.2 Coastal Processes

The harbor is exposed to Northern Hemisphere swell, Southern Hemisphere swell, and seas generated by local winds, which result in a high net littoral transport. Because the harbor is sheltered by Point Santa Cruz to the west and by Point Cypress at the south end of Monterey Bay, waves arriving at the harbor entrance have refracted considerably, with most waves arriving at the site from the southwest (between 200 and 230 degrees) with heights significantly reduced from their deep water values.

The nearshore area is located within the boundary of the Monterey Bay National Marine Sanctuary (MBNMS). The beach areas adjacent to the mean high water line are either Port District property or state (Twin Lakes State Beach), which is owned and managed by the California Department of Parks and Recreation with a permit for use issued to the Port District. The Port District leases tidelands and submerged lands from State Lands.

The Santa Cruz Small Craft Harbor lies within the Santa Cruz littoral cell, which extends from Pillar Point in Half Moon Bay south to the Monterey Bay submarine canyon. The majority of sediment enters the littoral cell through major rivers and local tributaries during winter rainstorms occurring primarily from November to March. While the absolute values for sediment sources, sediment sinks, and sediment transport rates are not fully understood, researchers agree that there is a net deficit of sand in the system (Sea Engineering and Moss Landing Marine Laboratories 2008).

Nearshore sediment transport in the northern Monterey Bay is driven by waves and wave induced currents (M&N 1978, USACE 1992). Sediments entering the ocean are sorted by the forces of waves and currents based on differences in grain size, density, and shape. Sediments larger than 180 microns travel in the littoral drift, or are deposited on beaches in the Santa Cruz area. Fine clay and silt sediments are transported offshore to the continental shelf, where they are deposited in abundance along a mid-shelf mud belt. The high-energy nature of the coastline (especially in the winter months from November to April) is of sufficient magnitude to suspend the majority of silt and clay sediment delivered to the study area.

The primary sediment transport direction is southeastward past the harbor because the primary source of waves is from the northwest (Northern Hemisphere swell). During January,

February, and March, local seas tend to cause a reversal, similar to that found for the Southern Hemisphere swell, but of significantly weaker magnitude (M&N 1978).

USACE (1992) cites several previous studies which developed estimates of sediment transport; these ranged from 61,500 to 500,000 CY per year. Recent estimates indicate that an average of approximately 262,000 CY of sand is transported southeastward past the Santa Cruz Harbor every year as littoral drift (Sea Engineering and Moss Landing Marine Laboratories 2008). Much of this deposits within the entrance channel. Other modes of shoaling are via leakage through voids in the entrance channel jetties, wind transport over the jetties, and seasonal influx. These have been estimated to be 13,000 CY, 7,000 CY, and 10,000 CY per year, respectively (USACE 1992). The sum total of sediment input to the harbor entrance is nearly 300,000 CY per year. About 80% of this shoaling occurs between December and April.

A review of survey records provided by the District shows that between May and November of 2010, the entrance channel shoaled by about 4 feet. However, a single 12 day period between December 14th and 26th resulted in shoaling of 5 to 10 feet within the entrance channel, which resulted in closure of the entrance channel for a brief period until depths were restored by dredging. Discussions with Port staff also confirmed that individual storm events between December and April have a high transport potential. Therefore, dredging activities have to continue through the winter as opposed to a one-time dredge episode for the entire entrance channel.

2.3 Dredging and Disposal Operations

The current dredging system (Figures 5 through 8) for the harbor entrance consists of a floating hydraulic dredge system that is owned by the Santa Cruz Port District. It has operated since 1986, from November to April of each year by Port District crew. During the most recent 10-year period, dredge volumes have averaged approximately 270,000 cubic yards per year. Current permits authorize dredging of the entrance channel to a design depth of 22 feet below mean lower low water (MLLW).

Dredged material from the harbor entrance and federal channel is primarily disposed onto the beach east of the harbor or in the adjacent near shore area. Sediments dredged from the harbor entrance and inner harbor differ in composition and presence of organic material. Materials dredged from the entrance and channel are typically composed of material with a content of 80% or greater sand. Decaying organic material (kelp and sea-grass) also is found in these sediments, which can produce unpleasant odors because of the release of H_2S as it decays. When the dredged material consists of coarse sand that is free of organics, it is placed higher up on the beach to increase the usable recreational beach. Onshore disposal occurs on the beach (dry zone) or below the surf line (within the surf zone) along Harbor Beach and Twin Lakes State Beach (Figure 8) from the east harbor jetty to approximately 12th Avenue. Additionally, the Port District, when asked by the County of Santa Cruz or State Parks, will re-supply the beach with sand if severe storms threaten 7th Avenue or East Cliff Drive.

However, in order to protect against odor emissions, even in predictably organic-free sand, the Port District discharges sandy material in the surf zone and nearshore sites over 98% of the time (SC Port District 2010). This often requires use of a tractor to push sand up on the receiving beach. The surf zone and nearshore disposal allows the water-soluble H_2S sufficient residence time to off-gas underwater. Nearshore disposal extends approximately 200 feet seaward of the water line, by use of an unanchored disposal pipeline. Dredged material is pumped through a submerged 16-inch pipe that runs most of the length of the harbor and then

along a 1,500 foot stretch of beach from the east harbor jetty to 12th Avenue. Current practice is to have most of this pipe buried in the sand along the upper beach with the flexible end moved by a bulldozer to access different points on the beach as necessary for sand placement. A second line controlled by valves goes out along the eastern breakwater and out to a buried anchor submerged offshore in the surf zone for nearshore placement. This movable flexible pipeline is stored at the base of the beach beneath East Cliff Drive roadway. Various discharge points between 5th Avenue and 12th Avenue can be accessed to best utilize wind, wave and tide conditions.

From 1997 to 2007, surfzone and nearshore disposal occurred via an unanchored pipeline traversing the beach and surfzone east of the Harbor at Twin Lakes Beach, to a location approximately 70 yards from the shoreline. The District also maintains an anchored offshore discharge line off the beach, but safety issues related to tending the pipe, the pipe burying itself, pipeline breakages, and shoaling of offshore areas including the navigation channel prevent the pipe from being continuously offshore. In December 2006, the California Coastal Commission approved the multiple pipeline configuration which formalized the disposal practices which had historically occurred between the east harbor jetty to 12th Avenue. A drawing depicting various disposal options for this pipeline is provided in Appendix B. Each of the three configurations allow multiple discharge points. Only one pipeline configuration and discharge point was in use at any one time. The pipes could be pushed directly into the ocean approximately 200 feet seaward, thereby accomplishing the H_2S suppression. The reconfigured offshore pipelines were not to be anchored to the seafloor, but were installed and pushed into the water on a daily basis. The discharge point is monitored and adjusted throughout each day of operation to ensure adequate water depth.

The purpose of this pipeline configuration is to provide the Port District with the flexibility to respond quickly to changing oceanographic conditions to reduce the amount of beach discharge to a minimal amount in order to comply with the Air Board's hydrogen sulfide protocol. In addition, these non-anchored pipelines were able to place sediment where it would reduce the opportunity for material to re-enter the harbor mouth, which has been a problem periodically with the anchored offshore disposal pipeline placed immediately east of the jetty. Finally, this configuration eliminates the downtime caused by the anchored pipe being constantly buried by its own heavy sand discharge.

The dredging operation requires the Port District to operate a D5-type tractor on Harbor Beach and on Twin Lakes State Beach to position and maintain the discharge pipes. The District also operates the tractor on the beach to: 1) protect the existing, permanent discharge pipe, 2) establish a discharge zone for onshore disposal at Harbor Beach, and 3) push sand to the upper beach after placement near the tide line, and 4) create a flow line for storm drainage from Schwann Lagoon as needed. The Coastal Commission has cited concerns that tractor operations can cause intermittent, temporary disruption to coastal access for pedestrians, swimmers, and/or surfers.

2.4 Monitoring of Hydrogen Sulfide Emissions / Odor

The Monterey Bay Unified Air Pollution Control District (MBUAPCD) has set a nuisance prevention protocol for discretionary dredging of 10 ppb H_2S on a 1-hour rolling average in the air at the boundary of the beach downwind of the discharge point, in response to complaints by neighbors about odor. If, during disposal operations, the 1-hour rolling average exceeds 10 ppb, surf zone disposal must shut down for the day, but may resume using the offshore disposal pipe. A shutdown can also occur if the emissions exceed the state's nuisance level of 30 ppb on a 1-hour rolling average. If the beach zone discharge is stopped as a result of either of the two situations mentioned, monitoring shall continue until the readings are below 10 ppb

rolling average and stay there for at least 10 minutes. If the beach discharge is terminated due to exceeding H_2S levels, the harbor district must contact the air district by fax, informing them of the termination, and include the following details: the readings that triggered the termination, the times the levels were exceeded, the time when beach discharge flow actually stopped, and all readings occurring until they returned to below 10 ppb. The District has two people on the beach with special, low-detection-limit handheld sensors linked to a computer by radio in the lifeguard stand with a third person to monitor air quality for hydrogen sulfide continuously while the dredge is in operation. Operations are frequently shut down when they hit hot spots in the harbor entrance that typically produce hydrogen sulfide emissions in excess of protocol or nuisance level limits.

The MBUAPCD permit also provides for an emergency declaration, which allows hydrogen sulfide emissions up to the state nuisance standard of 30 ppb for a one-hour rolling average. If that were to occur, the District must notify the MBUAPCD that an emergency situation exists (e.g., shoaled entrance conditions or other emergency situation), and that dredging will be performed under emergency provisions of the District's permit.

2.5 Summary Of Permit Conditions

Santa Cruz Harbor, under a 1986 Memorandum of Agreement with the U.S. Army Corps of Engineers, has maintained channel depths in the federal navigation channel using jointly-acquired dredging equipment. Entrance dredging and/or disposal require permits or authorizations from:

- U.S. Army Corps of Engineers / U.S. Environmental Protection Agency
- California Coastal Commission (CCC)
- California Regional Water Quality Control Board (RWQCB)
- State of California Department of Parks and Recreation
- Monterey Bay Unified Air Pollution Control District (APCD)
- Monterey Bay National Marine Sanctuary - The MBNMS does not regulate dredging, but the disposal of dredged materials into the Sanctuary is subject to MBNMS authorization.

Permits differ in their emphasis, but generally the Port District is permitted to place dredged sediment east of the harbor, onto the beach or in the surfline (underwater), or at permitted upland disposal sites. The limit on entrance volume is 350,000 CY per year (CY/yr) and the majority of the sediment must have a minimum 80% sand content. This volume has been exceeded only once (2009-2010). There is currently a 10,000 CY/yr limit on inner harbor sediment with 80+% sand content, and a 3,000 CY limit on fine-grained material (50% to 79% sand content), though permits that increase annual volume but restrict the daily disposal rate of fine-grained material are pending. If additional disposal capacity is needed, the permit also allows up to 35,000 CY/yr of upland disposal at other permitted site(s).

Since the entrance channel sediment is mostly sand, the amount of sediment characterization is typically limited to physical (grain-size) tests on surface grab samples. As a result, very little data exists on the depth and pattern of organics, which is the primary cause of the H_2S issue when placing the material on the beach.

A summary of the entrance dredging and disposal restrictions and allowable construction window (timing) from these permits is provided below in Table 1 (Strelow 2009 and PN 2010-00015S).

Table 1A. Permit Conditions Summary

Agency	Permit Conditions Relevant to Study	Timing
USACE	*Starting in the 2011-2012 season, permit modifications based on conditions described in USACE's Public Notice, and as summarized in Table 1B and Table 1C, is anticipated*	*See Table 1B and 1C below*
CCC	*A 5-year Coastal Commission permit with the same conditions as included in the USACE's public notice referenced above is pending*	*See Table 1B and 1C below*
CA RWQCB	Similar to USACE for entrance material. Inner harbor same as Coastal Commission.	No conditions
Dept of Parks and Recreation	Allows disposal of dredged Harbor materials onto portions of Twin Lakes State Beach through a surf line pipeline and for the temporary placement of related dredging equipment over portions of Twin Lakes State Beach. Incorporates provisions of Coastal Commission permit.	No disposal on Twin Lakes State Beach 1 week before and 1 week after Easter
APCD	Places limits on hydrogen sulfide emissions	During disposal
MBNMS	Provides consultation to USACE and restricts placement within Sanctuary limits defined disposal zone.	November 1 to April 30

Table 1B. USACE Permit Condition Summary for Federal Entrance Channel Dredging

Project Description

Dredge Santa Cruz Harbor federal entrance channel per 1958 legislative authority, and 1986 Cooperative Agreement between USACE and Santa Cruz Port District. Authorized depth ranges from 20-ft below MLLW near mouth to 15-ft below MLLW near the fuel dock. An additional 2-ft of overdepth is also allowed.

Material Classification:

Sandy (80% sand or greater)

Volume and Disposal Area Restrictions:

2,560,000 CY over 10 year's total. Disposal restricted to Nearshore Zone (littoral zone and on beach between East Jetty and 9th Avenue)

Disposal Timing Restrictions:

November 1 through April 30 of each year

Table 1C. USACE Permit Condition Summary for Inner-Harbor Dredging

Project Description:

Dredge North Harbor (Murray St Bridge to Arana Gulch culverts) and South Harbor (fuel dock to Murray St Bridge). Authorized depth ranges from 15-ft below MLLW near the launch ramp to 10-ft below MLLW further north, except immediately in front of Arana Gulch culverts where it is 16-ft below MLLW. An additional 2-ft of overdepth is also allowed.

Material Classification:

Varies based on location and timing, including:

- Type A (80% or greater sand)
- Type B (less than 80% sand)

Volume and Disposal Area Restrictions:

550,000 CY over 10 years total, with following additional restrictions:

- Nearshore Zone
    - Up to 20,000 CY/yr of Type A material, or
    - Up to 10,000 CY/yr of silts/clays + 10,000 CY/yr of sand, at a rate not more than 550 CY of silts and clays per day
- Upland (any permitted site) or Offshore (SF-14)
    - Up to 35,000 CY/yr (material restrictions based on disposal site permits)

Disposal Timing Restrictions:

- Nearshore Zone
    - November 1 through April 30 for Type A material
    - October 1 through February 28 for Type B material
- Upland (any permitted site) or Offshore (SF-14)
    - Dredging restricted to November 1 through April 30 for Entrance Channel
    - Dredging restricted to July 1 through April 30

3. SURVEY OF OTHER HARBORS / MARINAS

3.1 Survey Method

An initial task of this study was to conduct a survey of dredging/disposal practices at other harbors or marinas in urban settings that have oceanographic conditions similar to Santa Cruz Harbor.

Several marinas/ports/harbors in California which have jettied entrances, and known bypassing projects were contacted, and a Survey Questionnaire was sent to their representatives. The objective of the survey questionnaire was to gather information including dominant coastal processes, dredging demand, and dredging/disposal practices at these marinas/harbors, such that their dredging and disposal practices could be compared to the practices at Santa Cruz Harbor. The primary questions addressed the following criteria:

1. Coastal harbor providing year-round berthing for vessels at least 12' in draft
2. Near urbanized areas
    - Proximity to residential areas
    - Proximity to recreational/visitor-serving areas
3. Surrounding beaches subject to littoral drift and erosion
    - Beach nourishment required
    - Bluff erosion or other potential threat(s) to structures and resources
4. Channel depth maintenance method(s)
    - Recurring dredging/disposal
    - Permanent mechanical system (e.g. sand bypass)
    - Passive/structural system (e.g. jetties)
    - Ancilliary equipment used in operation
5. Dredging and disposal required
    - Frequency of dredging needs / volume dredged
    - Dredging/disposal regulated
6. Type of regulation if not in California, or lack of regulation (i.e. water quality, air quality, National Marine Sanctuary, Fish and Wildlife, etc.)

The results of the survey have been provided in Appendix C to this report, and a summary of the results is shown in Table 2. The table is coded based on the similarities (or differences) between the specific harbors/marinas and Santa Cruz Harbor. No shading or border indicates that the other harbor/marina has very similar conditions, dredging, and/or disposal practices as Santa Cruz Harbor. A shaded box with a dashed border indicates a partial similarity and a shaded box with a bold border indicates dissimilarity.

	Santa Cruz Harbor	Harbor/Marina (Listed from North to South Along California Coast)											Tweed Harbor, Australia
		Morro Bay Harbor	Santa Barbara Harbor	Ventura Harbor	Channel Islands Harbor	Port of Hueneme	Marina Del Rey	King Harbor	Newport Harbor	Dana Point Harbor	Oceanside Harbor	Mission Bay	
Coastal harbor providing year-round berthing for vessels at least 10' in draft	*yes*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Jettied entrance channel	*yes*	yes	yes (attached breakwater)	yes (and detached breakwater)	yes	yes	yes (and detached breakwater)	yes (attached breakwater)	yes	yes (attached breakwater)	yes	yes	yes
In close proximity to residential area	*yes*	partially	yes	yes	yes	no	yes	yes	yes	yes	partially	yes	yes
In close proximity to recreational/visitor serving area	*yes*	yes	yes	yes	yes	partially	yes	yes	yes	yes	yes	yes	yes
Surrounding beaches subject to littoral drift and erosion	*yes*	no (littoral drift is bi directional, only have seasonal erosion)	yes	yes (upcoast beach)	yes	yes	yes	yes	yes	yes	yes	no (San Diego River feeds downcoast beaches)	yes
Entrance channel depth maintenance method	*recurring dredging*	recurring dredging	recurring dredging	recurring dredging	recurring dredging, entrance sand trap	recurring dredging	recurring dredging	recurring dredging	recurring dredging	recurring dredging	recurring dredging	recurring dredging	permanent sand bypassing, (following initial dredging)
Entrance channel dredging frequency	*annually*	annually	annually	annually	every two years	> 20 years	3-5 years	> 10 years	> 10 years	> 10 years	annually	> 20 years	year-round
Entrance channel dredge volume (cubic yards)	>200,000	80,000-140,000	>200,000	>200,000	1,000,000	<80,000	140,000-200,000	<80,000	<80,000	<80,000	140,000-200,000	>200,000	>200,000
Dredge material placed on downcoast beaches	*yes*	yes (placed on beaches both to north and south of harbor)	yes	yes*	yes	no (dredge material placed in CAD site); but CAD site material went to downcoast beach	yes*	yes	entrance channel material disposed offshore; inner bay mat'l placed on beach	yes*	yes	no (placed on upcoast beach)	yes
Dredge material discharge location on beach	*dry beach and surfzone*	surfzone	dry beach and surfzone	surfzone	dry beach and surfzone (?)	N/A for entrance channel dredge material, but CAD site material went to downcoast beach	dry beach (and nearshore)	surfzone	dry beach (inner bay material - very small quantities)	dry beach	dry beach and surfzone	dry beach	dry beach and surfzone
Odor present during dredge material discharge on adjacent beaches	*yes*	yes	yes	yes	no	N/A	no	no	yes - (inner bay dredge material)	yes	yes	yes	no mention of odor
Type of dredge operation	*hydraulic*	hydraulic, hopper, clamshell, barge-mounted excavator	hydraulic	hydraulic, clamshell, hopper	hydraulic	hydraulic	hydraulic, clamshell	hydraulic, clamshell	clamshell	hydraulic, clamshell	hydraulic	hydraulic	sand bypassing
Type of Permanent Mechanical system (if any)	*none*	none	none	none	none	none	none	none	none	none	none	none	sand bypassing system - intake jetty and discharge pipes network

* and also offshore open ocean disposal and/or other. Ventura Harbor places fine-grain material in Santa Clara River mouth when river flowing.

Key
- Very similar to Santa Cruz Harbor conditions or operations
- Partially similar / relevant to Santa Cruz Harbor conditions or operations
- Not similar to Santa Cruz Harbor conditions or operations

3.2 Survey Results

Twelve harbors/marinas were surveyed to understand their dredging and disposal practices and to glean any potential practices that could be implemented at Santa Cruz Harbor. Many of the surveyed harbors/marinas have dredging and disposal practices similar to Santa Cruz. The primary similarities are:

- Sediment from longshore littoral transport deposits within harbor/marina entrances;
- Harbor/marina entrances need to be dredged on a recurring basis to maintain safe navigational passage;
- Entrance channels are protected by jetties;
- Dredge material is used for sand nourishment on beaches adjacent to the harbor/marina;
- Use of hydraulic dredge equipment.

All of these harbors had similar urban settings and coastal environments to Santa Cruz Harbor. All had jettied entrance channels, significant littoral sediment transport, and the need to frequently dredge their entrance channels to maintain safe navigation. All except one placed the channel dredged material on adjacent beaches, either on the dry beach or within the surfzone. (The one exception was Port of Hueneme which disposed their dredge material at a confined aquatic disposal (CAD) site due to contamination concerns. Material dredged to create the CAD site was deposited on a downcoast beach).

Half of the harbors surveyed dredge their entrance channels on an annual or bi-annual basis. The types of equipment used were very similar for all harbors, with the exception of Tweed River Harbor in Australia, which had a significantly different bypassing operation. In 2001, a permanent sand bypass system that operates year round was constructed near the harbor entrance; it excavates sand upcoast of the harbor entrance via an “intake jetty” (a pier with submerged pumps) and pipes the slurry under the harbor entrance to downcoast beaches. The system is comprised of a 450 meter long “intake jetty” (pier) which collects sand trapped in a depression under the jetty with a series of ten submerged jet pumps. A slurry pit receives the sand slurry and concentrates the sand slurry to the required density. A sand transfer system draws sand from the slurry pit and pumps it through a 400 mm steel pipeline under the Tweed River to one of four outlets along downcoast beaches. The sand discharge system is similar to Santa Cruz Harbor in that it is comprised of a combination of permanently installed and above-ground temporary pipe. The system also provides for moving sand from time to time using trailer suction dredges. The construction cost of the system was $23.3M (in 2001, Australian currency). A paper with further information about the Tweed River Harbor bypass system is provided in Appendix C.

Over time, many of the other harbors (over half) have experienced decaying marine life and/or kelp in their dredge disposal on adjacent beaches, but not on an ongoing basis. Two of the harbors cited the source of odor to be from decaying kelp. Santa Cruz Harbor is unique in that the sedimentation processes over the winter season require continuous dredging (versus a one-time, annual dredging event) and the fact that the odor from decaying marine life is regulated by the Air Pollution Control District.

3.3 Evaluate Current Dredging / Disposal Practice at Santa Cruz Harbor

The objective of this task was to evaluate current and future dredging needs as well as the ongoing disposal practices in light of the findings from the Task 1 survey, and objectively assess benefits (or adverse effects) of current practices. Evaluation criteria for the assessment included:

- Maintaining Santa Cruz Harbor's federal navigation channel to design depths and in the safest condition practical to ensure year-round access and refuge for recreational and commercial vessels.
- Maintaining safe passage year-round for marine rescue service providers,
- Accomplishing beach nourishment to the maximum extent practicable,
- Preserving or enhancing coastal access to the maximum extent practicable,
- Protecting marine resources to the maximum extent practicable,
- Ensuring that hydrogen sulfide emissions do not exceed levels allowed by the Monterey Bay Unified Air Pollution Control District.

The current dredging and bypassing operations at Santa Cruz Harbor fulfill two important objectives:

- Providing **safe harbor** and **navigation** to boaters; maintaining access to the harbor during winter months provides continued use of the harbor as a "harbor of refuge." This provides year round, useable and safe access to Monterey Bay for recreational, commercial, and marine rescue service purposes.
- Providing **recreational** uses by continuing the alongshore transport of sand meant for beaches downcoast of the harbor entrance (Twin Lakes Beach). Beach nourishment also facilitates beach recovery from seasonal erosion and storm damage.

Of particular interest to regulatory agencies are the impacts that the dredging and disposal operations could have on recreational users on the beach and in the water. During dredging and disposal operations, the beach remains open to the public. Beach nourishment operations are carried out November through April with minimal perceived impacts to public access, since the beach is less frequently used during these months due to inclement weather and/or wave conditions. Temporary, localized disruptions to full public use of the beach occur when the tractor is relocating the end of the discharge pipeline to abate odor issues. The pipeline configuration, both onshore and offshore, are well marked for safety purposes and do not permanently inhibit access or use of to the beach. Photographs showing recreational users on the beach during nourishment operations are provided in Appendix D.

Based on a review of the literature, site visits, meetings with Port District staff, and experience from other projects, an assessment of the Santa Cruz Harbor dredge and disposal practices is provided in Table 3.

Table 3. Assessment of Current Operations at Santa Cruz Harbor

Criteria	Assessment of Current Operations
Maintain federal navigation channel to design depths and in safest condition practical to ensure year-round access and refuge for recreational and commercial vessels	Current annual dredging operation strives to maintain 14 ft MLW as a minimum controlling depth through the dredging season, including frequency, duration, and timing need to continue to achieve this criteria
Maintain safe passage year-round for marine rescue service providers	Current annual dredging operations, including frequency, duration, and timing need to continue to achieve this criteria
Accomplish beach nourishment to the maximum extent practicable	Onshore and surfzone discharges achieve this criteria; however, the organics and subsequent H_2S emissions result in some nearshore disposal that may not immediately benefit Twin Lakes State Beach
Preserve or enhance coastal access to the maximum extent practicable	Coastal access is preserved and enhanced by nourishing the beach with dredged sand (bypassing). The organics and subsequent H_2S emissions during discharge operations require realignment of the pipe via dozers, which temporarily affects public use of the beach in localized areas. H2S mitigation measures result in some nearshore disposal operations that may not immediately benefit Twin Lakes State Beach
Protect marine resources to the maximum extent practicable	No issues have been identified
Hydrogen sulfide emissions do not exceed levels allowed by the Monterey Bay Unified Air Pollution Control District	Although this is unpredictable because of the nature of deposition of organics, current annual operations do achieve this criteria by discharging sediment into surfzone or nearshore areas

4. POTENTIAL MODIFICATIONS TO CURRENT PRACTICES

This section presents a description of potential modifications to current dredging/disposal practices. The modifications are intended to improve the entrance channel maintenance dredging operation by achieving one or more of the following objectives:

A. Reduce the incidence of above threshold releases of Hydrogen Sulfide that trigger MBUAPCD protocol shut-down of dredging operations.

B. Reduce the amount of flexible dredge discharge pipeline handling that requires dozer operation on the east beach.

C. Reduce the need for dredged material rehandling and beach grooming that requires dozer operation on the east beach.

These objectives are implicitly recognized by the Operations Manual of the Santa Cruz Harbor Dredging Program, but are highlighted here because the potential modifications target elements of the dredging operation being reviewed by the Coastal Commission as part the Port District's 5-year permit renewal. In achieving these objectives the Port also hopes to enhance the efficiency of the entrance channel dredging operation to achieve greater economy without compromising safety. Furthermore the modifications must be coordinated with the Port's Inner Harbor Dredging which utilizes the same dredge plant at certain times and is also covered by the Port's Maintenance Dredging Permit.

The modifications that seek to reduce the release of hydrogen sulfide are particularly significant since two of the currently practiced disposal methodologies, anchored offshore and surf line (wet zone), which were developed to mitigate the hydrogen sulfide releases, also increased dozer operations on the beach. Hence if the hydrogen sulfide releases are reduced, an additional benefit will be a reduction in dozer operations. Further reduction in dozer operation should be possible based on the proposed modification of the dry zone (above surf-line) discharge methodology. The increase in the amount of dredged sand placed in the dry zone is desirable because it furthers the Port's (and the Coastal Commission's) goals of enhancing recreational access and protecting coastal bluffs from erosion along the beach east of the harbor.

The following descriptions of the potential modifications include the theory of operation, required equipment acquisition, an order of magnitude upfront cost, and recurring operations and maintenance cost estimates, and a brief discussion of risks associated with implementation of the modification. A subsequent comparison of the various modifications with the current practices may be used to determine if any modifications warrant further consideration. The modifications are categorized as follows:

Type A: Reduce Incidence of Hydrogen Sulfide Releases

Type B: Reduce Discharge Pipeline Handling Related Dozer Operations

Type C: Reduce Material Re-Handling/Grooming Related Dozer Operations

4.1 Description of Potential Modifications

4.1.1 Seawater Spray System

Concept: Provide seawater spray system to take up hydrogen sulfide at discharge point (Type A) and move discharge point to dry zone (Type B/C).

The Seawater Spray system consists of the following major components (see Figure 9):

- Screened seawater intake located close to the dredge suction to minimize concerns over seawater intake impacts
- Pump unit on dredge with requisite pipelining to deliver seawater to dredged material discharge point (on the dry beach)
- Spray nozzle to discharge seawater as a fine mist over the dredged material discharge

The theory of operation is that the hydrogen sulfide entrained in the dredged slurry, which volatilizes upon discharge and then travels downwind, will instead be re-dissolved by the seawater mist blanketing the discharge. The entrained hydrogen sulfide will then return with the run-off to the Bay. The system can be allowed to run continuously, or be activated intermittently by the leverman on the dredge when encountering a "pocket" likely to contain hydrogen sulfide.

The sizing of the system components will largely depend on the level of hydrogen sulfide in the dredge material and the efficacy with which the sprayer mist entrains the gas. This system will require additional investigation, first in the lab, then in field, to determine its efficacy. The sizing of the equipment will also be dependent on such tests. For concept level analysis, it is assumed that the capacity will be roughly equivalent to fire (3" pipe / 2 1/2" hose) flows.

The principal advantage of the system is its simplicity, which allows testing and eventual implementation at relatively low costs and can be utilized on an as-needed basis.

The principal short-coming is the uncertainty surrounding the efficacy of the system, which can only be resolved by performing a series of investigations. Further concern may surround the impact of the spray field on beach users, and of the seawater mist on downwind receptors.

The upfront cost consists of equipment purchase and installation for the seawater pump on the dredge, the delivery piping which could "piggy-back" on the dredge pipeline, and the sprayer apparatus at the point of discharge. The cost allowance is estimated to be $137,000. The recurring cost is the incremental cost upon the current dredge operation to operate and maintain the seawater spray system. This cost is very approximate, with operations and maintenance estimated at $110,000 per year.

4.1.2 Poor Boy Degasser

Concept: Provide "Poor Boy" Degasser in discharge pipeline to trap hydrogen sulfide (Type A) and move discharge point to dry zone (Type B/C)

The Poor Boy Degasser system consists of the following major components (see Figure 10):

- A 'poor boy' degasser (also known as a Mud-Gas separator or gas-buster for separating gas from drilling muds or similar slurries) inserted in the dredged material disposal pipeline, on-shore.
- A hydroxide (or equivalent) scrubber to purge Hydrogen Sulfide from the gas stream captured by the separator prior to release.

The theory of operation is that the hydrogen sulfide entrained in the dredged slurry when present in sufficient quantity to cause downwind problems can be separated from the slurry by a series of baffles in a large tank and captured by a gas scrubber. As with the spray system, it can be allowed to run continuously, or be activated intermittently on an as-needed basis.

The sizing of the system components will largely depend on the level of hydrogen sulfide in the dredged material. The sizing of the poor boy degasser is on the upper limit of typical equipment used in the drilling industry, being a tall cylinder about 8 ft in diameter and 20 ft tall, and the hydrogen sulfide scrubber is a specialized form of standard industrial gas scrubbers. If intermittent operation of the separator/scrubber is practical given the infrequent occurrence of excessive release of hydrogen sulfide, the limiting equipment may be suitable for brief periods of operation. In this case, the dredge pipeline will have to be outfitted to redirect the flow to the separator/scrubber when necessary.

The principal advantage of the system is its ability to capture hydrogen sulfide and prevent its release, but at an increased technologic sophistication that translates into greater cost for testing and eventual implementation. While the separator involves no moving parts, the scrubber requires considerable attention to insure proper operation (charging with fresh chemicals and disposal of spent liquor). The separator and scrubber equipment also represent a visual intrusion on the beach and the scrubber will require a power supply and blower to withdraw the hydrogen sulfide from the separator and pass it through the scrubber.

The equivalent to this system discussed in the Phase 1 study is the use of a hopper barge anchored in the entrance channel with a submerged dredged material discharge in its bin to minimize the release of hydrogen sulfide. The hopper bin when full will require rehandling of the dredged material by a separate pump/discharge pipeline. The bin may need to be covered to prevent release of hydrogen sulfide from the bin if it cannot be kept in solution. In this case, the scrubber will likely be needed as well.

The upfront cost consists of equipment purchase and installation for the poor-boy separator and the scrubber, including the tie-in piping to the dredge pipeline. The cost allowance is estimated to be $327,000. The recurring cost is the incremental cost upon the current dredge operation to operate and maintain the separator/scrubber, including scrubber chemicals. This cost is very approximately $185,000 per year.

4.1.3 Degassing Eductor or Booster Pump

Concept: Provide degassing eductor on the dredge pump suction line, or a booster pump in the discharge pipeline to trap hydrogen sulfide (Type A) and move discharge point to dry zone (Type B/C)

- The degasser system consists of the following alternatives with the respective major components (See Figure 11):

Alternate A: Eductor on Dredge Pump Suction Line

- Gas trap on dredge suction line in front of the pump with vacuum assist.
- Gas scrubber to purge hydrogen sulfide from the gas stream captured by the trap.

Alternate B: Booster Pump in Discharge Pipeline

- YOKOTA type air-water separating pump adapted for “mud-sand slurry, seawater” application.
- Gas scrubber to purge hydrogen sulfide from the gas stream captured by the separator.

The theory of operation for eductor Alternate A on the dredge is that the entrained gas at depth greatly expands in volume under the pump section and can be more easily separated from the slurry by a suitably configured box trap just in front of the pump. The box trap has a separate pump that maintains a suction on the trap to pull off the separated gas. The hydrogen sulfide can then be captured by a gas scrubber, or through underwater disposal as hydrogen sulfide is water soluble..

The theory of operation of the booster pump Alternate B on shore uses the process of centrifugal separation that naturally occurs in the impellor pump to advantage. The patented YOKOTA slurry pump incorporates an interlocked air-water separating impellor. The hydrogen sulfide gas can be stripped off and captured by a gas scrubber. As with the previous systems, it can be allowed to run continuously or activated intermittently on an as-needed basis..

The sizing of the system components will largely depend on the level of hydrogen sulfide in the dredged material. The sizing of the YOKOTA pump in particular is on the upper limit of the available capacity for slurry transfer, but the sizing is further complicated by its use as a booster in the existing pipeline (when no booster is actually required based on pipeline losses). The booster pump will require a power source; either a new suitably sized electric drop for an electric driven pump, or a diesel fuel system for a diesel driven pump. Scrubber limitations similar to those discussed for the poor boy degasser apply as well.

The principal advantage of the system is similar to the previous systems – ability to capture hydrogen sulfide and prevent its release. The eductor or the booster pump, and the scrubber will require regular attention. The booster pump may offer a lesser visual intrusion on the beach than the poor boy degasser, but the booster pump operation will produce another form of intrusion, particularly if a diesel driven pump is selected. The dredge-mounted eductor avoids any visual or other impact on the beach.

Although the YOKOTA pump has not been developed as a prime mover for a dredging plant, its capability may be considered in the event that the Port is considering a replacement dredge, or a major rebuild of its current plant. An eductor on the dredge suction line is common in the dredging industry, but the separated gas is normally vented to the atmosphere, not an option in this case. Subsea gas release may be an option, but this depends on the ability of sea water to "scrub" the gas before it surfaces. Further study and testing would be necessary to prove the method out.

The upfront cost consists of equipment purchase and installation for the separator (the eductor for Alternate A and the booster pump for Alternate B) and the scrubber, including the tie-in piping to the dredge pipeline. The cost allowance for the eductor is estimated to be $245,000, and for the booster pump $499,000. The recurring cost is an incremental cost upon the current dredging operation to operate and maintain the separator/scrubber, including scrubber chemicals. This cost is very approximately $185,000 per year for Alternate A and $203,000 for Alternate B.

4.1.4 Cutter-Head Sweeps

Concept: Perform cutter head sweeps in order to "meter" dredge intake of organic matter/ hydrogen sulfide (Type A) and move discharge point to dry zone (Type B/C)

The cutter head sweeps system consists of the following major components (See Figure 12):

- A cutter head dredge, which includes the option to refit the Port's existing dredge as a cutter head.

The theory of operation is that removing sediment in a number of lifts, and churning the material prior to pumping, will reduce the dredge intake of decomposing vegetation and hydrogen sulfide that apparently is responsible for the hydrogen sulfide releases.

They depth of the dredge face and hence the number of sweeps is based on the Seabright's capability with a cutter head (or a comparable contract dredge could be brought in to test the concept). Empirical testing involves the conduct of sweeping operations and correlation with the results of hydrogen sulfide monitoring. Substantial reduction in the number of Hydrogen Sulfide monitoring over threshold readings would be deemed a successful outcome.

The principal advantage of the system is similar to that of the seawater spray system – relative simplicity. However, the short-coming is similar as well – uncertainty surrounding the efficacy of the system, though the cutter head sweeps do not bring with it the spray field impacts on beach users or downwind receptors.

An additional concern is the impact of conducting cutter head sweeps on the efficiency of maintaining the channel; the current dredging practice which emphasizes potholing with the snorkel and suction pipe is less impacted by wave action as compared to cutter suction dredges, which are most effective where wave exposure is limited. Additionally, fouling of the cutterhead by kelp and other marine debris, as well as potential fish entrainment issues, could possibly emerge as potential issues.

The upfront cost consists of installing the original cutter head (the original equipment is assumed to be operational) on Seabright. The cost allowance is estimated to be $41,000. The recurring cost is the incremental cost upon the current dredge operation for Seabright to function as a cutter head dredge for which we would apply an estimated increase of around 20%, or very approximately $260,000 per year. If the port elects to use a contract cutter head dredge to conduct the testing rather than re-fit the Seabright, then the upfront costs would likely be greater since the contract cost would be in addition to the re-fit cost in the event the testing proves successful.

4.1.5 Pre-Dredge Plowing or Jetting

Concept: Perform predredge plowing or jetting to promote submerged release of organic matter/hydrogen sulfide (Type A) and move discharge point to dry zone (Type B/C)

The pre-dredge plowing (or jetting) system consists of the following major components (See Figure 13):

- A sufficiently powerful work boat to tow a plow (or equipped with powerful jetting pumps).
- A subsea plow capable of reaching the required depth (or jetting apparatus).

The theory of operation is that buried pockets of decomposing vegetation can be dislodged and the trapped hydrogen sulfide can be released with the aid of the plow or the jetting apparatus. The disturbed sediment is expected to be sufficiently free of hydrogen sulfide to avoid a serious release following dredging.

The sizing of the system components and the proper plowing (or jetting) technique would be based on empirical testing. Plowing (or jetting) operations would be conducted prior to dredging, and correlated with the results of hydrogen sulfide monitoring. A successful outcome would be judged in the same manner as for the cutter head sweeps

The principal advantage of the system is similar to that of the cutter head sweeps in dispersing concentrations of subsea pockets of hydrogen sulfide prior to dredging. However, the concern

is that the occurrence of pockets of decomposing vegetation is random and that the plowing (or jetting) pattern may not intersect them, resulting in no benefit. In that regard, the systematic sweeping of the cutter head provides a significant advantage. Furthermore, the ability to plow deeply into sediments or obtain substantial release of hydrogen sulfide by deep jetting needs to be validated.

The pros of plowing are that it is a continuous process and probably more economical over longer distances. The cons are that it is more difficult to maneuver and position in tight channels and it will likely require a larger tow vessel than is currently available to the Port unless a small plow and many more passes are substituted.

The pros of jetting are that it can be more easily positioned in the channel and adjacent to structures and can probably be conducted to greater sediment depths in a single pass than plowing. The cons are that it is probably slower than plowing, will require a bigger vessel and crew, and will have a smaller weather window in which to operate.

An option to consider is combining the above into a jet-assisted plow operation, and to limit the plowing and/or jetting to periods of time immediately after storms that typically bring detritus to the entrance channel, or when the mature kelp beds offshore start breaking up.

The upfront cost consists of equipment purchase and installation on a suitable workboat. The Dauntless is assumed to be adequate, in which case the cost allowance is estimated to be $163,000. The recurring cost is the incremental cost upon the current dredge operation for Dauntless to perform the plowing (or jetting) function for (an assumed) 26 days in addition to her other duties (and assumes there is sufficient “standby” time in her current schedule for this to occur). This cost is very approximately $148,000 per year.

4.1.6 Upcoast Sand Trap

Concept: Restore Upcoast Sand Trap and Continue Dredging of Sand Trap (See Figure 14)

The restoration of the Upcoast Sand Trap and subsequent single phase maintenance dredging was studied by the Corps of Engineers (most recently) in their 1992 Reconnaissance Report. This modification would use a hopper or clamshell dredge at the beginning of each dredge season to dredge an excavation roughly 2000 feet long between the 15 foot and 25 foot (MLLW) contours just offshore of the harbor entrance (see Figure 14). Annually about 200,000 cubic yards of sand would be removed from the trap and disposed of one mile to the east in an area between the 15 foot and 20 foot contours near Corcoran Lagoon. The disposal site is expected to be dispersive and close enough to shore to keep sand in the littoral system though it is not certain that the recreational beach between the east jetty and Blackpoint will see any immediate benefit. It is expected that the amount of sand removed from the sand trap area in front of the harbor would reduce wave heights at the entrance and the amount of sand currently dredged from the entrance channel itself by the Port.

The benefits and costs analysis provided by the Corps for this alternative did not result in a favorable recommendation for Federal participation in the project. The benefits attributed to improved navigation (through lower wave height) and reduced entrance channel dredging by the Port (through offshore trapping) do not offset the cost of the offshore trap operation. Furthermore, the alternative is based on an offshore disposal operation at a dispersive site that lies within the Monterey Bay National Marine Sanctuary. The costs would be considerably greater if the site could not be permitted, or if sand placement on the east beach is required, necessitating double handling of the material. And should the matter of hydrogen sulfide control become an issue during dredging of the offshore sand trap or the Port’s continued

maintenance dredging of the entrance, the costs would increase further still, as the issue was not addressed in the Corp's alternative analysis.

However, the greatest shortcoming is that the Upcoast Sand Trap with disposal at the dispersive offshore site does not provide assurance that the east beaches will be nourished to the extent deemed necessary by the Coastal Commission to provide the desired public recreational benefit and protection to the coastal bluff. Furthermore, the beach provides protection for important public infrastructure – East Cliff Drive and a wastewater force main, water lines, and electric lines within its right of way.

The upfront cost consists of contract dredging of the Upcoast Sand Trap at the start of the dredging season. The recurring cost consists of the same at the beginning of each successive season. The cost allowance per dredging season is estimated to be $4,584,000, with dredge mobilization representing a substantial portion of the cost. Savings to the Port through a reduction of annual entrance channel dredging are difficult to estimate, but given an average Port dredging quantity of 250,000 cubic yards and assuming that roughly 350,000 cubic yards of sandy material bypasses the entrance, the Port is still likely to trap (and dredge) over 100,000 cubic yards annually. This dredging requirement will bring the hydrogen sulfide and beach nourishment concerns along with it, and a proportional share of the current dredging costs that are reflected in the above estimate.

4.1.7 Extend Jetties

Concept: Extend Jetties to Reduce Entrance Channel Maintenance Need

The extension of the entrance jetties as a means of reducing the maintenance dredging within the entrance channel conducted by the Port was also studied by the Corps. The theory of operation is that the extended jetties, while not eliminating the requirement for maintenance dredging, would increase the depth over the shoal that forms at the mouth of the harbor and result in a decreased need for dredging within the entrance channel (i.e. more material would be permitted to bypass the entrance naturally).

The Corp's investigation did not include a benefits and costs analysis of this alternative since the apparent cost of the jetty extensions so overwhelmed the benefits that the Corps removed the alternative from further consideration. In addition, the Port's maintenance dredging of the entrance probably is not eliminated entirely and the matter of hydrogen sulfide and beach nourishment concerns could still be an issue.

Given the prior dismissal of this plan, and recognizing that technical studies well beyond the scope of this study would be necessary to provide even a conceptual design for the jetty extensions, a cost estimate has not been generated. However, based on prior experience in similar coastal settings, the initial construction cost, assuming 500 feet of new jetty extension, is expected to be well over $10 million. It should be emphasized, however, that even if this option shows potential promise from a performance standpoint, the issues associated with permitting and building permanent structures in the Marine Sanctuary, without the benefit of eliminating the ongoing dredging, would overwhelm any performance benefits that could be gained.

4.1.8 Offshore Pipeline

Concept: Provide Offshore Disposal via Permanently Anchored Pipeline with Multiple Outlets (See Figures 15 & 16)

The conversion to offshore disposal via a permanently anchored pipeline would allow permanent offshore disposal, thereby controlling the hydrogen sulfide odor problem. The

modification consists of a permanently buried pipeline in the dry zone of the beach that turns seaward in the vicinity of the 6th (or 7th) Avenue and proceeds to daylight on a trestle out over the surf zone to a depth of approximately 15 ft MLLW (see Figures 15 & 16). The pipeline is anchored to the trestle above the surf, which is preferable to shallow burial in the surf zone because the mobility of the sandy bottom exposes the pipeline to both physical damage and plugging. The distribution pipe on the trestle would be outfitted with a number of submerged outlet pipes to discharge slurry at various depths depending on beach nourishment requirements. The outlets would be designed (and selected by the dredge operator) to maximize dredged material disposal as high on the beach as practical while minimizing the release of hydrogen sulfide, and the need to re-handle the material with dozers to build dry beach. But since the method facilitates offshore disposal to control the hydrogen sulfide odor problem, more dredged material will likely use the offshore method, with less material placed on the dry beach, thus increasing the need for rehandling the material with dozers.

In any case, the outlets are all located within the permitted disposal area boundary to facilitate permitting of the trestle, and although the trestle may receive careful scrutiny by the Coastal Commission, any adverse impacts on beach users should be offset by a reduction in the objectionable hydrogen sulfide releases and those dozer operations on the beach that are related to pipeline outlet manipulation.

The upfront costs consist of trestle and pipeline construction. Construction through the surf zone is particularly challenging and costly because a temporary construction trestle will likely be needed to place the pipeline supports. The cost allowance is estimated to be $1,692,000. The recurring cost is the incremental cost upon the current dredge operation to operate and maintain the trestle and multiport pipeline which may be offset by potential saving due to reduced dozer operation. This cost has not been estimated but should very approximately be a wash with current costs (reduced pipeline manipulation costs offset by increased beach material handling costs).

4.1.9 Dry-Zone Disposal Diffusers

Concept: Provide Dry-Zone Disposal via Permanently Installed Pipeline with Multiple Discharge Diffusers (see Figures 17 & 18).

The conversion to dry-zone disposal via a permanently installed pipeline would become possible by the effective control of the hydrogen sulfide releases. The modification consists of a permanently buried pipeline in the dry zone of the beach with multiple outlet diffusers located between the 5th Ave and 7th Ave (see Figures 17 & 18). The outlet diffusers will, of necessity, be exposed on the dry beach, but they will be designed (and selected by the dredge operator) to maximize beach profile build up using the settling characteristics of the dredged material to form a delta deposit around the diffuser. As the deposit builds around one diffuser and overlays the preceding, preparations can be made to activate the subsequent diffuser. Further re-handling of the beach material will largely be left to natural forces as the material will be discharged as high on the beach as practical. Re-handling or grooming of the beach deposit should only be required on special occasions.

This modification is intended to be provided in conjunction with any of the preceding modifications that reduce the release of hydrogen sulfide sufficiently to permit abandonment of the offshore and surf-line disposal methods.

The upfront cost consists of construction of the outlet diffusers on the existing burred pipeline. The cost allowance to fabricate and install 8 diffusers is estimated to be approximately $240,000. The recurring cost is the incremental cost upon the current dredging operation to operate and maintain the outlet diffusers. These recurring costs have not been estimated as

they are likely to be a cost saving due to the reduction in dozer operation made possible by the associated Hydrogen Sulfide control method with which the dry beach disposal is linked. The amount of savings can be better estimated once a preliminary diffuser design is developed.

4.2 Evaluation of the Potential Modifications

A summary of the Potential Modifications is presented on Table 4.

An evaluation of the potential modifications in which they are scored as superior (1 to 5) or inferior (-1 to -5) relative to the current practice (0 implies no change) for the eight comparison criteria is presented on Table 5. The highest score represents the best potential improvement; a negative score suggests that the Port is better served by the current practice than it would be by the potential modification.

The evaluation indicates that the degassing eductor on the dredge with the hydrogen sulfide scrubber offers the best potential improvement in performance. The upcoast sand trap and the jetty extension received a negative score and further consideration of these modifications appear unwarranted.

In deciding whether to proceed with the testing of the highest ranked (or other) potential modification, the Port District should proceed with the appropriate investigations to help ensure a successful outcome.

If a solution is found to permanently control the hydrogen sulfide problem, then the Port may consider the installation of the permanent dry beach disposal diffuser system to take full advantage of the odor control improvement, and address the tractor operation issue. This way forward should not only allow the Port to improve the efficiency of its entrance channel dredging operation, but enhance its ability to nourish the east beach and satisfy objectives for public access and protection of East Cliff Drive and other essential public infrastructure within its right of way.

Table 4: Summary of Potential Modifications to Existing Practices

	MODIFICATION								
	1. Seawater Spray System	**2. Poor Boy Degasser**	**3A. Degassing Eductor**	**3B. Degassing Booster Pump**	**4. Cutter-Head Sweeps**	**5. Pre-Dredge Plowing or Jetting**	**6. Upcoast Sand Trap**	**7. Extend Jetties**	**8. Offshore Disposal Pipeline**
Type	A B C	A B C	A B C	ABC	A B C	A B C			A B
Schematic Figure	9	10	11	11	12	13	14	-	15, 16
Pros	Reduces H_2S release; Increases dry zone dispersal; Reduces tractor operations						Reduces channel dredging	Reduces H_2S release; Increases dry zone dispersal; Reduces tractor operations	Reduces H_2S release
Cons / Uncertainties	H_2S scrubbing efficacy; Aesthetics	Degasser capacity; H_2S trapping efficacy; Aesthetics	H_2S trapping efficacy	Booster pump capacity; Booster pump operation	H_2S dispersal efficacy; Feasibility in swells	H_2S dispersal efficacy	Beach nourishment efficacy; H_2S release reduction; Permittability	Beach nourishment efficacy; Permittability; Dredging still needed	Beach nourishment efficacy; Aesthetics; Permittability
Upfront costs[(1)] ($1,000's)	$137	$327	$245	$490	$41	$163	$4,584 (See 3)	>$10,000	$1,692
Annual recurring cost [(2)] ($1,000's)	$110	$185	$185	$203	$260	$148	$4,584 (See 3)	(See 4)	(See 5)

1) Very preliminary estimate of cost in 2011 dollars. Soft costs (environmental, permitting, engineering, contract administration) not included

2) Very preliminary estimate of net increment to current channel maintenance dredging program for annual cost of conducting modified operation, includes potential savings allowance on account of reduced dredging volume or beach dozer operation, in 2011 dollars.

3) Assumes contract dredge for initial (and annual) dredging of offshore trap, and reduced volume of Port's annual channel dredging volume.

4) Costs not estimated. Modification requires further study to prepare cost estimate.

5) Costs expected to be small incremental change.

Table 5: Evaluation of Potential Modifications to Existing Practices

		MODIFICATION								
		1. Seawater Spray System	2. Poor Boy Degasser	3A. Degassing Eductor	3B. Degassing Booster Pump	4. Cutter-Head Sweeps	5. Pre-Dredge Plowing or Jetting	6. Upcoast Sand Trap	7. Extend Jetties	8. Offshore Disposal Pipeline
CRITERIA	Increase days of entrance channel navigation	+2	+4	+4	+4	+2	+2	+4	+4	+2
	Increase nourishment of down coast beaches	+3	+4	+4	+4	+3	+3	-4	-2	+2
	Decrease dozer operation on beaches	+3	+4	+4	+4	+3	+3	+2	+2	+2
	Decrease hydrogen sulfide releases	+2	+4	+4	+4	+3	+2	+2	+2	+3
	Decrease impact on Monterey Bay Habitat	+3	+4	+4	+4	+3	+3	-5	-3	-1
	Decrease cost maintenance dredging	-2	-2	-2	-3	-3	-2	-5	0	0
	Upfront costs/risks	-2	-3	-2	-3	-1	-2	-5	-5	-5
	Enhance permit ability	+1	-2	+5	+1	+3	+3	-3	-5	1
	TOTAL	+10	+13	+21	+15	+13	+12	-14	-7	+4

Expected performance relative to current practice

Superior	No Change	Inferior
+5	0	-5

5. SUMMARY & RECOMMENDATIONS

The current dredging and bypassing operations at Santa Cruz Harbor fulfill two important objectives:

- Providing **safe harbor** and **navigation** to boaters; maintaining access to the harbor during winter months provides continued use of the harbor as a "harbor of refuge." This provides year round, useable and safe access to Monterey Bay for recreational, commercial, and marine rescue service purposes.
- Providing **recreational** uses by continuing the alongshore transport of sand meant for beaches downcoast of the harbor entrance (Twin Lakes Beach). Beach nourishment also facilitates beach recovery from seasonal erosion and storm damage.

A review of current dredging/disposal practices was carried out by the Moffatt Nichol project team for the Santa Cruz Port District at the request of the California Coastal Commission. Present practices involve dredging sediment from the entrance and reuse of these coarser grained sediments for beach replenishment downcoast on the harbor beach and the Twin Lakes State Beach. Air emissions of hydrogen sulfides from the beach replenishment operation have been a particular challenge for the Port District. Strict emission limitations imposed by the Monterey Bay Unified Air Pollution Control District have significantly influenced operational practices and costs for by-pass sediment dredging at the harbor entrance. Smaller volumes of finer sediment from the upper harbor have been disposed of in the surf zone east of the harbor jetty as previous studies and a recent study by the United States Geological Survey (Storlazzi et al., 2011) have established that these fine sediments do not accumulate locally on the shoreline and/or inner shelf but are effectively moved offshore. Dredging operations are guided by the Operations Manual, Santa Cruz Harbor Dredging Program (SC Port District, 2010).

The dredging and bypassing methods employed by the Santa Cruz Harbor District are comparable to practices at other harbors. Practices implemented at Santa Cruz Harbor over the past several years with regulatory approvals have met all of the Harbor's criteria including maintenance of a year-round safe passage for vessels, provide necessary beach nourishment, meet strict hydrogen sulfide air emission requirements, and maximize and preserve coastal access and marine resources. Of particular interest to regulatory agencies are the impacts that the dredging and disposal operations could have on recreational users on the beach and in the water. During dredging and disposal operations, the beach remains open to the public. Beach nourishment operations are carried out November through April with minimal perceived impacts to public access, since the beach is less frequently used during these months due to inclement weather and/or wave conditions. Temporary, localized disruptions to full public use of the beach occur when the tractor is relocating the end of the discharge pipeline to abate odor issues. The pipeline configurations, both onshore and offshore, are well marked for safety purposes and do not inhibit access or use of the beach.

Nevertheless, hydrogen sulfide air emission practices have been costly to implement and have significantly affected the efficiency of dredging operations by reducing daily production rates. Eight potential modifications to current practices have been identified and considered in this present study. If the ongoing issues associated with nuisance odors and public perception of the District's practices continues, the District may want to explore implementation of one or more of the high-ranking potential modifications. The degasser options, especially the on-dredge eductor, shows promise and should be explored further with vendors of such systems. As demonstration projects, the cutter-head and plowing/jetting options could also be considered if the eductor type degassing system does not perform well.

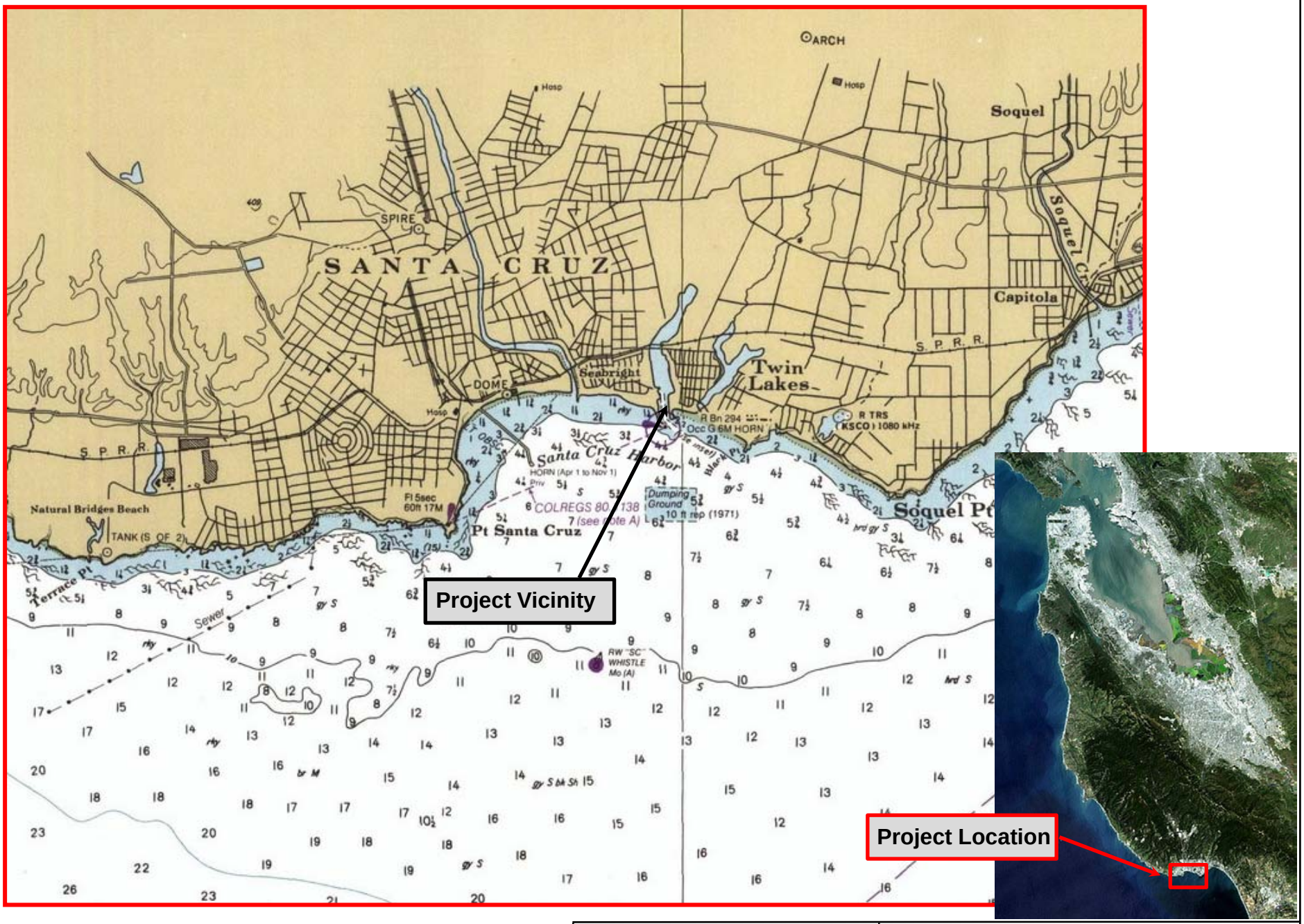
Initial recommendations to evaluate the potential for success for any of the modifications include the following:

- Add coring and sulfide analyses to the sediment sampling and testing program in the entrance and upcoast sediment trap areas to determine the amount and distribution of sulfides present, to better analyze and develop potential operational modifications.
- Quantify kinetics of sulfide reactions with seawater and conduct simple laboratory and field tests of seawater scrubbing to minimize hydrogen sulfide releases.
- Gather additional observations about vegetation management, including exploring the possibility of periodic raking of the entrance bottom to remove large kelp or algae materials before burial and hydrogen sulfide formation.

6. REFERENCES

1. Moffatt & Nichol, 1978, Santa Cruz Harbor Shoaling Study, Santa Cruz Harbor, California, prepared for U.S. Army Corps Of Engineers, San Francisco District, June 1978
2. Sandoval and Associates Consulting Services, 2008. Santa Cruz Kelp Monitoring and Habitat Assessment Progress Report – Year 1, prepared for Santa Cruz Port District, October 11, 2008.
3. Santa Cruz Port District, 2010, Operations Manual, Santa Cruz Harbor Dredging Program, Revised October 29, 2010.
4. Sea Engineering and Moss Landing Marine Laboratories, 2008, The Role of Mud in Regional Productivity and Species Diversity, prepared for Santa Cruz Port District, January 2008.
5. Storlazzi, C.D., Conaway, C.H., Presto, M.K., Logan, J.B., Cronin, Katherine, van Ormondt, Maarten, Lescinski, Jamie, Harden, E.L., Lacy, J.R., and Tonnon, P.K., 2011, The Dynamics of Fine-Grain Sediment Dredged from Santa Cruz Harbor, U.S. Geological Survey Open-File Report 2011-1045.
6. Strelow Consulting, 2009, Santa Cruz Harbor Dredge Management Plan, prepared for Monterey Bay National Marine Sanctuary, prepared in association with the Santa Cruz Port District, March 2009.
7. U. S. Department of Health and Human Services, Public Health Service, 2007. Evaluation of Hydrogen Sulfide Migration at Twin Lakes Beach and Adjacent to the Santa Cruz Harbor, Santa Cruz County, California, June 6, 2007.
8. USACE 1992, Reconnaissance Report, Santa Cruz Harbor Shoaling, General Investigation Study, U.S. Army Corps of Engineers, San Francisco District, May 1992.

FIGURES



MOFFATT & NICHOL

WALNUT CREEK, CALIFORNIA

Figure 1:
Project Location & Vicinity

Obliques by Kinnetic Laboratories

MOFFATT & NICHOL

WALNUT CREEK, CALIFORNIA

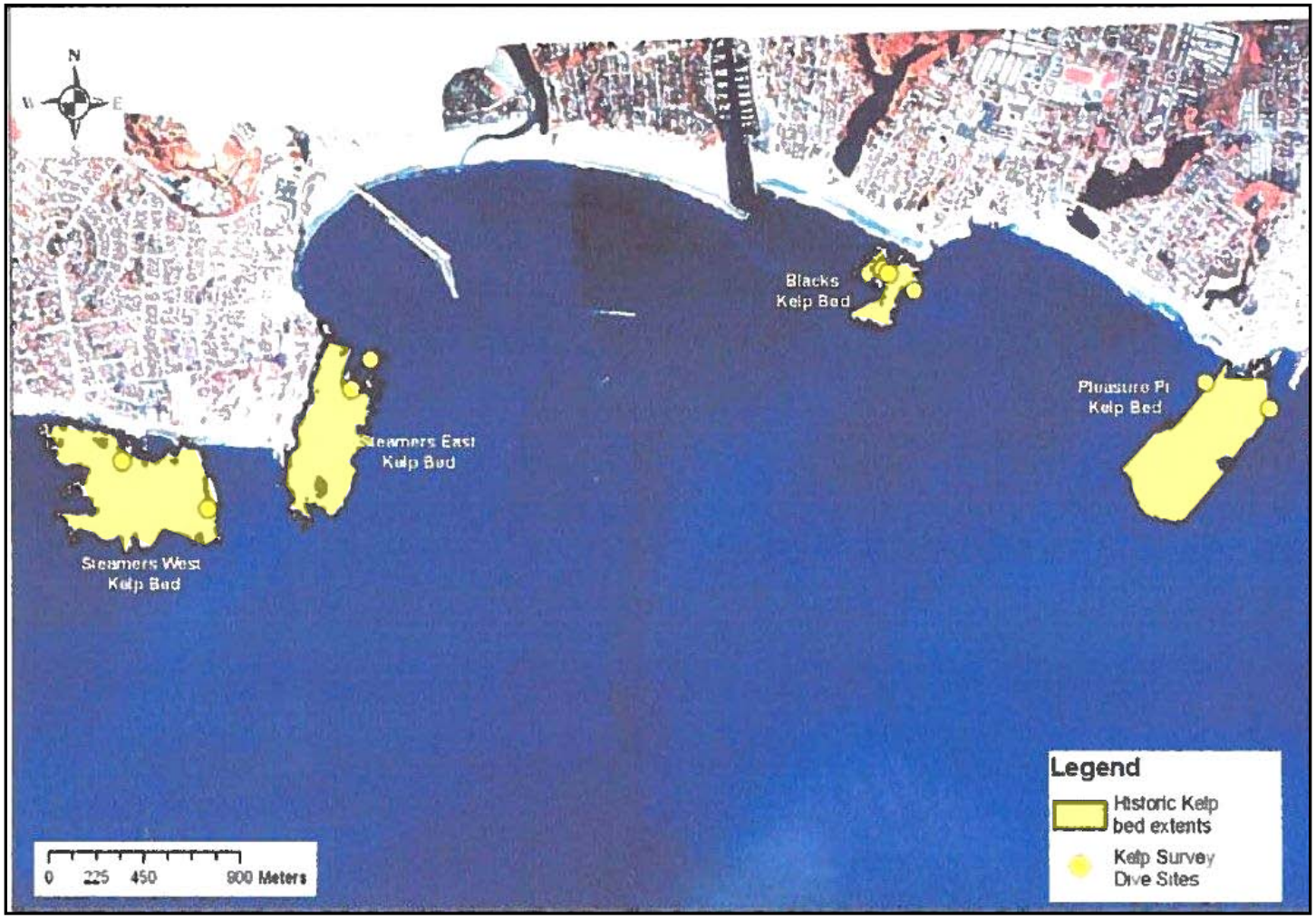
Figure 2:
Santa Cruz Harbor Looking West

Obliques by Kinnetic Laboratories

MOFFATT & NICHOL

WALNUT CREEK, CALIFORNIA

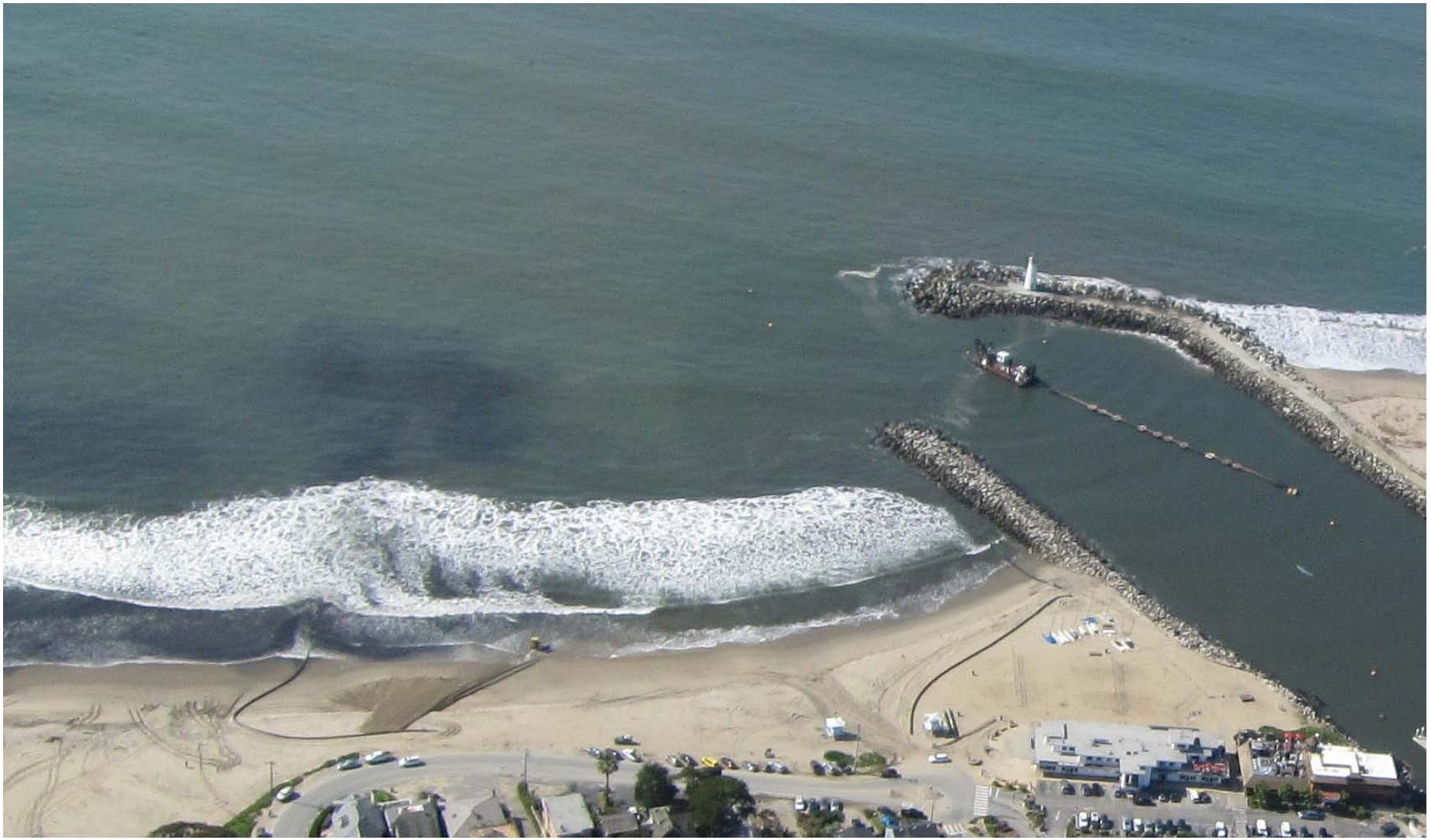
Figure 3: Twin Lakes Beach



MOFFATT & NICHOL

WALNUT CREEK, CALIFORNIA

Figure 4. Location of Nearby Kelp Beds (Sandoval Assoc., 2011)



Obliques by Kinnetic Laboratories

MOFFATT & NICHOL

WALNUT CREEK, CALIFORNIA

Figure 5: Dredging Operations at Santa Cruz Harbor

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WALNUT CREEK, CALIFORNIA

Figure 6. Beach Disposal

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Figure 7. Sand Placement on Beach

Obliques by Kinnetic Laboratories

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WALNUT CREEK, CALIFORNIA

Figure 8: Sand Moved to Upper Beach via Dozers

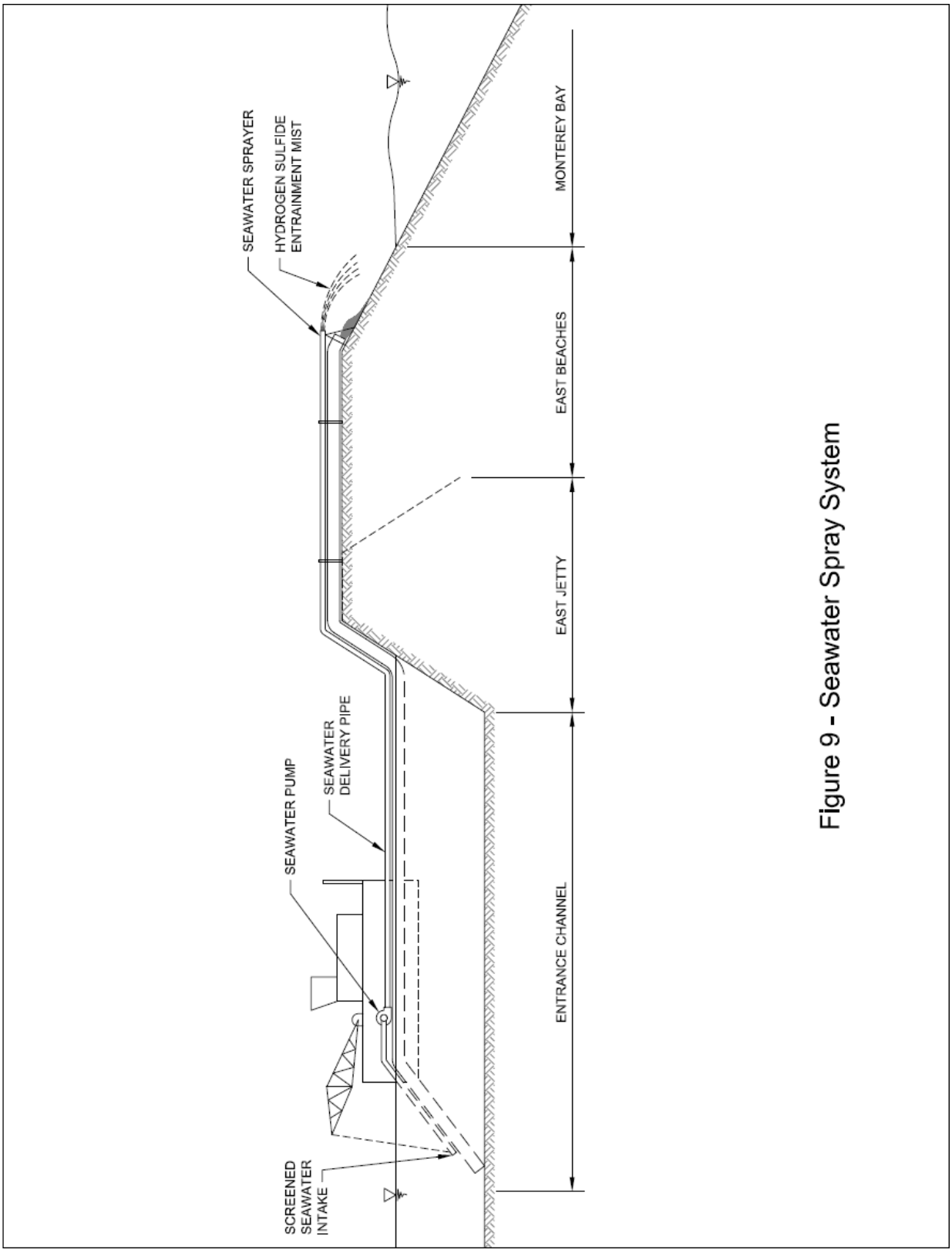


Figure 9 - Seawater Spray System

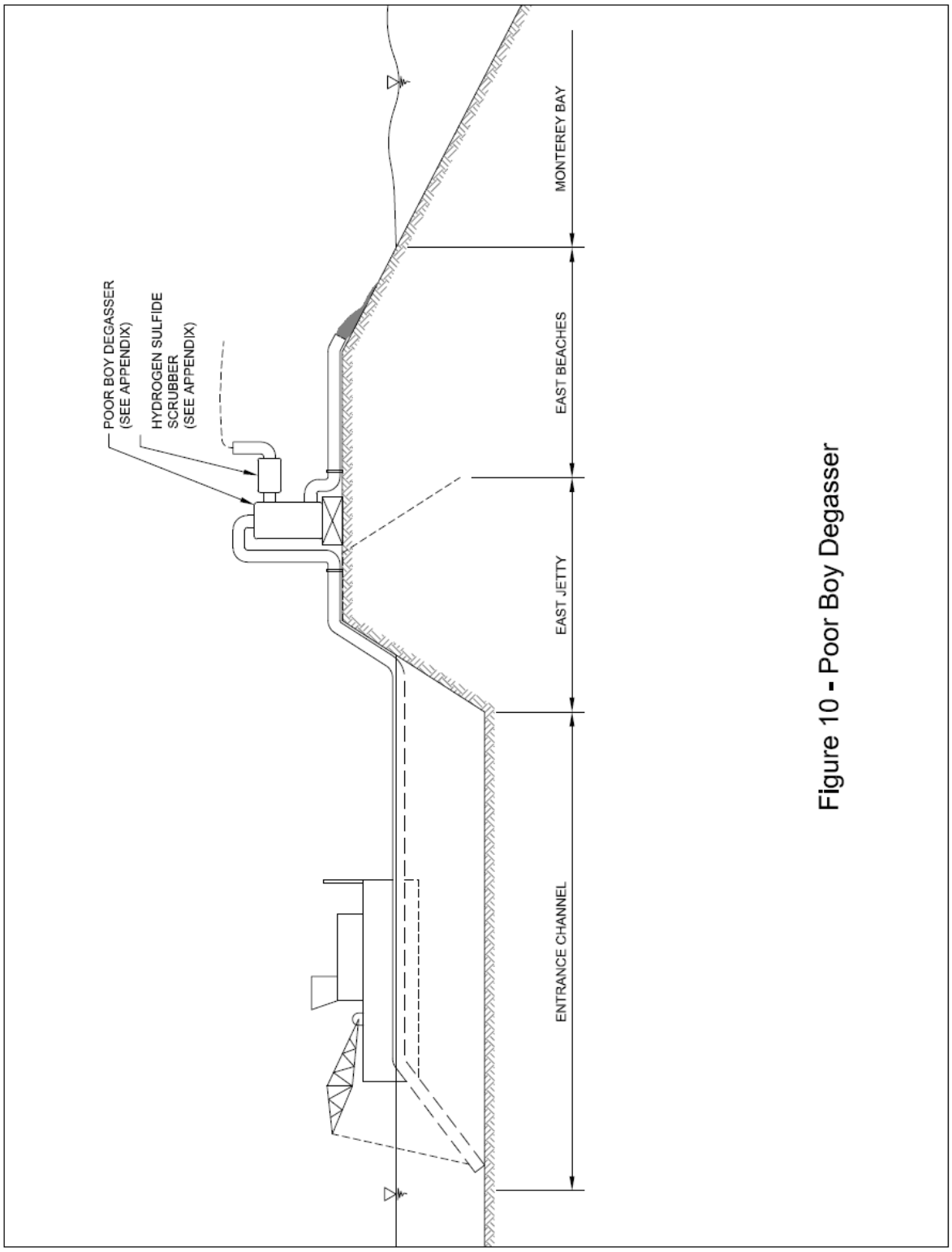


Figure 10 - Poor Boy Degasser

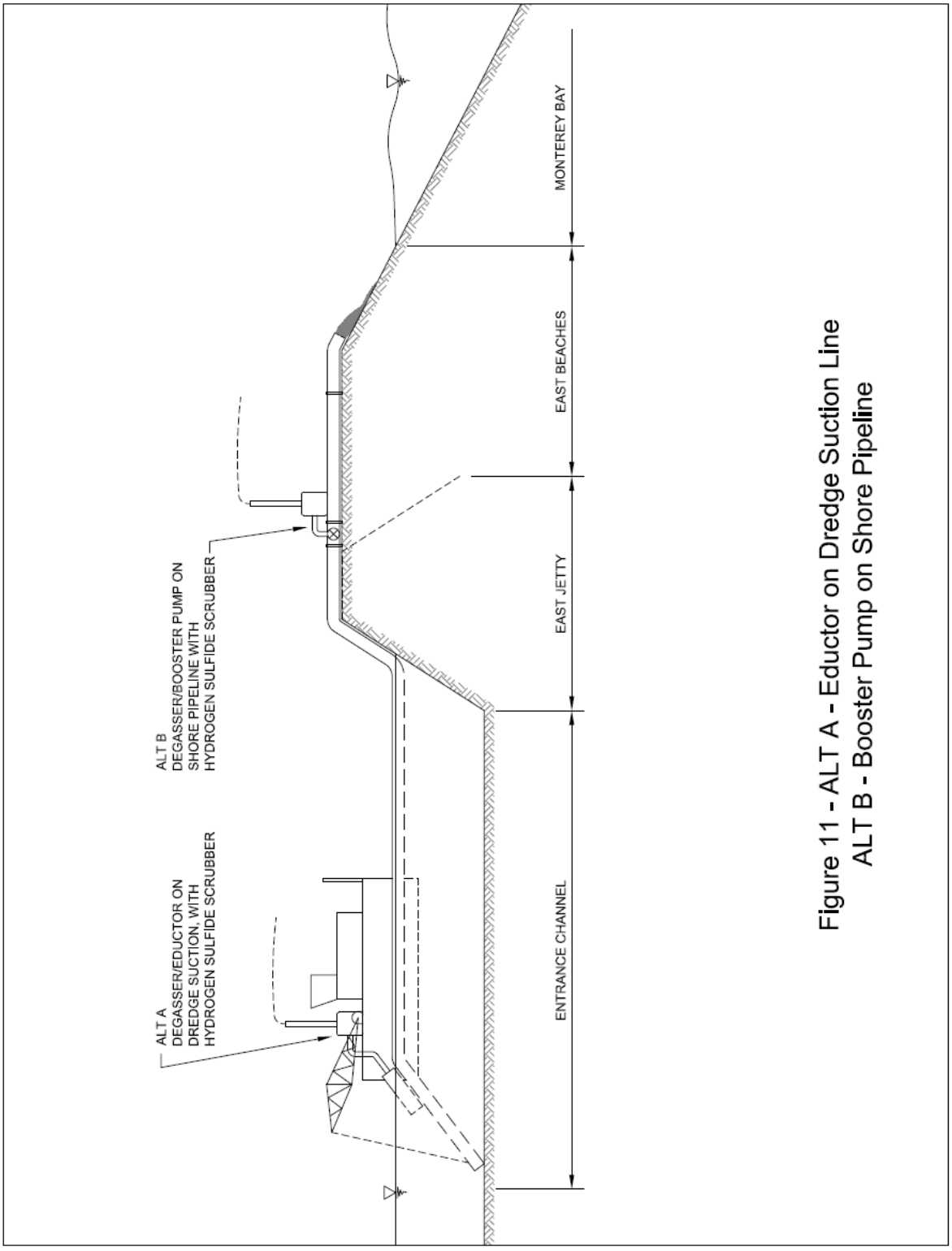


Figure 11 - ALT A - Eductor on Dredge Suction Line
ALT B - Booster Pump on Shore Pipeline

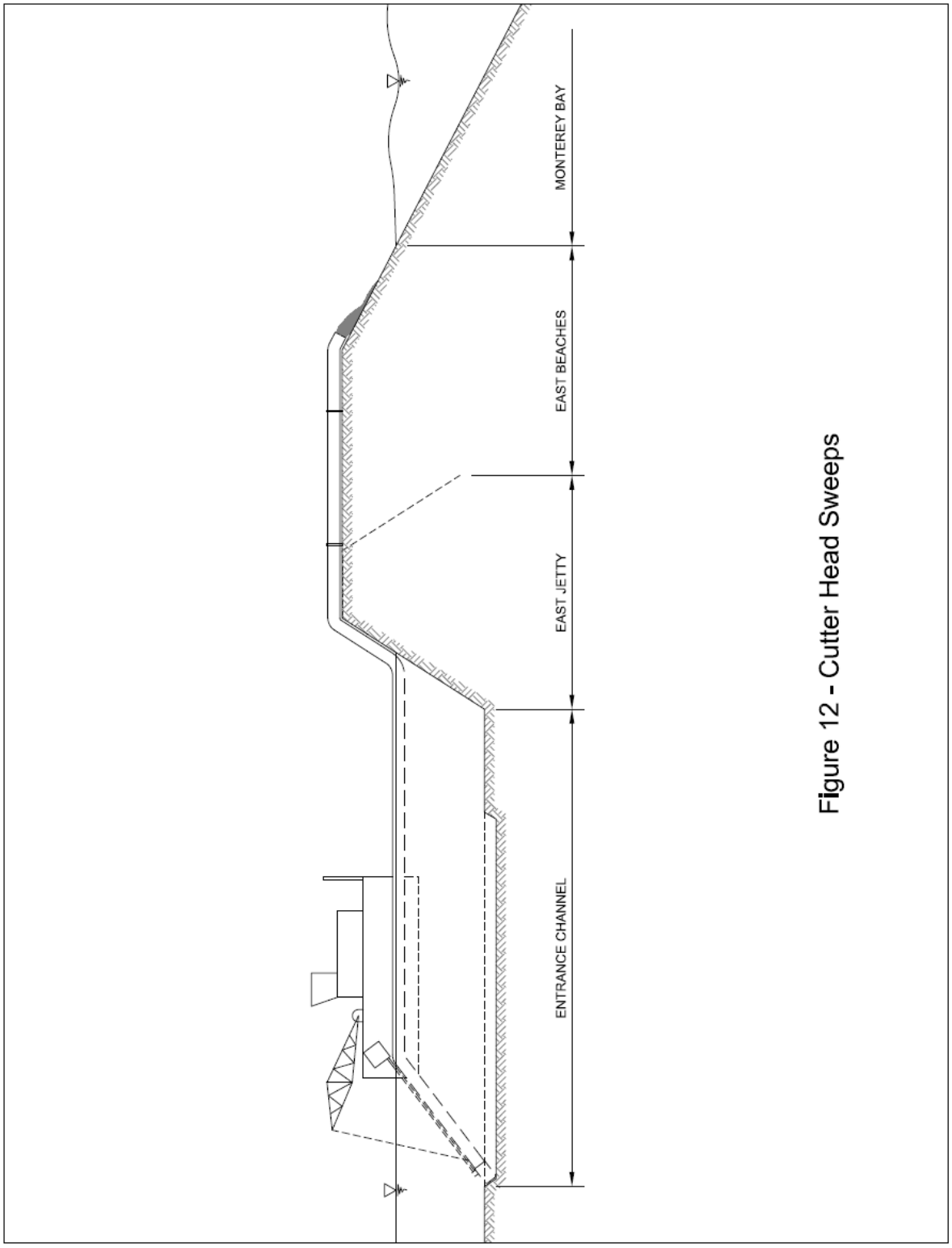


Figure 12 - Cutter Head Sweeps

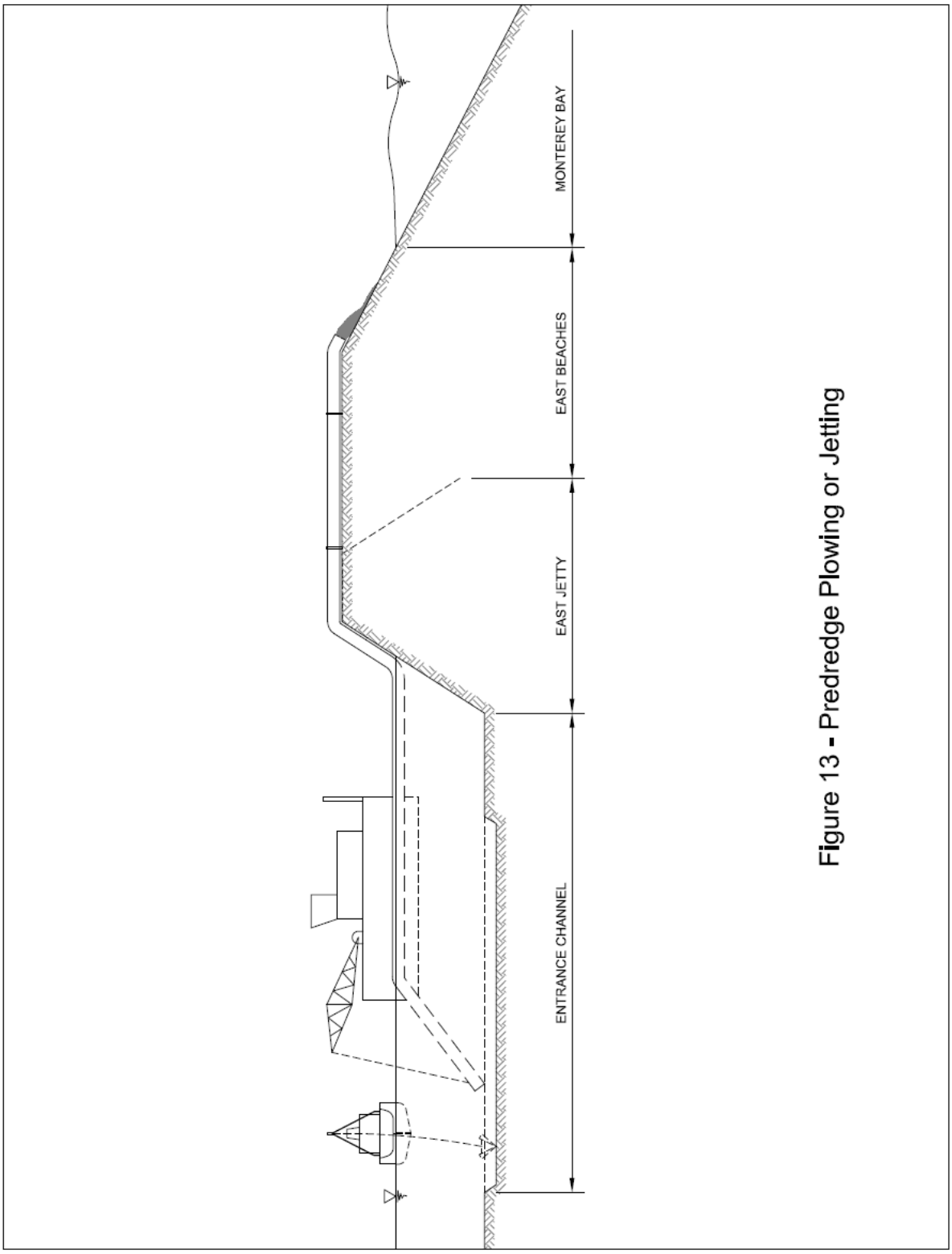


Figure 13 - Predredge Plowing or Jetting

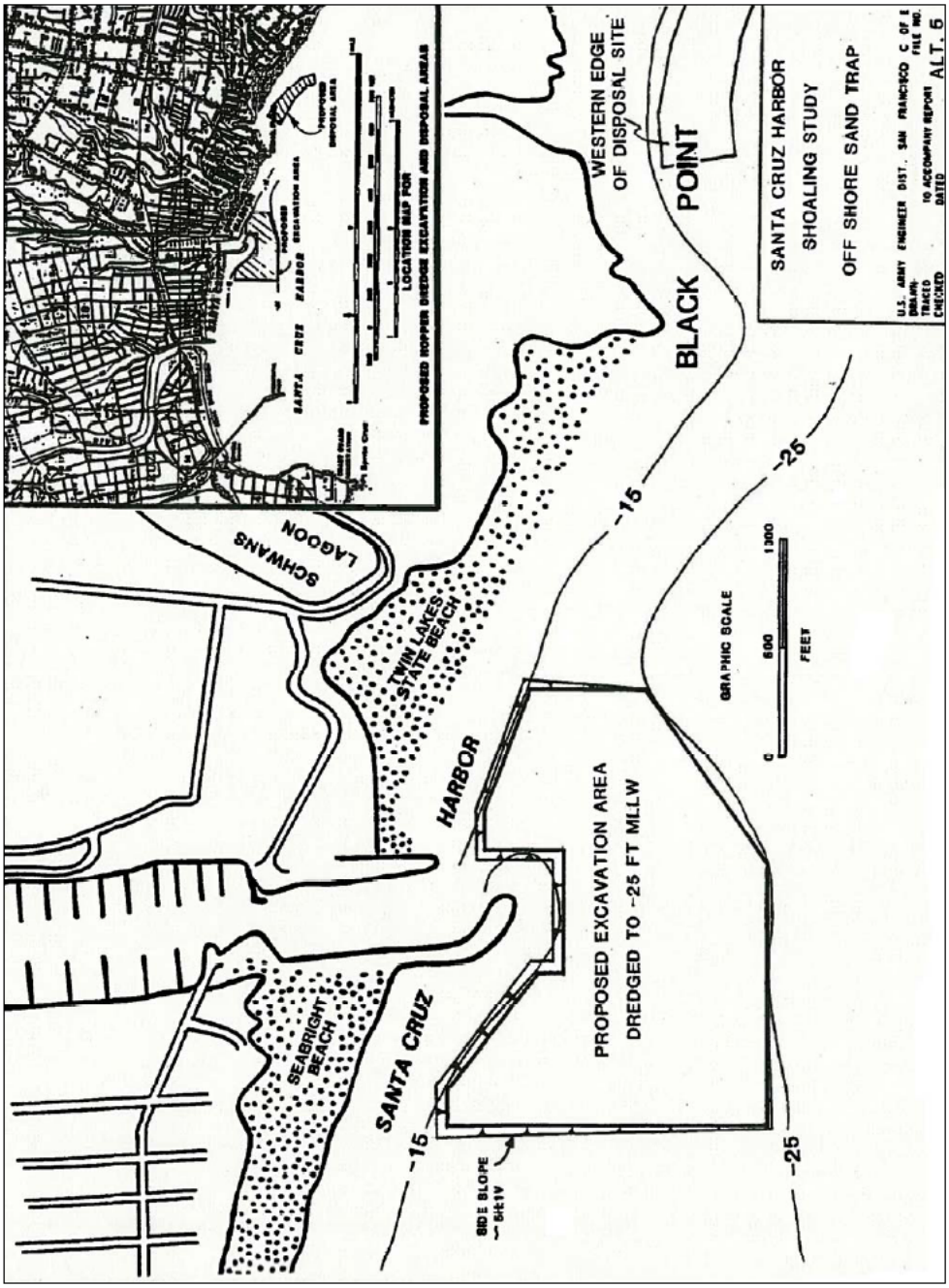


Figure 14 - Restore Upcoast Sand Trap with Downcoast Offshore Disposal Site

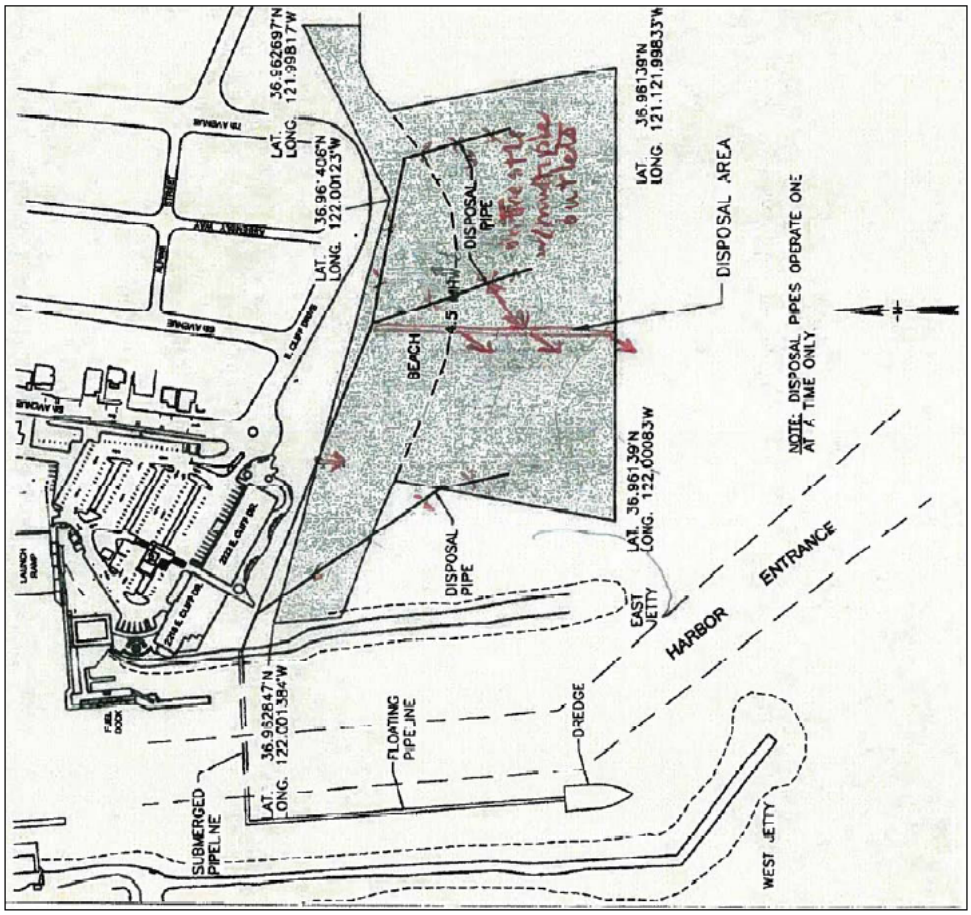


Figure 15 - Offshore Disposal Pipeline Plan

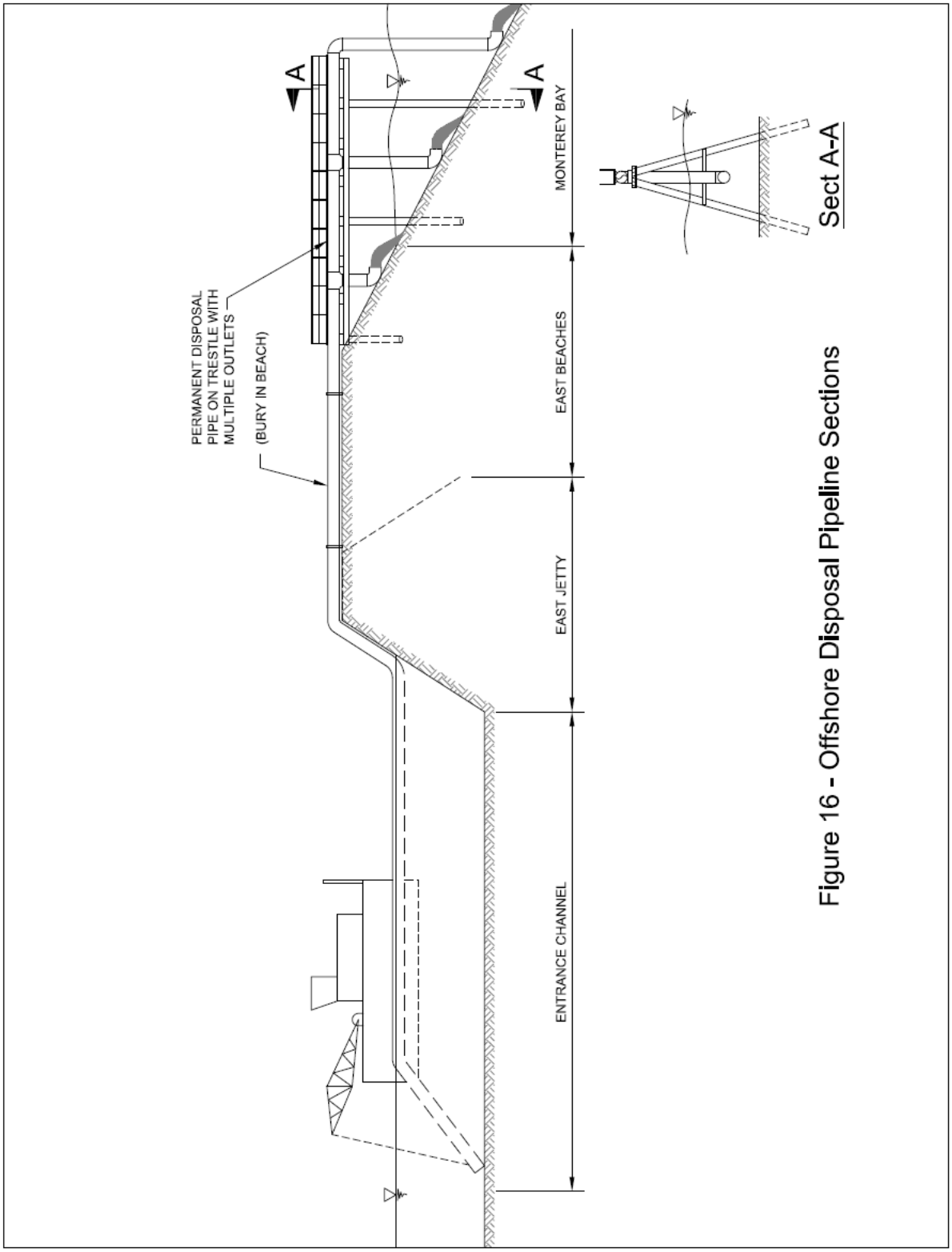


Figure 16 - Offshore Disposal Pipeline Sections

Fig 17 - Dry Zone Disposal Plan

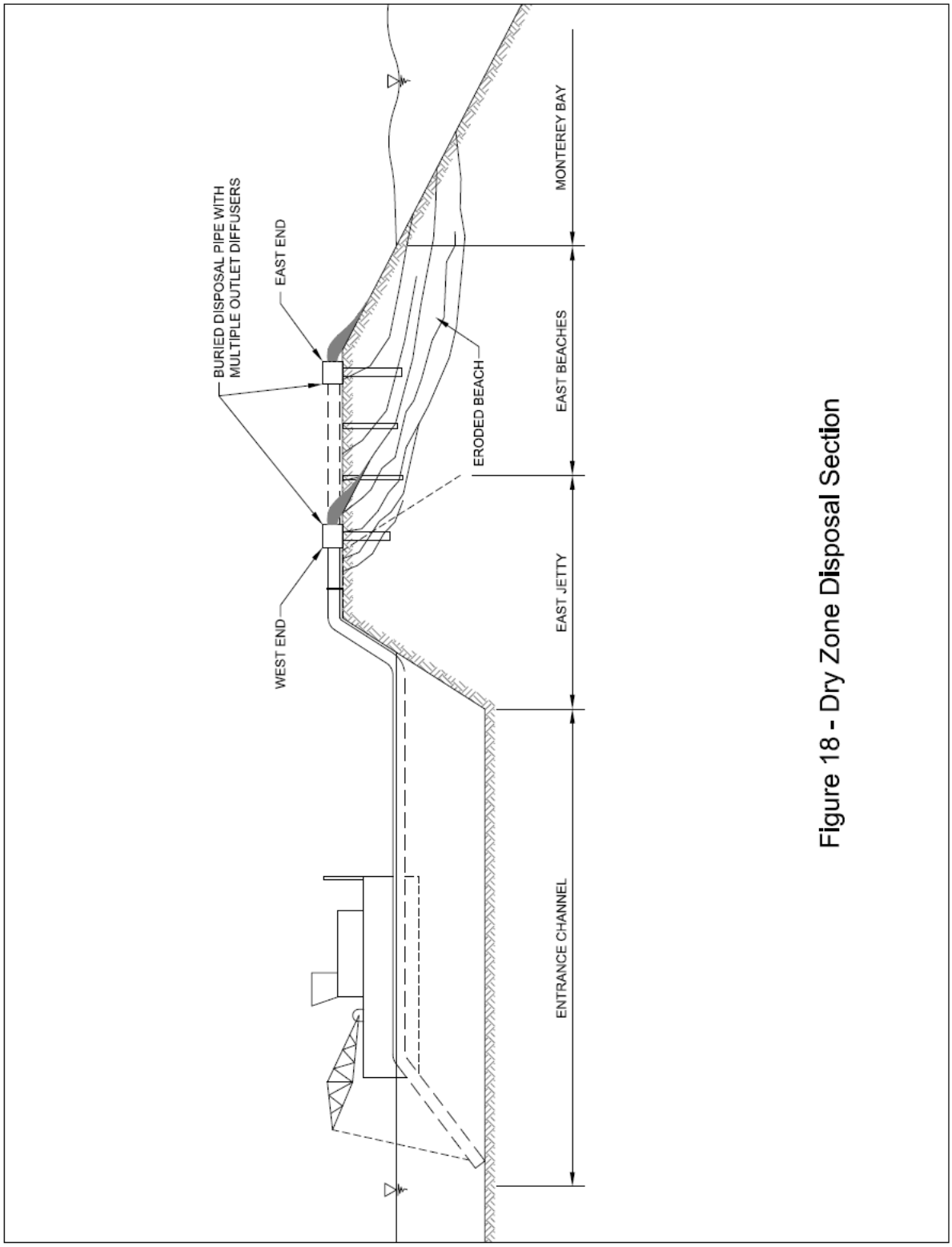


Figure 18 - Dry Zone Disposal Section

APPENDIX A

VEGETATION OBSERVATIONS AT SANTA CRUZ HARBOR

(STORM OF MARCH 24-25, 2011)

APPENDIX C

VEGETATION OBSERVATIONS AT SANTA CRUZ HARBOR

STORM OF MARCH 24-25, 2011

Kinnetic Laboratories, Inc.

Observations of vegetation in nearshore drift and deposited along the shoreline near and around Santa Cruz Harbor was performed on 24 March during the storm of 24-25 March 2011 (Figure 1). Obvious terrestrial wood debris was observed discharged at the mouth of the San Lorenzo River (Figure 2). The combination of storm and tidal surge caused erosion of newly placed sand east (downcoast) of the jetty (Figure 3) and deposited a mix of terrestrial and marine organic debris along the beach face (Figure 4). Giant kelp (*Macrocystis pyrifera*) fragments comprised a large percentage of the organic debris washed up on the beach downcoast of the harbor mouth (Figure 5).

A representative sample of organic debris was collected from material thrown by storm waves over the west jetty breakwater from the upcoast sand trap area (Figures 6 and 7). A subsample of material was taken from the sample and divided into major components (Figure 8). These components consisted surfgrass (Figure 9), red algae (Figure 10), brown algae (Figure 11), and terrestrial debris (Figure 12).

Two species of surfgrass, *Phyllospadix scouleri* (Scouler's surfgrass) and *P. torreyi* (Torrey's surfgrass), are commonly found along Santa Cruz County shorelines. *P. scouleri* has a thicker blade than *P. torreyi*. The subsample of surfgrass is likely to contain both species and comprised approximately 25 to 30% of the total debris mixture (Figure 9). Eelgrass, *Zostera marina*, is sometimes mistaken for surfgrass but no eelgrass was found in the collected debris. Eelgrass beds within Monterey Bay are limited to the estuarine environment of Elkhorn Slough and its entrance to the bay (CDFG, 2010). Both surfgrass (*Phyllospadix sp.*) and eelgrass (*Zostera sp.*) are prohibited species under California Ocean Sport Fishing Regulations (CDFG, 2011 and SIMoN, 2011) and may not be cut or disturbed.

Various red algae comprised approximately 25 to 30% of the total debris mixture (Figure 10). Various brown algae, though primarily *M. pyrifera*, comprised approximately 30% of the total debris mixture (Figure 11). Organic debris from terrestrial sources comprised approximately 5 to 10% of the total debris mixture with willow and oak leaves being the most common component of this fraction.

None of the surfgrass or algal species encountered during this survey are listed or proposed for listing as endangered or threatened under the Federal or California Endangered Species Acts. Nor are any listed as threatened species by the World Conservation Union (formerly the International Union for the Conservation of Nature) (SIMoN, 2011).

REFERENCES

CDFG (California Department of Fish and Game), 2010. Status of the Fisheries Report an Update Through 2008. Report to the California Fish and Game Commission as directed by the Marine Life Management Act of 1998. Prepared by the California Department of Fish and Game Marine Region, August 2010. page 16-5.

CDFG (California Department of Fish and Game), 2011. Ocean Sport Fishing Regulations – Effective March 1, 2011 through February 28, 2012. page 56.

SIMoN (Sanctuary Integrated Monitoring Network), 2011. Monterey Bay National Marine Sanctuary Special Status Species, www.sanctuarysimon.org/monterey/sections/specialSpecies/.

Figure 1. Storm of March 24-25, 2011

Figure 2. Vegetation Discharged Off the San Lorenzo River

Figure 3. Erosion of Newly Placed Sand at Beach East of Jetty, March 24, 2011.

Figure 4. Organic Debris Deposited at Downcoast Beach

Figure 5. Beached Organic Debris Downcoast of the Harbor Mouth with a Large Percentage of Giant Kelp

Figure 6. **Representative Sample of Organic Debris Collected from Material Thrown Over the Breakwater by Storm Surge is Comprised of a Mixture of Marine Algal Fragments, Surfgrass, and Miscellaneous Terrestrial Plants.**

Figure 7. Close-up Image of Representative Sample of Organic Debris.

Figure 8. **Representative Sample of Organic Debris (left) and Subsample Divided into Distinct Piles of the Main Components (right). The Larger Component Piles are Roughly Proportional to Their Contribution of the Total Debris Mixture.**

Figure 9. Surfgrass Component of Divided Organic Debris Subsample.

Figure 10. Red Algae Component of Divided Organic Debris Subsample.

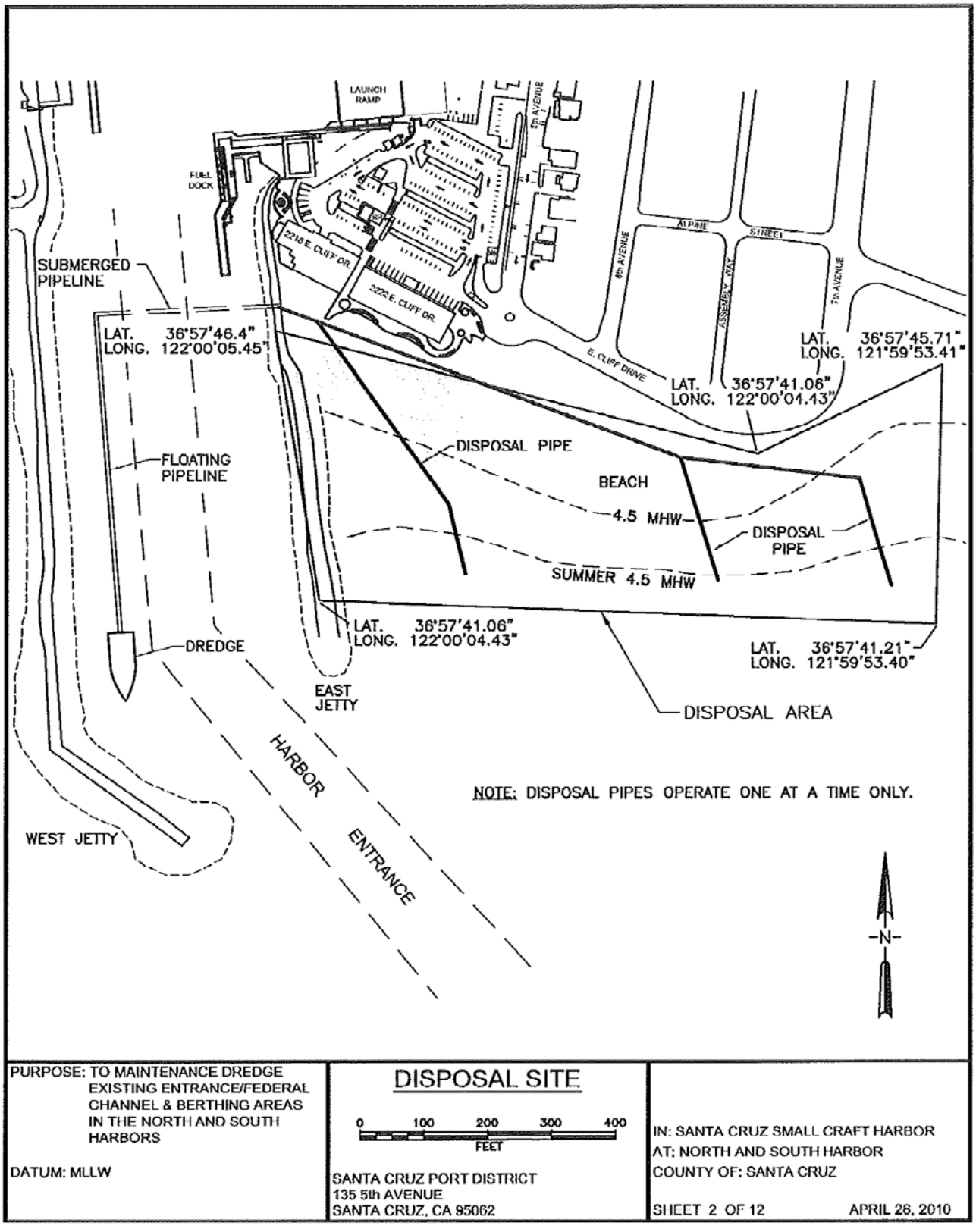
Figure 11. **Brown Algae, including Giant Kelp, Component of Divided Organic Debris Subsample.**

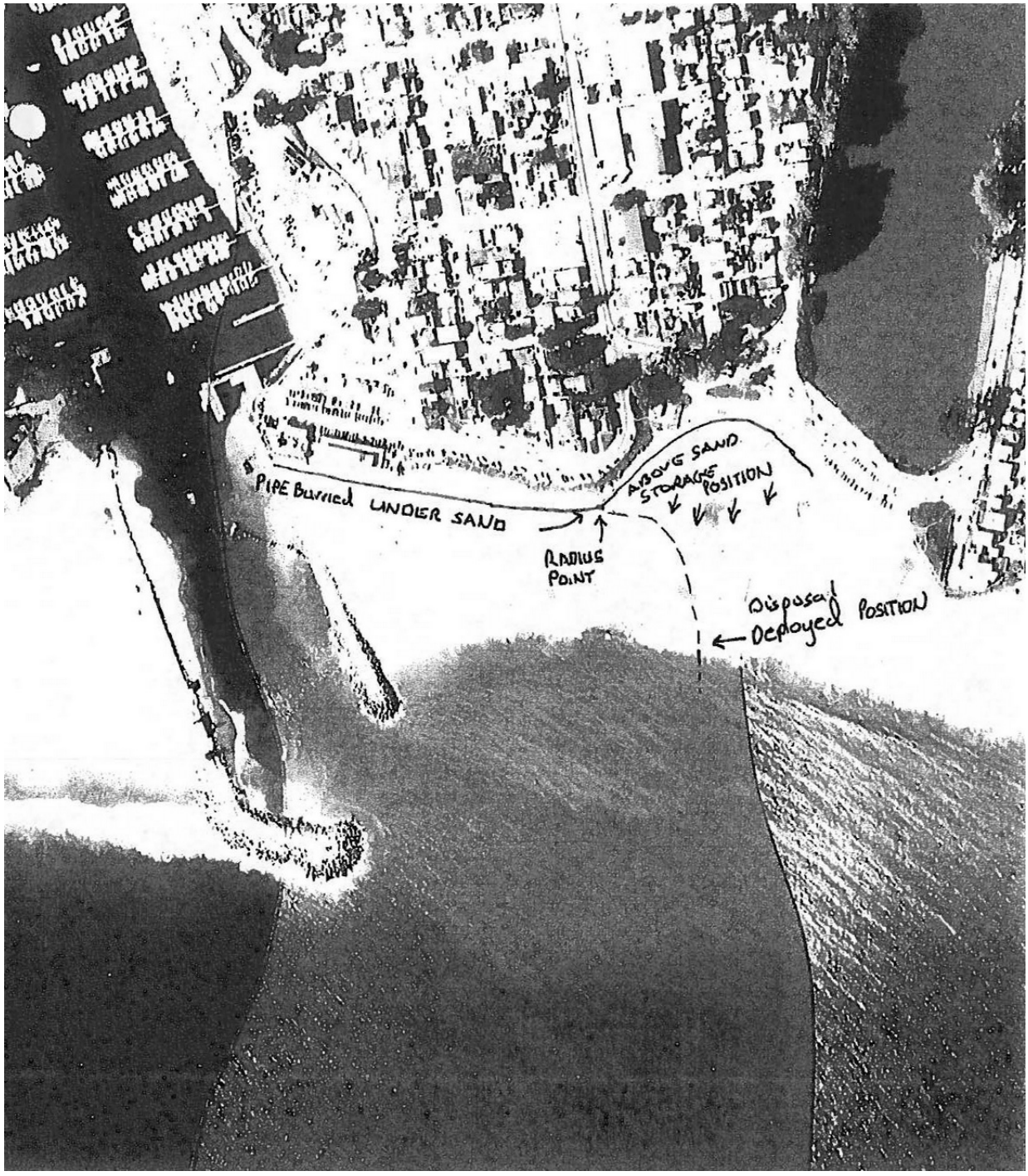
Figure 12. Terrestrial Component of Divided Organic Debris Subsample.

APPENDIX B

DREDGED MATERIAL DISPOSAL PIPELINE LAYOUT

(Santa Cruz Port District, 2010)


LAUNCH RAMP
FUEL DOCK
5th AVENUE
2218 E. CLIFF DR.
2222 E. CLIFF DR.
ALPINE
STREET
4th AVENUE
ASSEMBLY WAY
7th AVENUE
E. CLIFF DRIVE
SUBMERGED PIPELINE
LAT. 36°57'46.4"
LONG. 122°00'05.45"
LAT. 36°57'45.71"
LONG. 121°59'53.41"
LAT. 36°57'41.06"
LONG. 122°00'04.43"
FLOATING PIPELINE
DISPOSAL PIPE
BEACH
4.5 MHW
DISPOSAL PIPE
SUMMER 4.5 MHW
LAT. 36°57'41.06"
LONG. 122°00'04.43"
LAT. 36°57'41.21"
LONG. 121°59'53.40"
DREDGE
EAST JETTY
DISPOSAL AREA
HARBOR ENTRANCE
NOTE: DISPOSAL PIPES OPERATE ONE AT A TIME ONLY.
WEST JETTY
-N-
PURPOSE: TO MAINTENANCE DREDGE EXISTING ENTRANCE/FEDERAL CHANNEL & BERTHING AREAS IN THE NORTH AND SOUTH HARBORS
DATUM: MLLW
DISPOSAL SITE
0 100 200 300 400
FEET
SANTA CRUZ PORT DISTRICT
135 5th AVENUE
SANTA CRUZ, CA 95062
IN: SANTA CRUZ SMALL CRAFT HARBOR
AT: NORTH AND SOUTH HARBOR
COUNTY OF: SANTA CRUZ
SHEET 2 OF 12
APRIL 26, 2010


PIPE Buried UNDER SAND
RADIUS POINT
ABOVE SAND STORAGE POSITION
Disposal Deployed POSITION

APPENDIX C

SURVEY OF OTHER HARBORS / MARINAS

Summary Sheets and Completed Survey Forms for Each Harbor/Marina

Morro Bay Harbor

Morro Bay, CA
Owner: City of Morro Bay
Website: http://www.morro-bay.ca.us/index.aspx?nid=144

Summary:

- Annual dredging of entrance channel;
- Dredge material discharged on beaches to the north and south, in surf zone;
- Dredge equipment used: hydraulic, hopper, clamshell.

Survey contact:
Eric Endersby, Harbor Operations Manager, City of Morro Bay
EEndersby@morro-bay.ca.us

Morro Bay Harbor

Eric Endersby
4-11-11
via phone interview

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

Federal/Corps dredging.

(1) What is the marina's average volume of dredge material per episode?

- ☐ <80,000 CY
- ☒ 80,000 – 140,000 CY - annual
- ☐ 140,000 – 200,000 CY
- ☒ >200,000 CY - periodic (>5 yrs) when do entire harbor

(2) What is the average frequency of dredge episodes?

- ☒ Annually entrance channel + "Wave entrance improvement proj." (deepening outside entrance channel)
- ☐ 1-3 years
- ☐ 3-5 years
- ☒ >5 years — Fall 2009-2010 dredged entire harbor ~300K cy w/ Fed. ARRA fun

(3) Is the entire marina dredged in one episode?

- ☒ No
- ☐ Yes

If no, please explain: entrance channel sep. frequency needed than rest of harbor.

(4) Marina dredging is completed:

- ☒ Mechanically
- ☒ Hydraulically

Type (e.g. Suction, Cutterhead, Clamshell, etc.) barge mounted excavator (AIS); hopper dredge - split hull disposal - beach to south (Morro Strand); hydraulic pipeline - beach to north.

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- ☒ Scow –
- ☐ Crane
- ☐ Bulldozer
- ☐ Other
- ☐ Crane
- ☒ Booster Pump
- ☐ Toyo Pump

(6) Dredging duration is:

☒ <1 month – annual w/ hopper ☐ < 6 months
☒ <3 months - when doing entire harbor ☐ < 9 months
☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft ☐ < 15 ft
☐ < 12ft ☒ > 15 ft – "Wave improvement" area = -40
entrance channel = -20'
inner (after turn corner) = -14

(8) Where is dredge material disposed of?

☒ Nearshore waters ☒ Downstream beach – Surf zone } ie. place mat'l both to South & north of harbor
☐ Offshore waters (outside of littoral zone) ☒ Other – "upcoast" beach 2surf zone }

(9) Are there organics present in the dredge material?

☐ No ☒ Yes

If Yes please provide percentage and/or sediment testing reports.
- decayed kelp.

(10) Have there ever been issues with odor during dredge operations?

☐ No ☒ Yes - periodically throughout disposal timeframe (Oct-Feb).

If Yes please describe Surfer's Complained. Relatively Sparsely-used beaches (housing only at northern end of beach discharge sites). Educated surfer's on what was going on.

(11) Do you have a permanent sand by-passing system?

☒ No ☐ Yes

If Yes please describe _____

_____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☒ 2 – 8 ft ☒ 8 – 14 ft
☒ 14 – 20 ft ☒ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☒ No- only get seasonal effects. ☐ Yes

Location: _____

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No ☒ Yes

Location: both sides of harbor

(15) Is the littoral transport rate along the shoreline known?

☒ No ☐ Yes

Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☒ Longshore Direction: both ways/directions (possibly tied to seasons)

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☒ No ☐ Yes

If Yes please describe _____

_____

If you feel that there are any additional details which have not been provided above please feel free to comments below:

_____

_____

_____

_____

_____

_____

_____

Santa Barbara Harbor

Santa Barbara, CA
Owner: City of Santa Barbara
Website: http://www.santabarbaraca.gov/Government/Departments/Waterfront/index.htm

Summary:

- Annual dredging of entrance channel;
- Dredge material discharged on downcoast beaches, in surf zone and occasionally on dry beach;
- Dredge equipment used: hydraulic.

Survey contact:
Karl Trieberg, Waterfront Facilities Manager, City of Santa Barbara
KTrieberg@SantaBarbaraCA.gov

Santa Barbara Harbor

Karl Trieberg
4-1-11

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- ☐ <80,000 CY
- ☐ 80,000 – 140,000 CY
- ☐ 140,000 – 200,000 CY
- ☒ >200,000 CY

(2) What is the average frequency of dredge episodes?

- ☒ Annually
- ☐ 1-3 years
- ☐ 3-5 years
- ☐ >5 years

(3) Is the entire marina dredged in one episode?

- ☒ No
- ☐ Yes

If no, please explain:

Santa Barbara Harbor is dredged annually in two cycles, spring and fall.

(4) Marina dredging is completed:

- ☐ Mechanically
- ☒ Hydraulically

Type (e.g. Suction, Cutterhead, Clamshell, etc.) Cutterhead

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- ☐ Scow
- ☒ Crane
- ☒ Bulldozer
- ☒ Other Excavator, barge, dredge tender, AWD heavy lift
- ☐ Crane
- ☐ Booster Pump
- ☐ Toyo Pump

(6) Dredging duration is:

- ☐ <1 month
- ☒ <3 months
- ☐ < 6 months
- ☐ < 9 months
- ☐ > 9 months

(7) Maintenance Dredging Depth is:

- ☐ < 10 ft
- ☐ < 12ft
- ☐ < 15 ft
- ☒ > 15 ft

(8) Where is dredge material disposed of?

usually surf zone, but Sometimes higher up on beach.

- ☐ Nearshore waters
- ☐ Offshore waters (outside of littoral zone)
- ☒ Downstream beach
- ☐ Other _____

(9) Are there organics present in the dredge material?

- ☐ No
- ☒ Yes

Very minor but some kelp and other marine detritus.

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

- ☐ No
- ☒ Yes

If Yes please describe Occasionally dredge picks up decomposing organic material that smells bad at discharge site.

(11) Do you have a permanent sand by-passing system?

- ☒ No
- ☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

- ☒ 2 – 8 ft
- ☐ 8 – 14 ft

☐ 14 – 20 ft ☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☒ No ☐ Yes

Location: _____

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☒ No ☐ Yes

Location: _____

(15) Is the littoral transport rate along the shoreline known?

☐ No ☒ Yes

Rate: 320,000 c.y. per year

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☒ Longshore Direction: West to east

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☒ No ☐ Yes

If Yes please describe _____

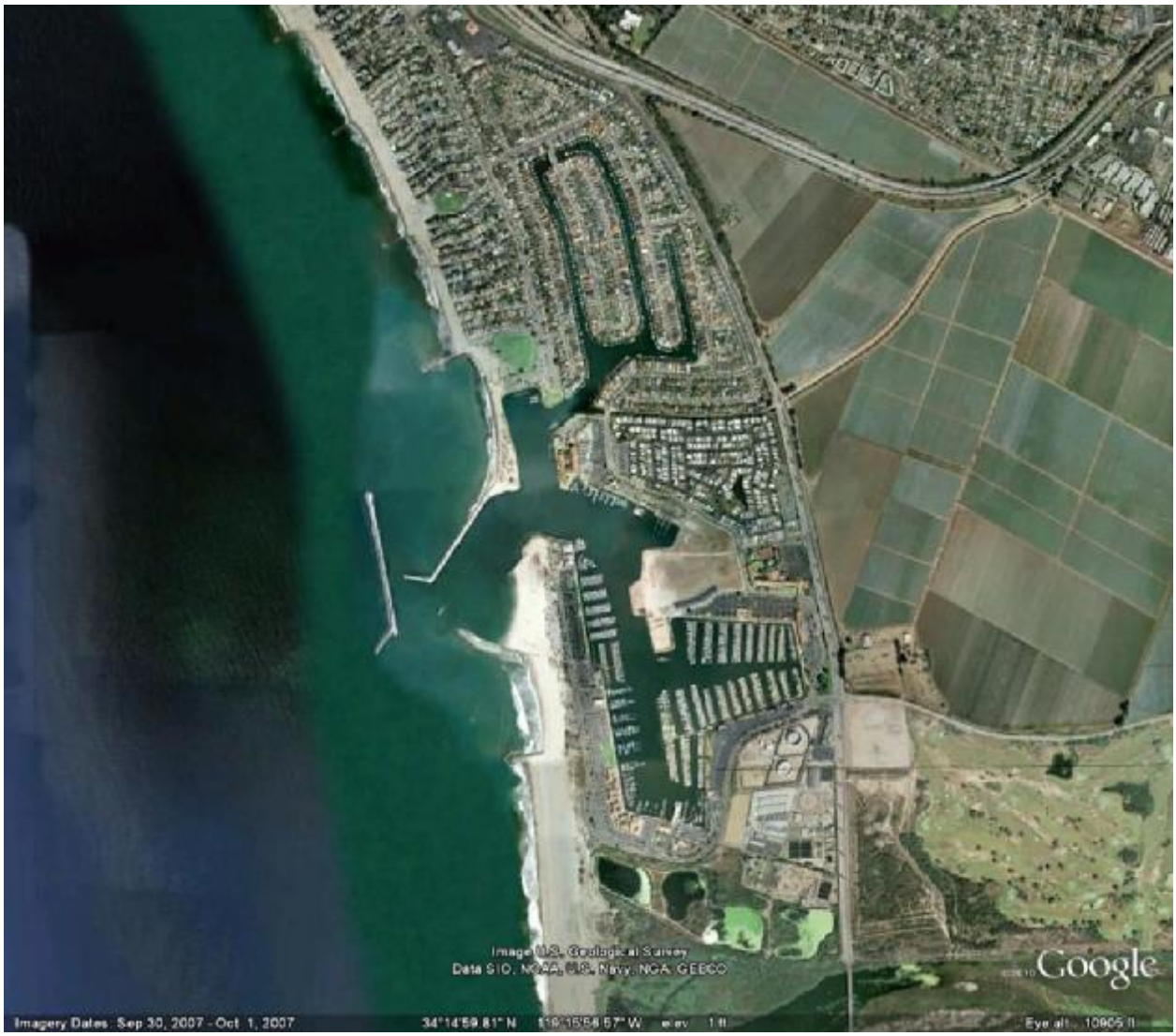
If you feel that there are any additional details which have not been provided above please feel free to comments below:

Ventura Harbor

Ventura, CA
Owner: Ventura Port District
Website: http://www.venturaharbor.com/index.html

Summary:

- Annual dredging of entrance channel;
- Entrance channel dredge material discharged on downcoast beaches, in surf zone;
- Inner harbor fine-grain material disposed in vicinity of mouth of Santa Clara River when river is flowing;
- Dredge equipment used: hydraulic, hopper, clamshell.



Survey contact:
Richard Parsons, Dredging Program Manager, Ventura Port District
rwpdredging@hotmail.com

Ventura Harbor

Richard Parsons - 4/11/11
Ventura Port District
via phone interview

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- [x] <80,000 CY - Port District dredging - inner harbor
- [ ] 80,000 – 140,000 CY
- [ ] 140,000 – 200,000 CY
- [x] >200,000 CY - Federal project (entrance channel + sand trap to north)

(2) What is the average frequency of dredge episodes?

- [x] Annually - Fed proj.
- [x] 1-3 years - Port District inner harbor
- [ ] 3-5 years
- [ ] >5 years

(3) Is the entire marina dredged in one episode?

- [x] No
- [ ] Yes

If no, please explain: Fed and Port District projects separate. Focus on shoaled areas.

(4) Marina dredging is completed:

- [x] Mechanically (sometimes) - Hopper, Clamshell
- [x] Hydraulically (usually) - Cutterhead

Type (e.g. Suction, Cutterhead, Clamshell, etc.)

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- [x] Scow (Dump w/ clamshell op)
- [ ] Crane
- [ ] Bulldozer
- [ ] Other no screens on hydr. discharge pipes.
- [ ] Crane
- [ ] Booster Pump
- [ ] Toyo Pump

(6) Dredging duration is:

☒ <1 month
☒ <3 months
} varies

☐ < 6 months
☐ < 9 months
☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft
☐ < 12ft
☐ < 15 ft
☒ > 15 ft – Fed proj = -20' to -40'
Inner harbor = -18'

(8) Where is dredge material disposed of?

☐ Nearshore waters
☐ Offshore waters (outside of littoral zone)
☒ Downstream beach – Fed Proj.: South Beach + McGrath Beach (surf zone disposal.
☒ Other *

(9) Are there organics present in the dredge material? – have experienced Arundo (large reeds) in harbor – raked/removed from bottom sep from dredging + disposed upland

☒ No / not significant
☐ Yes

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

☐ No
☒ Yes

If Yes please describe odor detected, but did not receive complaints from public – no residences / businesses along beaches/discharge sites.

(11) Do you have a permanent sand by-passing system?

☒ No
☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☒ 2 – 8 ft – usually
☐ 14 – 20 ft
☐ 8 – 14 ft
☒ >20 ft – sometimes.

* Inner harbor mat'l fine-grain – Port District places mat'l in vicinity of mouth of Santa Clara River (to south of harbor entrance) – only when river is flowing.

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☐ No ☒ Yes

Location: upcoast (to north) — Pierpoint - groin field.

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No ☒ Yes

Location: downcoast beach (when over-nourish

(15) Is the littoral transport rate along the shoreline known?

☐ No ☒ Yes

Rate: avg ~600K cy/year

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☒ Longshore Direction: west to east (~north to south)

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ☒ Yes

If Yes please describe Surfer's Point (to north) — beach nourishment

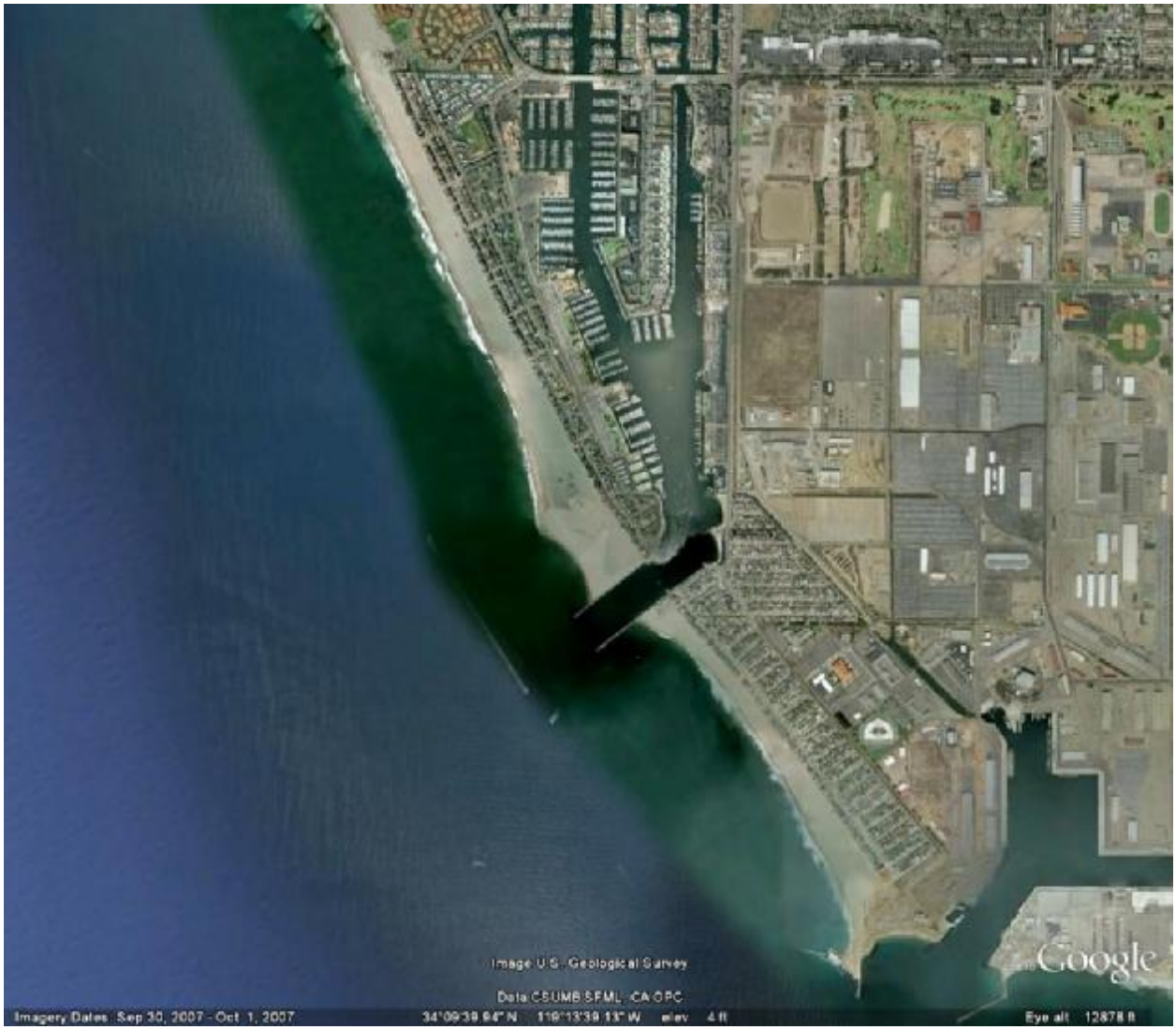
If you feel that there are any additional details which have not been provided above please feel free to comments below:

Channel Islands Harbor

Oxnard, CA
Owner: County of Ventura
Website: http://www.channelislandsharbor.org/index.html

Summary:

- Bi-annual (every two years) dredging of entrance channel and sand trap to north of harbor;
- Dredge material discharged on downcoast beaches, including beach downcoast of Port of Hueneme (i.e. bypass Port of Hueneme);
- Dredge equipment used: hydraulic.



Survey contact:
Jack Peveler, Harbor Master, County of Ventura
Jack.Peveler@ventura.org

Channel Islands Harbor

Jack Peveler
4-15-11

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- ☐ <80,000 CY
- ☐ 80,000 – 140,000 CY
- ☐ 140,000 – 200,000 CY
- ☐ >200,000 CY ***(1,000,000 CY)***

(2) What is the average frequency of dredge episodes?

- ☐ Annually
- ☐ 1-3 years (***every two years)***
- ☐ 3-5 years
- ☐ >5 years

(3) Is the entire marina dredged in one episode?

- ☐ No
- ☐ Yes

If no, please explain: *The outer harbor sand trap and channel entrance*

(4) Marina dredging is completed:

- ☐ Mechanically
- ☐ ***xx Hydraulic suction cutterhead***

Type (e.g. Suction, Cutterhead, Clamshell, etc.) _____

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- ☐ Scow
- ☐ Crane
- ☐ Bulldozer ***xxx***
- ☐ Other _____
- ☐ Crane
- ☐ Booster Pump
- ☐ Toyo Pump

(6) Dredging duration is:

- ☐ <1 month
- ☐ <3 months ***XXX***
- ☐ < 6 months
- ☐ < 9 months
- ☐ > 9 months

(7) Maintenance Dredging Depth is:

- ☐ < 10 ft
- ☐ < 12ft
- ☐ < 15 ft
- ☐ > 15 ft ***35' sand trap -20' entrance channel***

(8) Where is dredge material disposed of?

- ☐ Nearshore waters
- ☐ Offshore waters (outside of littoral zone)
- ☐ Downstream beach ***XXX*** on beach - acts as feeder beach for downcoast area
- ☐ Other _____

(9) Are there organics present in the dredge material?

- ☐ No ***XXX***
- ☐ Yes

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

- ☐ No ***XXX***
- ☐ Yes

If Yes please describe _____

_____

(11) Do you have a permanent sand by-passing system?

- ☐ No ***XXX***
- ☐ Yes

If Yes please describe _____

_____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

- ☐ 2 – 8 ft ***XXX***
- ☐ 14 – 20 ft
- ☐ 8 – 14 ft
- ☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☐ No ***XXX*** ☐ Yes

Location: _____

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No ☐ Yes ***XXX***

Location: ***Sand trap, north of entrance channel***

(15) Is the littoral transport rate along the shoreline known?

☐ No ***XXX*** ☐ Yes

Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☐ Longshore Direction: North to south longshore

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ☐ Yes

If Yes please describe The process was developed as a down coast erosion control measure

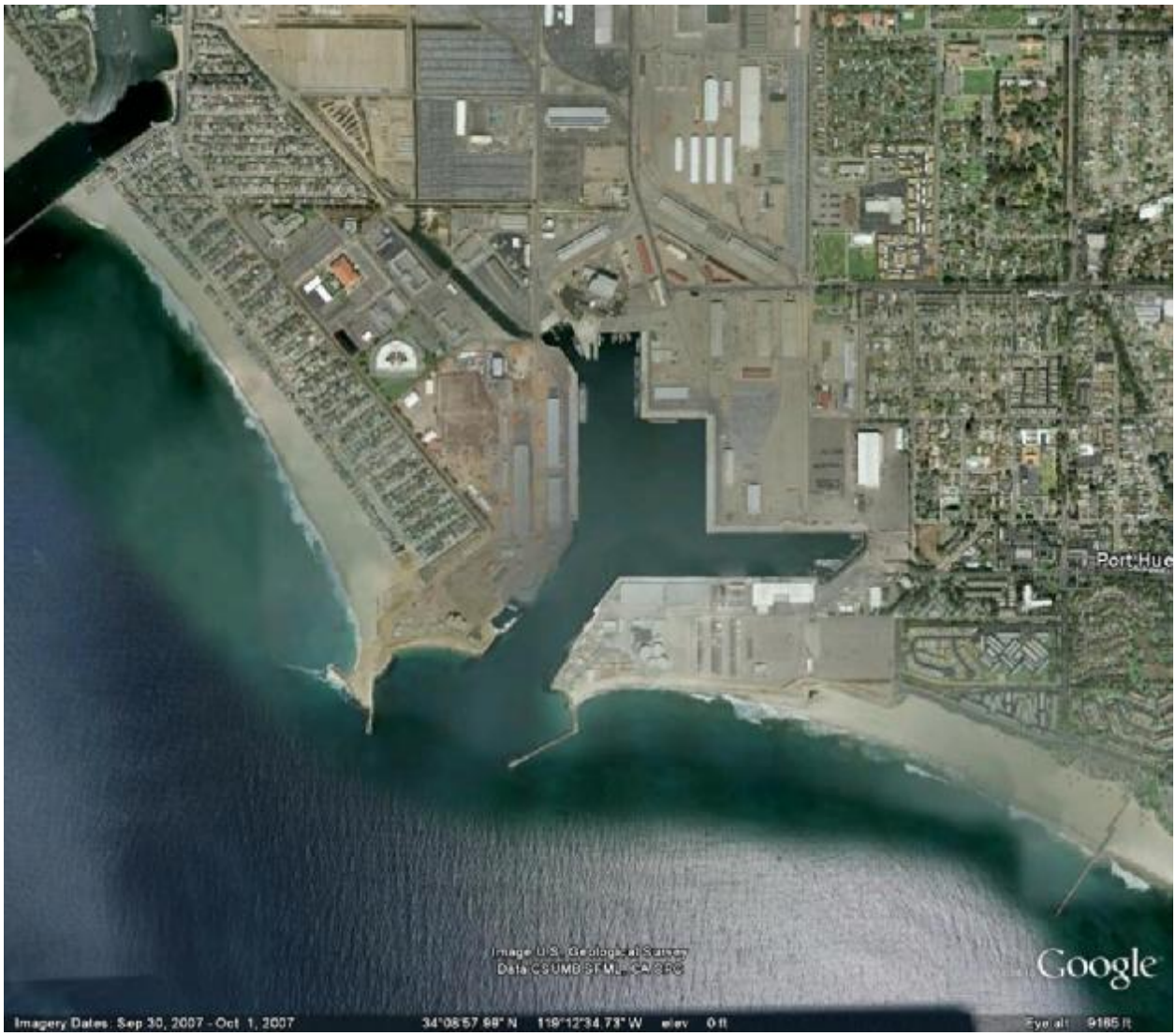
If you feel that there are any additional details which have not been provided above please feel free to comments below:

Port of Hueneme

Port Hueneme, CA
Owner: Oxnard Port District (and Navy)
Website: http://www.portofhueneme.org/home.php

Summary:

- Naval/commercial harbor – no recreational vessels;
- Very infrequent dredging (~every twenty years) because of offshore submarine canyon and upcoast Channel Islands Harbor dredging;
- Harbor dredge material disposed in Confined Aquatic Disposal (CAD) site within Port;
- CAD site dredge material disposed on downcoast beach.



Survey contact:
Chris Birkelo, Director of Engineering, Port of Hueneme
cbirkelo@portofhueneme.org

Port Hueneme

Chris Birkelo
4/7/11
via phone interview

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- [x] <80,000 CY
- [ ] 80,000 – 140,000 CY
- [ ] 140,000 – 200,000 CY
- [ ] >200,000 CY

(2) What is the average frequency of dredge episodes?

- [ ] Annually
- [ ] 1-3 years
- [ ] 3-5 years
- [x] >5 years

- just did 1st maintenance dredge in >20 yrs
- don't accrete in entrance channel because of nearby offshore submarine canyon.

(3) Is the entire marina dredged in one episode?

- [x] No
- [ ] Yes

If no, please explain: _____

(4) Marina dredging is completed:

- [ ] Mechanically
- [ ] Hydraulically

Type (e.g. Suction, Cutterhead, Clamshell, etc.) _____

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- [ ] Scow
- [ ] Crane
- [ ] Bulldozer
- [ ] Other _____
- [ ] Crane
- [ ] Booster Pump
- [ ] Toyo Pump

(6) Dredging duration is:

☐ <1 month
☐ <3 months
☐ < 6 months
☐ < 9 months
☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft
☐ < 12ft
☐ < 15 ft
☐ > 15 ft

(8) Where is dredge material disposed of?

☐ Nearshore waters
☐ Offshore waters (outside of littoral zone)
☐ Downstream beach
☒ Other CAD Site

(9) Are there organics present in the dredge material?

☐ No
☐ Yes

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

☐ No N/A
☐ Yes

If Yes please describe _____

_____

(11) Do you have a permanent sand by-passing system?

☒ No
☐ Yes

If Yes please describe _____

_____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☐ 2 – 8 ft
☐ 14 – 20 ft
☐ 8 – 14 ft
☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☐ No ☐ Yes

Location: _____

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No ☐ Yes

Location: _____

(15) Is the littoral transport rate along the shoreline known?

☐ No ☐ Yes

Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☐ Longshore Direction: _____

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ☐ Yes

If Yes please describe _____

If you feel that there are any additional details which have not been provided above please feel free to comments below:

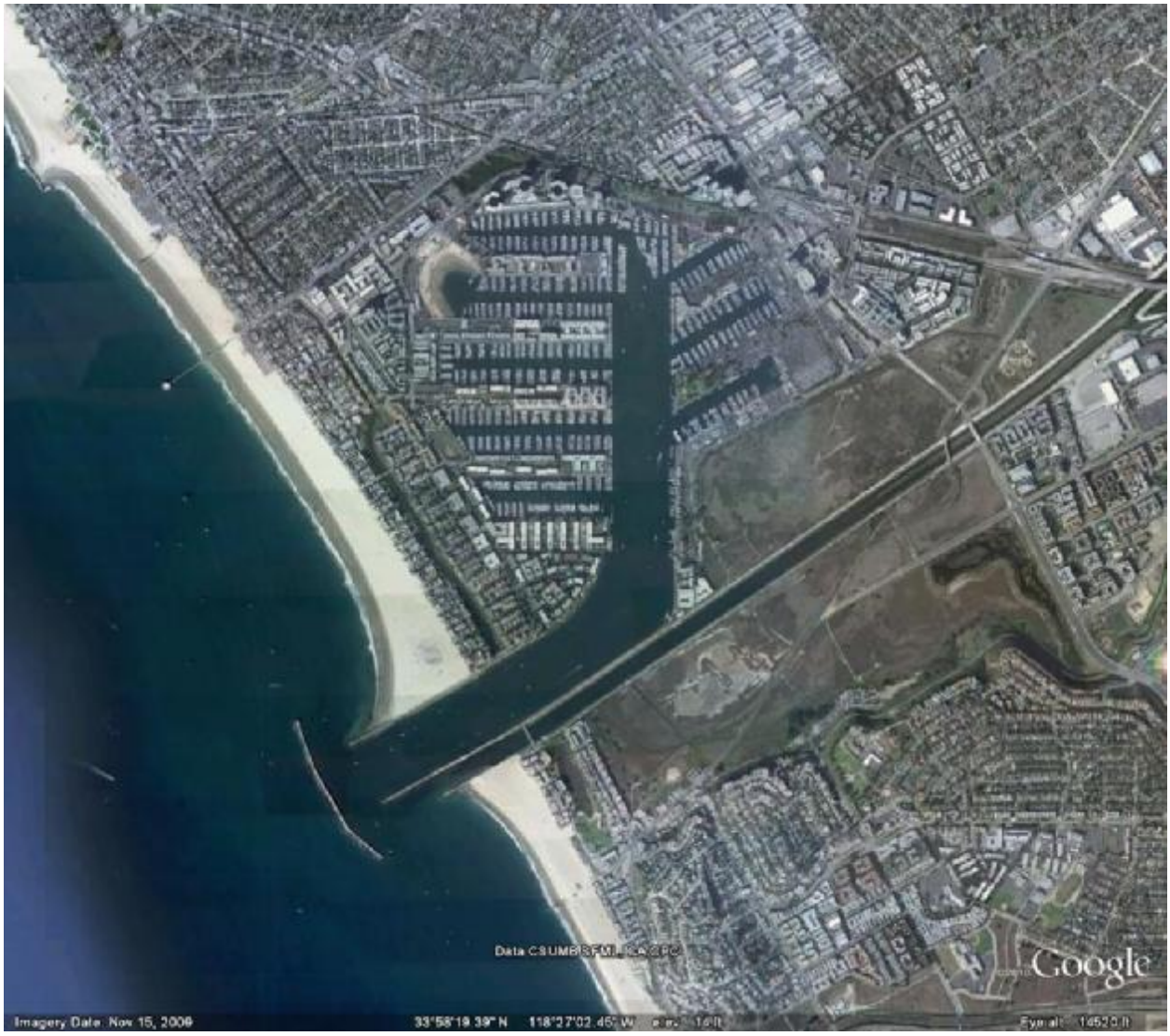
Channel Is. Harbor entrance channel dredging — they "bypass" Port Hueneme by placing dredge mat'l on beach South of P.H. jetty.

Marina del Rey Harbor

Marina del Rey, CA
Owner: Los Angeles County
Website: http://beaches.lacounty.gov/wps/portal/dbh/mdr/ and
http://www.visitmarinadelrey.com/about-the-marina

Summary:

- Dredging of entrance channel every 3-5 years;
- Dredge material discharged on downcoast beaches, on dry beach, in nearshore, and offshore;
- Dredge equipment used: hydraulic, clamshell.



Survey contact:
Cesar Espinosa, L.A. County Dept Beaches and Harbors
CEspinosa@bh.lacounty.gov

Marina del Rey

Cesar Espinosa
4-5-11

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- ☐ <80,000 CY
- ☐ 80,000 – 140,000 CY
- **X** 140,000 – 200,000 CY
- ☐ >200,000 CY

(2) What is the average frequency of dredge episodes?

- ☐ Annually
- ☐ 1-3 years
- **X** 3-5 years
- ☐ >5 years

(3) Is the entire marina dredged in one episode?

- **X** No
- ☐ Yes

If no, please explain: Dredging of the Marina depends on how much sediment is present at the entrance to the harbor, and available funds.

(4) Marina dredging is completed:

- **X** Mechanically
- **X** Hydraulically

Type (e.g. Suction, Cutterhead, Clamshell, etc.) Both methods have been used in Marina del Rey, Hydraulic and Clamshell.

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- **X** Scow
- **X** Crane
- **X** Crane
- **X** Booster Pump
- **X** Bulldozer
- ☐ Toyo Pump
- ☐ Other loaders, work and crew boats, and various trucks.

(6) Dredging duration is:

- ☐ <1 month
- ☐ < 6 months

X <3 months

☐ < 9 months

☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft

☐ < 12ft

☐ < 15 ft

X > 15 ft

(8) Where is dredge material disposed of?

X Nearshore waters

X Offshore waters (outside of littoral zone)

X Downstream beach

X Other Clean material is disposed at Dockweiler State Beach and nearshore. Contaminated material needs site that will take contaminated sediments. (POLB)

(9) Are there organics present in the dredge material?

X No

☐ Yes

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

X No

☐ Yes

If Yes please describe _____

(11) Do you have a permanent sand by-passing system?

X No

☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

X 2 – 8 ft

☐ 8 – 14 ft

☐ 14 – 20 ft ☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

X No ☐ Yes

Location: _____

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No **X** Yes

Location: Sand trap at N. Jetty

(15) Is the littoral transport rate along the shoreline known?

X No ☐ Yes

Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

X Longshore Direction: North to South observed

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

X No ☐ Yes

If Yes please describe _____

_____

If you feel that there are any additional details which have not been provided above please feel free to comments below:

_____

_____

_____

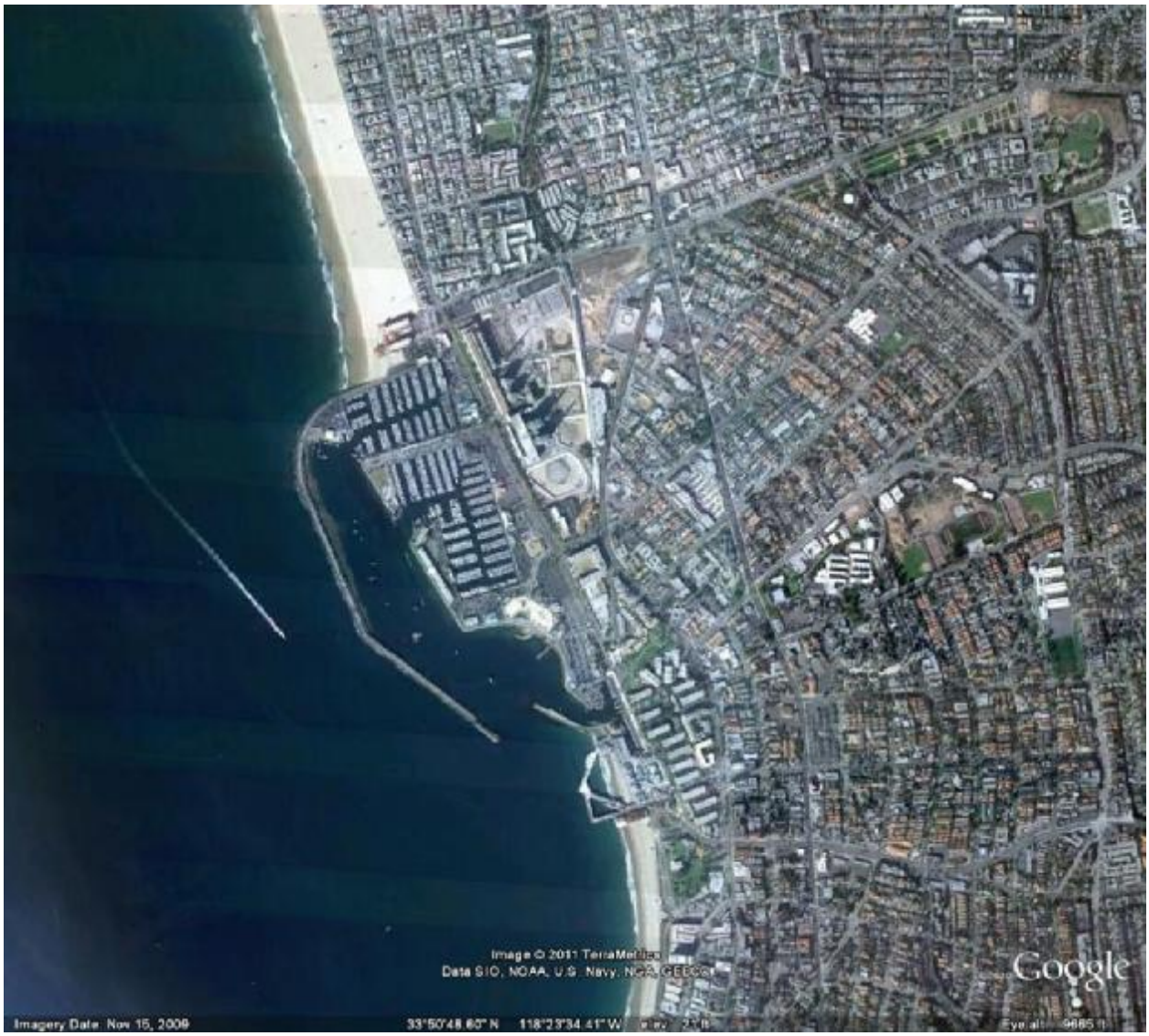
_____

King Harbor

Redondo Beach, CA
Owner: City of Redondo Beach
Website: http://www.redondo.org/depts/hbt/harbor/default.asp

Summary:

- Infrequent dredging;
- Dredge material discharged on downcoast beach, in surf zone;
- Dredge equipment used: hydraulic, clamshell.



Survey contact:
James Allen, City of Redondo Beach

King Harbor - James Allen, City of Redondo Beach
3/30/11 - via telephone.

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- [x] <80,000 CY
- [ ] 80,000 – 140,000 CY
- [ ] 140,000 – 200,000 CY
- [ ] >200,000 CY

(2) What is the average frequency of dredge episodes?

- [ ] Annually
- [ ] 1-3 years
- [ ] 3-5 years
- [x] >5 years – last dredging in 2004 & 1989.

(3) Is the entire marina dredged in one episode?

- [x] No – South end entrance basin – 10ft sand bar at south end. and area on inside of breakwater (sediment comes over + thru porous breakwater)
- [ ] Yes

If no, please explain:

(4) Marina dredging is completed:

- [x] Mechanically
- [x] Hydraulically

Type (e.g. Suction, Cutterhead, Clamshell, etc.) have done both ways:
1) mechanical-onto scow-then barged to beach + pumped on shore
2) hydraulic pipeline all the way from harbor to beach.

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- [x] Scow
- [ ] Crane
- [ ] Bulldozer
- [ ] Other depends on occasion (see above)
- [ ] Crane
- [x] Booster Pump
- [ ] Toyo Pump

(6) Dredging duration is:

☐ <1 month
☐ <3 months
☒ < 6 months
☐ < 9 months
☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft
☐ < 12ft
☒ < 15 ft
☐ > 15 ft

(8) Where is dredge material disposed of?

~150 yds*

☐ Nearshore waters
☐ Offshore waters (outside of littoral zone)
☒ Downstream beach - South of pier (near residences)
☐ Other _____

(9) Are there organics present in the dredge material?

screened
storm drain + power plant discharge - very clean water coming in

☒ No
☐ Yes

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

☒ No
☐ Yes

If Yes please describe but sediment discharged in tidal zone, not higher up on beach.

(11) Do you have a permanent sand by-passing system?

☒ No
☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☒ 2 – 8 ft
☐ 14 – 20 ft
☐ 8 – 14 ft
☐ >20 ft

* KG note: looks like >> 150 yds from Google Earth

Seasonal - County pushes sand to erosional spot (~150 yds South of Pier)

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☒ No ☒ Yes
Location: ~150 yds South of pier

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No ☒ Yes
Location: upstream beach + pass

(15) Is the littoral transport rate along the shoreline known?

☒ No ? ☐ Yes
Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☐ Longshore Direction: _____
☐ Cross-shore ☐ Mixed ☒ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ☒ Yes

If Yes please describe two groins - south of erosion area
1 2 one non-existent & the other relatively new - "doesn't seem to be doing anything"

If you feel that there are any additional details which have not been provided above please feel free to comments below:

- need to dredge again soon; trying to drum up funding to do this.

Newport Harbor

Newport Beach, CA
Owner: City of Newport Beach (and County of Orange for Newport Dunes Marina - Upper Newport Bay)
Website: http://www.newportbeachca.gov/index.aspx?page=148

Summary:

- Infrequent dredging of entrance channel;
- Entrance channel dredge material disposed offshore;
- Dredge equipment used: clamshell.

Survey contact:
Chris Miller, Harbor Resources Manager, City of Newport Beach
CMiller@city.newport-beach.ca.us

Newport Harbor

Chris Miller
City of Newport Beach
4/7/11
via phone interview

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- [x] <80,000 CY - 2003 (~43K cy)
- [x] 80,000 – 140,000 CY - 1981 (~82 Kcy)
- [ ] 140,000 – 200,000 CY
- [ ] >200,000 CY

(2) What is the average frequency of dredge episodes?

- [ ] Annually
- [ ] 1-3 years
- [ ] 3-5 years
- [x] >5 years (every ~30 years in entrance channel)

(3) Is the entire marina dredged in one episode?

- [x] No
- [ ] Yes

If no, please explain: Corps - entrance channel & lower bay Fed channel*; Corps - Upper bay = separate proj.* City / homeowners under docks - RGP 54 permits (typically 500-600 cy)

(4) Marina dredging is completed:

- [x] Mechanically* - Corps dredging
- [x] Hydraulically = local/under docks

Type (e.g. Suction, Cutterhead, Clamshell, etc.) * Corps dredging = Clamshell & then barge/scow to LA-3 offshore disposal.

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- [x] Scow
- [ ] Crane
- [ ] Bulldozer
- [ ] Other _____
- [ ] Crane
- [ ] Booster Pump
- [ ] Toyo Pump

(6) Dredging duration is:

☐ <1 month
☐ <3 months
☐ < 6 months
☐ < 9 months
☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft
☐ < 12ft
☒ < 15 ft - other channels.
☒ > 15 ft - main channel

(8) Where is dredge material disposed of?

☐ Nearshore waters
☐ Offshore waters (outside of littoral zone)
☐ Downstream beach
☒ Other Corps-entrance channel mat'l to LA-5
local - under docks mat'l to adjacent beach.

(9) Are there organics present in the dredge material?

☐ No
☒ Yes – very dark dredge mat'l from under docks; likely organic mat'l is from ~~downstream~~ San Diego River watershed.

If Yes please provide percentage and/or sediment testing reports. ____

(10) Have there ever been issues with odor during dredge operations?

☐ No
☒ Yes

If Yes please describe Smell when mat'l placed on local beaches; smell goes away w/in a few days + sand bleaches out w/in a couple weeks. Residents do not complain (people seem to understand process)

(11) Do you have a permanent sand by-passing system?

☐ No
☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☒ 2 – 8 ft
☐ 14 – 20 ft
☐ 8 – 14 ft
☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☒ No ☐ Yes

Location: _____

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☒ No ☐ Yes

Current dredging needs are from mat'l coming from watershed. Location: _____

(15) Is the littoral transport rate along the shoreline known?

☒ No ☐ Yes

Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☒ Longshore Direction: north to South

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ☒ Yes

If Yes please describe existing groin fields on upcoast beach & some backpassing.

If you feel that there are any additional details which have not been provided above please feel free to comments below:

A few years ago, dredged ~7,500 cy w/in bay harbor (fronting condos complex). Placed mat'l on China Cove & Corona del Mar beaches. Let mat'l dry out & trucked to beaches. No smell. "People putting towels on it the very next day".

Dana Point Harbor

Dana Point, CA
Owner: County of Orange
Website: http://www.ocgov.com/ocgov/OC%20Dana%20Point%20Harbor

Summary:

- Infrequent dredging;
- Dredge material discharged at downcoast beach and small beach within harbor (on dry beach) and offshore;
- Dredge equipment used: hydraulic and clamshell.

Survey contact:
David Rocha, Orange County Dana Point Harbor Department
DRocha@ocdph.com

Dana Point Harbor

David Rocha
4-7-11

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- ☒ <80,000 CY
- ☐ 80,000 – 140,000 CY
- ☐ 140,000 – 200,000 CY
- ☐ >200,000 CY

(2) What is the average frequency of dredge episodes?

- ☐ Annually
- ☐ 1-3 years
- ☐ 3-5 years
- ☒ >5 years

(3) Is the entire marina dredged in one episode?

- ☒ No
- ☐ Yes

If no, please explain: Funding is not available to dredge entire harbor.

(4) Marina dredging is completed:

- ☒ Mechanically
- ☒ Hydraulically

Type (e.g. Suction, Cutterhead, Clamshell, etc.) Some portions by clam shell crain majority by hydraulic suction cutterhead

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- ☒ Scow
- ☐ Crane
- ☒ Bulldozer
- ☒ Other 2 miles of pipeline and tenders and tug
- ☐ Crane
- ☒ Booster Pump
- ☐ Toyo Pump

(6) Dredging duration is:

- ☐ <1 month
- ☐ <3 months
- ☒ < 6 months
- ☐ < 9 months
- ☐ > 9 months

(7) Maintenance Dredging Depth is:

- ☐ < 10 ft
- ☐ < 12ft
- ☒ < 15 ft
- ☐ > 15 ft

(8) Where is dredge material disposed of?

- ☐ Nearshore waters
- ☒ Offshore waters (outside of littoral zone)
- ☒ Downstream beach
- ☐ Other _____

(9) Are there organics present in the dredge material?

- ☐ No
- ☒ Yes

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

- ☐ No
- ☒ Yes -

If Yes please describe **Had issue with sand from anaerobic zone the odor stopped in approximately 4 days after pumping was completed. Sand dried to white color.**

See attached media contact info.

(11) Do you have a permanent sand by-passing system?

- ☒ No
- ☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

- ☒ 2 – 8 ft
- ☐ 8 – 14 ft

☐ 14 – 20 ft ☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☐ No ☒ Yes

Location: Capo Beach down coast of the harbor

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☒ No ☐ Yes

Location: _____

(15) Is the littoral transport rate along the shoreline known?

☒ No ☒ Yes

Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☒ Longshore Direction: north to south (west to east)

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ☒ Yes

If Yes please describe As part of the last two dredguing cycles , there has been beach nourishment operations on Capo Beach(downcoast) and Babay Beach(Within the Dana Point Harbor)

If you feel that there are any additional details which have not been provided above please feel free to comments below:

COUNTY OF ORANGE
OC DANA POINT HARBOR

Brad Gross, Director
24650 Dana Point Harbor Drive
Dana Point, CA 92629
Telephone: (949) 923-2236
Fax: (949) 923-3792

FOR IMMEDIATE ATTENTION

OC DANA POINT HARBOR NEWS MEDIA/BOARD OFFICE CONTACT

TO: Media Contact List

FROM: Lisa Smith, Deputy Director

STAFF MEMBER CONTACTED: Lisa Smith, Deputy Director

DATE/TIME OF CONTACT: November 14, 2008

MEDIA INVOLVED: The OC Register

MEDIA REPRESENTATIVE/PHONE NO. Chris Danes 949-492-5135

Nature of Communication/Request:

To understand why the current pumping of sand onto Capo Beach has a foul odor and looks black.

Information Provided:

Explained the sand will stop omitting a foul odor and the appearance will improve once it has had a chance to dry. The sand on Baby Beach had the same smell and appearance until approximately 4 days after pumping was completed. Explained the testing that occurred prior to the dredging by SD Regional Water Quality Control Board and the Army Corps of Engineers, the testing that goes on during the dredging by the OC Health Department and OC Environmental Resource Services for bacteria, in addition to the testing occurring to verify consistency with original testing. All tests are performed according to the SD Water Quality Control Board and Army Corps of Engineers standards.

Chris indicated he would call back if he had additional questions.

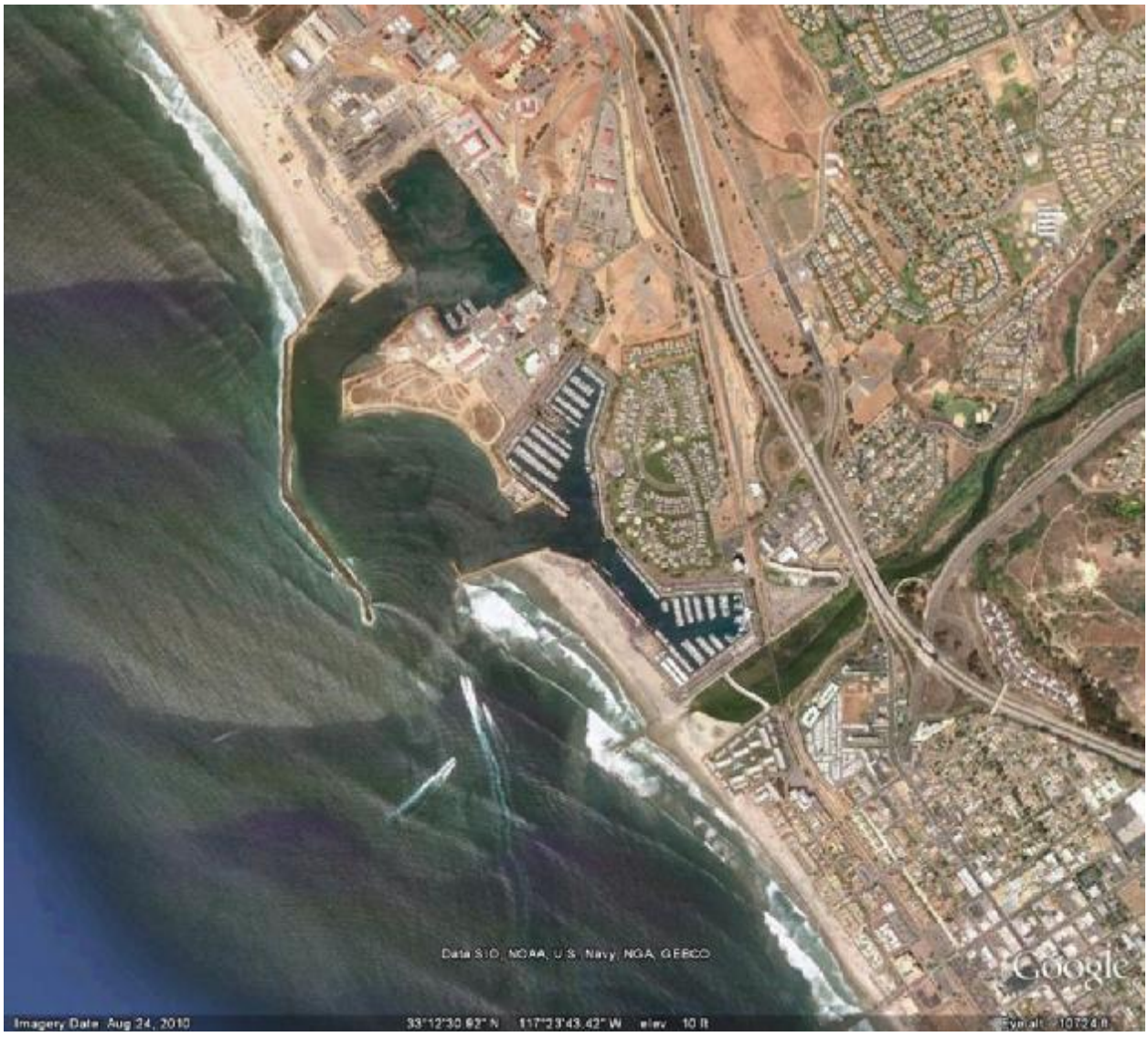
ADDITIONAL COPIES SENT TO: Brad Gross, Director
OC Dana Point Harbor

Oceanside Harbor

Oceanside, CA
Owner: Oceanside Harbor District
Website: http://www.ci.oceanside.ca.us/Datarelation.aspx?Content=204

Summary:

- Annual dredging of entrance channel;
- Dredge material discharged at downcoast beach, in surf zone and on dry beach;
- Dredge equipment used: hydraulic.



Survey contact:
Frank Quan, Oceanside Harbor District,
FQuan@ci.oceanside.ca.us

Oceanside Harbor

Frank Quan
3-30-11

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

☐ <80,000 CY
☐ 80,000 – 140,000 CY
☒ 140,000 – 200,000 CY
☐ >200,000 CY

(2) What is the average frequency of dredge episodes?

☒ Annually
☐ 1-3 years
☐ 3-5 years
☐ >5 years

(3) Is the entire marina dredged in one episode?

☒ No
☐ Yes

If no, please explain: Only the entrance channel is dredged.

(4) Marina dredging is completed:

☐ Mechanically
☒ Hydraulically

Type (e.g. Suction, Cutterhead, Clamshell, etc.) Dredging in Oceanside is an Army Corps of Engineers project and is awarded to the lowest responsible bidder.

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

☒ Scow
☒ Crane
☒ Bulldozer
☐ Other _____
☒ Crane
☒ Booster Pump
☐ Toyo Pump

(6) Dredging duration is:

☒ <1 month
☐ <3 months
☐ < 6 months
☐ < 9 months
☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft
☐ < 12ft
☐ < 15 ft
☒ > 15 ft

(8) Where is dredge material disposed of?

☐ Nearshore waters
☐ Offshore waters (outside of littoral zone)
☒ Downstream beach
☐ Other _____

(9) Are there organics present in the dredge material?

☐ No
☒ Yes - marine life

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

☐ No
☒ Yes

If Yes please describe Several complaints from seasonal residents every year.

(11) Do you have a permanent sand by-passing system?

☒ No
☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☒ 2 – 8 ft ☐ 8 – 14 ft

☐ 14 – 20 ft ☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☐ No ☒ Yes

Location: Entire length of city.

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No ☐ Yes

Location: _____

(15) Is the littoral transport rate along the shoreline known?

☒ No ☐ Yes

Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☐ Longshore Direction: _____

☐ Cross-shore ☐ Mixed ☒ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ☒ Yes

If Yes please describe Sand replenishment

If you feel that there are any additional details which have not been provided above please feel free to comments below:

Mission Bay

San Diego, CA
Owner: City of San Diego
Website: http://www.sandiego.gov/park-and-recreation/parks/missionbay/

Summary:

- Infrequent dredging;
- Dredge material discharged at upcoast beach, on dry beach;
- Dredge equipment used: hydraulic.

Survey contact:
Paul Jacob, Parks and Recreation Dept, City of San Diego
PJacob@sandiego.gov

Mission Bay ~~Mission Bay~~ Paul Jacob~~s~~ - 4/6/11
City of San Diego Parks + Rec Dept *
via phone interview

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- ☐ <80,000 CY
- ☐ 80,000 – 140,000 CY
- ☐ 140,000 – 200,000 CY
- ☒ >200,000 CY ——— 550K cy

(2) What is the average frequency of dredge episodes?

- ☐ Annually
- ☐ 1-3 years
- ☐ 3-5 years
- ☒ >5 years @ since 1984

(3) Is the entire marina dredged in one episode?

- ☐ No
- ☒ Yes

If no, please explain: entrance channel, Mariner's Basin, Quervo Basin, et al
~~can't~~ did not dredge where funding not enough

(4) Marina dredging is completed:

- ☐ Mechanically
- ☒ Hydraulically (on Ocean)

Type (e.g. Suction, Cutterhead, Clamshell, etc.) Suction / cutterhead
placed on Mission Beach (up to 2 miles) near residences

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- ☐ Scow
- ☐ Crane
- ☐ Bulldozer
- ☐ Other no other eqpmt
- ☐ Crane
- ☐ Booster Pump
- ☐ Toyo Pump

(6) Dredging duration is:

* Parks + Rec Dept responsible for dredging inland of bridge; Corps responsible for seaward of bridge.

☐ <1 month
☒ <3 months
☐ < 6 months
☐ < 9 months
☐ > 9 months

(7) Maintenance Dredging Depth is:

☐ < 10 ft
☐ < 12ft
☐ < 15 ft
☒ > 15 ft

shore face slope 10:1 to toe to +12' MS above MHTL constrained by board Scuppers on inland side

(8) Where is dredge material disposed of?

☐ Nearshore waters
☒ ~~Downstream~~ Upcoast beach – north of entrance channel *
☒ Other

(9) Are there organics present in the dredge material?

☐ No
☒ Yes

If Yes please provide percentage and/or sediment testing reports. – not quantified

(10) Have there ever been issues with odor during dredge operations?

☐ No
☒ Yes

If Yes please describe Smell lasted a couple of days, episodically during discharge on beach ~~for~~ over ~4 weeks, discharge period! Smell went away completely quickly after construction completed.

(11) Do you have a permanent sand by-passing system?

☒ No
☐ Yes

If Yes please describe _____

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☒ 2 – 8 ft
☐ 14 – 20 ft
☐ 8 – 14 ft
☐ >20 ft

* not enough area on downcoast beach to place dredge quantity.

although Mission Beach did get nourishment sand as part of SANDAG project.

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☒ No – San Diego River feeds downcoast beaches (e.g. Ocean Beach)

☐ Yes
Location: _____

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No

☒ Yes – but mat'l does get thru jetty.
Location: _____

(15) Is the littoral transport rate along the shoreline known?

☒ No

☐ Yes
Rate: _____

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☒ Longshore Direction: north to south

☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☒ No (SANDAG)

☐ Yes

If Yes please describe _____

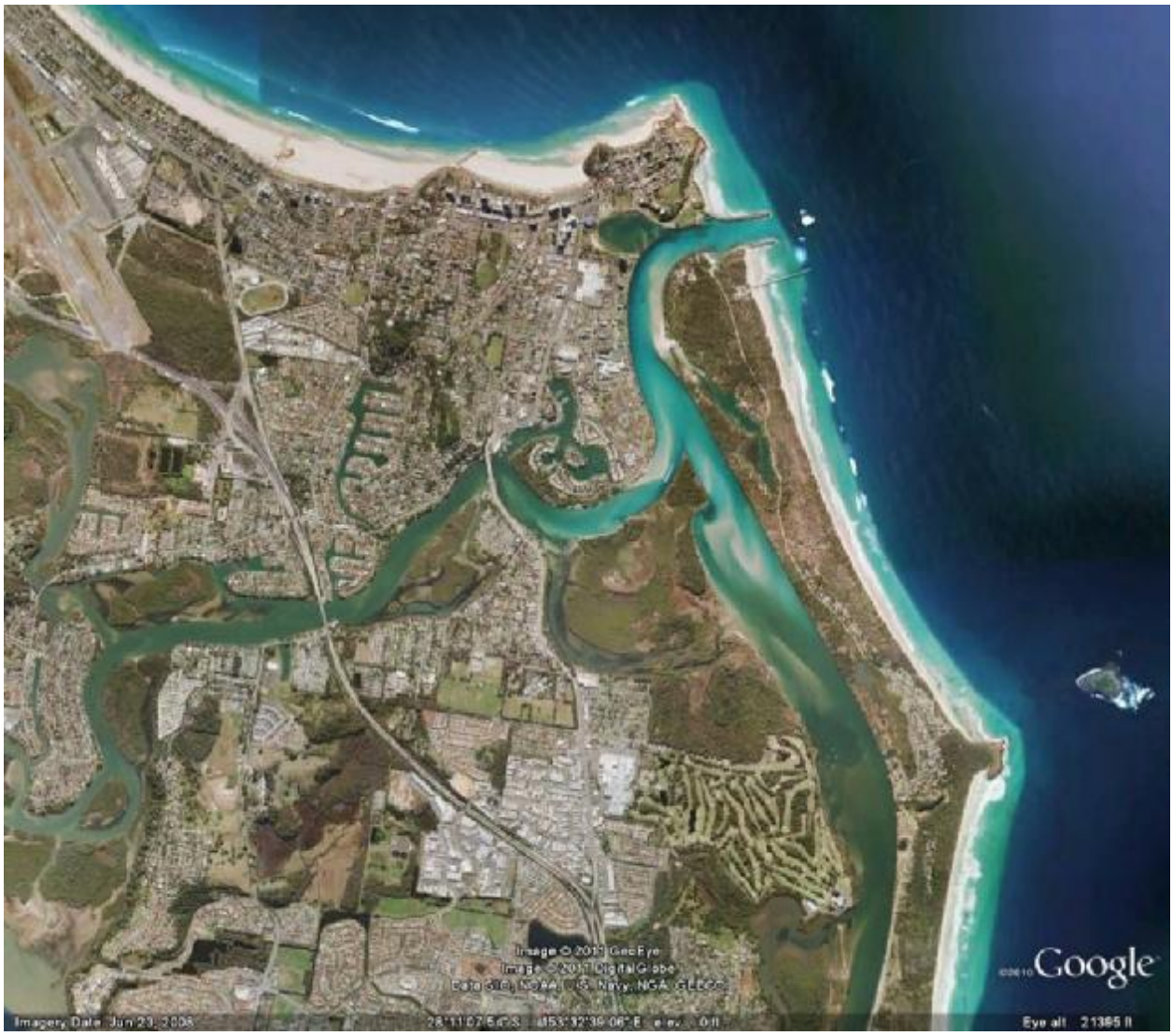
If you feel that there are any additional details which have not been provided above please feel free to comments below:

Tweed River Harbor

Queensland, Australia
Owner: Queensland Government, NSW Land and Property Management Authority
Website: http://www.tweedsandbypass.nsw.gov.au/

Summary:

- Year-round sand bypassing operation;
- Dredge material discharged on downcoast beaches;
- Dredge equipment used: permanent bypass system comprised of sediment intake jetty upcoast of harbor entrance and hydraulic discharge pipes to downcoast beaches;
- Prior to sand bypassing system, material removed in entrance via hopper dredge and deposited in nearshore.



Survey contact (done via website information):
http://www.tweedsandbypass.nsw.gov.au/

Tweed River Harbor, Australia

4-15-11
KG via website info

Introduction
This questionnaire is intended to describe the coastal processes, dredging demand, and dredging and disposal operation of your facility. Please fill out the questions below to the best of your ability and provide any additional details and information you feel is appropriate. Thank you for your time and information.

(1) What is the marina's average volume of dredge material per episode?

- ☐ <80,000 CY
- ☐ 80,000 – 140,000 CY
- ☐ 140,000 – 200,000 CY
- ☒ >200,000 CY

(2) What is the average frequency of dredge episodes?

- ☒ Annually
- ☐ 1-3 years
- ☐ 3-5 years
- ☐ >5 years

(3) Is the entire marina dredged in one episode?

- ☐ No N/A
- ☐ Yes

If no, please explain: _____

(4) Marina dredging is completed:

- ☐ Mechanically
- ☒ Hydraulically

Second phase: permanent bypassing;
Inital phase via trailing suction dredge – pumped via pipeline onto upper beaches & nearshore.

Type (e.g. Suction, Cutterhead, Clamshell, etc.) "Sand collection jetty" – Sand trap in conjunction w/ ten submerged jet pumps; into slurry pit & then pumped via pipeline ~~to~~ under River to downcoast beaches.

(5) Additional Equipment used in the dredge and disposal operation: (check all that apply)

- ☐ Scow
- ☐ Crane
- ☐ Crane
- ☐ Booster Pump
- ☐ Bulldozer
- ☐ Toyo Pump
- ☒ Other Unique system – see above discharge pipe series w/ four potential outlet locations

(6) Dredging duration is:

☐ <1 month
☐ <3 months
☐ < 6 months
☐ < 9 months
☒ > 9 months – year-round

(7) Maintenance Dredging Depth is:

☐ < 10 ft
☐ < 12ft
☐ < 15 ft
☐ > 15 ft

(8) Where is dredge material disposed of?

☐ Nearshore waters
☐ Offshore waters (outside of littoral zone)
☒ Downstream beach – four outlets.
☐ Other _____

(9) Are there organics present in the dredge material?

☒ No – not noted although mentions Sand is initially a grey colo
☐ Yes + then bleaches out.

If Yes please provide percentage and/or sediment testing reports.

(10) Have there ever been issues with odor during dredge operations?

☒ No
☐ Yes

If Yes please describe _____

(11) Do you have a permanent sand by-passing system?

☐ No
☒ Yes

If Yes please describe See above.

(12) Wave conditions outside the marina annually range from: (Check min and max values)

☐ 2 – 8 ft
☐ 14 – 20 ft
☐ 8 – 14 ft
☐ >20 ft

(13) Has long-term erosion occurred in the vicinity of the marina? (e.g. downstream beach, downstream bluff, etc.)

☐ No ☒ Yes
Location: downcoast beaches

(14) Is there significant sediment accumulation outside of the marina? (e.g. upstream beach, upstream jetty, etc.)

☐ No ☒ Yes
Location: upcoast beach

(15) Is the littoral transport rate along the shoreline known?

☐ No ☒ Yes
Rate: 500K m^3/yr ≈ 650K cy/yr

(16) What is the dominant direction of littoral transport in the vicinity of the marina?

☒ Longshore Direction: north to south
☐ Cross-shore ☐ Mixed ☐ Unknown

(17) Has there been or are there ongoing improvements to address erosion in the vicinity of the marina (such as beach nourishment, groin fields, sea walls, etc.)?

☐ No ? ☐ Yes

If Yes please describe _____

If you feel that there are any additional details which have not been provided above please feel free to comments below:

System cost $23.3 M, (in 2001)

Sand Bypassing the Tweed River Entrance:

An Overview

Alan Dyson
Project Director (NSW), Tweed River Entrance Sand Bypassing Project
New South Wales Department of Land & Water Conservation
PO Box 3720 Parramatta 2124
AUSTRALIA
E-mail: adyson@dlwc.nsw.gov.au

Stephen Victory
Project Director (Queensland), Tweed River Entrance Sand Bypassing Project
Queensland Environmental Protection Agency
QGHL, 27 Quinlan Street Deagan 4017
AUSTRALIA
E-mail: Stephen.Victory@env.qld.gov.au

Tom Connor
Project Manager, Tweed River Entrance Sand Bypassing Project
Brown and Root Services Asia Pacific Pty Ltd
299 Coronation Drive Milton 4064
AUSTRALIA
E-mail: tom.connor@halliburton.com

Abstract

The entrance bar of the Tweed River has historically been a concern for navigators. Extensions to the river entrance walls were built in the early 1960s to improve the situation. This was relatively successful for a period, but over time sand accreted on the beach to the south of the entrance and, as sand began to pass the entrance again, a new bar developed seaward of the old bar. During this transition period, extensive erosion occurred on beaches to the north. As the Tweed River is in NSW and the affected beaches are in Queensland, the problems were jointly addressed. A solution was agreed that involved artificially bypassing sand from south of the entrance area to the Queensland beaches.

From the start of work in 1995 until the permanent sand bypassing system began operations in May 2001, 3.6 million cubic metres of sand were dredged from the entrance and used to nourish the beaches to the north. This restored the condition of the southern Gold Coast beaches to their former condition and gave some relief to boat operators.

A permanent system, which has the capacity to move the full littoral transport through pipelines placed under the river and below ground, was built in 14 months and commissioned in May 2001, after the channel was again cleared.

The sand bypassing system is an environmental sustainable method of maintaining the improved beach and navigation conditions.

1. Introduction

The breakwaters at the entrance to the Tweed River were extended in the early 1960s to improve navigation conditions. Navigation conditions improved as a result of the works, but this improvement did not last. Sand accreted to the south of the entrance and, as sand began to pass the entrance again, a new bar formed and navigation conditions worsened.

Beaches to the north eroded to an extent that sea walls were constructed to protect property and infrastructure. They had not fully recovered by the early 1990s, despite the construction of groynes and associated beach nourishment works.

Studies showed that there is a net littoral drift of about 500,000 m^3 a year to the north at this site, and that the interruption of this sand movement by the walls could account for much of this erosion.

2. Interstate Agreement

As the Tweed River entrance is near the border between NSW and Queensland, the problems became a matter for extensive negotiations between the two States. These led to an agreement to undertake a joint project with the following aims:

- establish and maintain an improved navigable entrance to the Tweed River; and

- place an initial quantity of sand on the southern Gold Coast beaches to restore their amenity, and then provide a continuous supply of sand to those beaches,

The agreed solution, which satisfied these objectives, was to artificially move sand from the entrance area to the Queensland beaches.

The work was to be carried out in two stages:

- dredge sand from the entrance and use it to restore the beach profile by placing a net 2.55 million m^3 of sand, and

- develop a permanent sand bypassing system, to collect sand from the southern side of the Tweed River entrance and transport it to the Queensland beaches in perpetuity.

The agreement was ratified by acts of parliament in each state.

3. Initial Dredging and Nourishment

The beaches of the Southern Gold Coast were substantially depleted and navigation conditions were poor when the agreement was reached between the States. Consequently, it was considered desirable to dredge the bar and restore the southern beaches of the Gold Coast as a matter of priority before the construction of the sand bypassing system.

An environmental impact assessment study established the benefit of undertaking this work, and led to the granting of planning approvals.

A contract was awarded to Dredeco Pty Ltd and work commenced in April 1995. A large trailing suction dredge moved about 1.5 million m^3 in a period of 5 weeks. Placement of 600,000 m^3 of sand on the upper beaches from Rainbow Bay in the east to North Kirra in the West was achieved by pumping from a bow pipe through a specially constructed pipeline. This provided an immediate benefit to beach users.

An additional 900,000 m^3 was placed in the nearshore area to provide a foundation to maintain the improvements. While the use of a large dredge was economical, the large volume in each load deposited resulted in an uneven bed surface that adversely affected surfing conditions for several months.

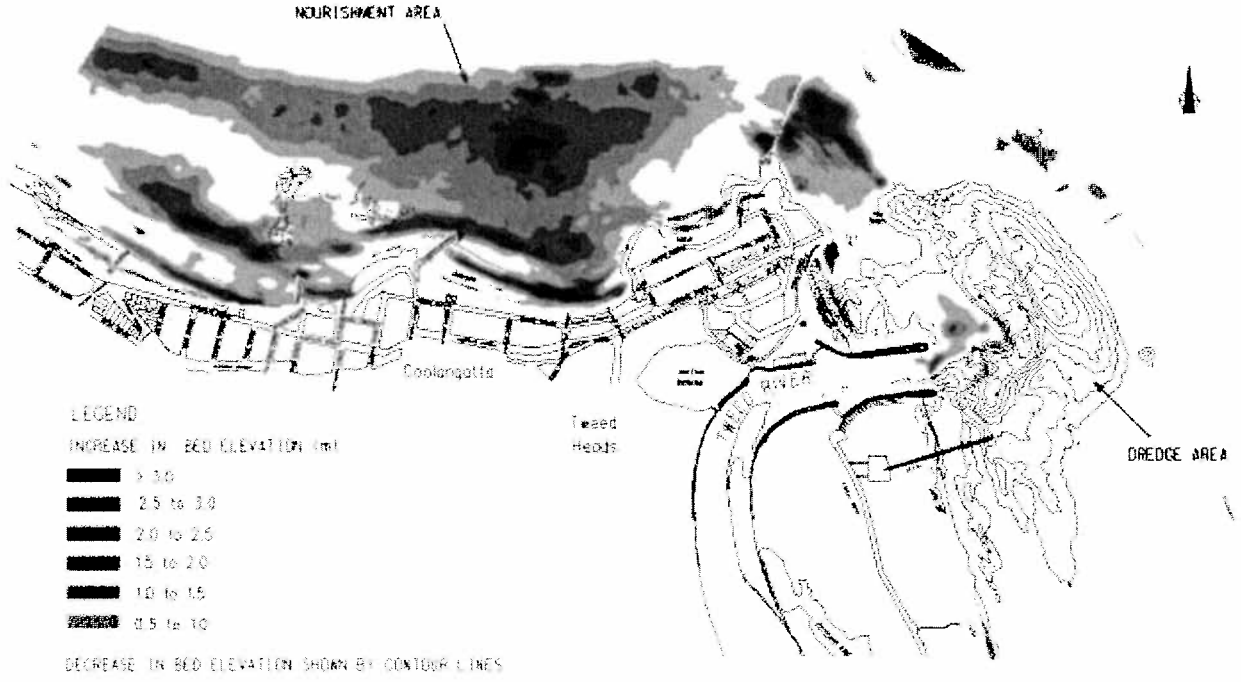


Figure 1 – Bed level changes (April 1995 – January 2001)

Dredging of the river entrance to improve navigation was carried out by shallower drafted vessels. During this work, the placement area was extended to include an area to the east of Snapper Rocks (See Figure 1). This area was under consideration for the primary outlet for the fixed sand bypassing system and is a location from which sand moves naturally to feed the upper beaches of the southern Gold Coast. This placement area also provided shorter travel distances for the dredges and was supported by the surfing community. The placement in this area proved successful and led to further use of this area in later dredging campaigns.

In August 1997, McQuade Marine was contracted for a second dredging and nourishment campaign. No sand was placed on the upper beach as the upper beach conditions were still in a good condition. However, about 40,000 m^3 of sand were placed in very shallow water. The Snapper Rocks (East) location was targeted for a larger proportion of the placement volume. The navigation channel was cleared and 800,000 m^3 of sand were placed over a 9 month period.

Further dredging was carried out in conjunction with the construction of the sand bypassing system (refer Section 4). Less sand could be placed at Snapper Rocks East during this campaign, as the permanent system was being constructed to discharge sand to this area. The nearshore nourishment area was designed to have contours similar to those that existed prior to the extension of the Tweed River breakwaters. A total of 600,000 m^3 was placed to this design between April 2000 and June 2001.

Over a six year period, a total of 3.6 million m^3 of sand was taken from the entrance and placed on the beaches at a cost of $17M. The net result was an increase of over 2.5M m^3 of sand in the beach profile, as shown in Figure 1. Details of this dredging and beach nourishment work are in Boswood et al, 2001, and information on dredge supervision is in Cummings et al, 2001.

4. Fixed Sand Bypassing System

The second stage of the project is to maintain good navigation conditions at the entrance to the Tweed River and to provide a continuous supply of sand to the beaches of the southern Gold Coast at a rate consistent with the natural processes in order to maintain their recreational amenity.

4.1. Procurement

As the project was innovative, and the technology uncertain, it was thought that it would be desirable for the sand bypassing system to be run by the private sector to limit the need for day to day involvement of the two Governments. The involvement of the private sector was a difficult task for the size of the project because of the large variability in the coastal processes, and hence the risks associated with the undertaking.

It was decided that the risk could best be shared by involving a private sector partner in a long-term agreement in which payment would be related to the performance of the system.

A call was made for expressions of interest in 1997 to obtain information about technologies that might be used by proponents in order to ensure that all probable options were considered in the environmental studies.

A Call for Proposals, made in October 1997, attracted 10 submissions. Two firms were then chosen to forward detailed proposals. These were received in November 1998.

A selection panel reviewed and evaluated the detailed proposals against a number of pre-determined criteria and recommended that negotiations be held with a consortium led by McConnell Dowell Constructors (Aust) Pty Limited to design, build and operate a system until September 2024.

These negotiations were successful, and performance based contracts were signed in December 1999. More information on this process is in Dyson *et al* (1999).

4.2. Planning Approval

Environmental Impact Assessment Studies (Hyder *et al, 1997)* were carried out prior to a decision on design, as it had been decided to obtain development approval before selecting a company to design, construct and operate the system.

Apart from predicting a deeper entrance and improved stability and amenity of the southern Gold Coast beaches (with resultant positive economic and community benefits), the environmental studies predicted the following:-

- A change in the shape, alignment and surf quality of Duranbah Beach (immediately to the North of the entrance),
- Increased wave activity on the entrance walls,
- Insignificant changes to tides, floods and storm surge propagation in the Tweed River,
- Improved water quality within the river.

Planning approval was finally obtained in July 1998.

4.3. Design

The permanent system collects sand with 11 jet pumps supported from a pier located about 250 m south of the southern breakwater. Up to five jet pumps are operated at a time, powered by high pressure water collected from the river. The sand and water mixture is then pumped under the Tweed River to the required outlet at Snapper Rocks East, Snapper Rocks West, Kirra Point, or Duranbah Beach (See Figure 2). Two pumps in series are used to move sand the larger distance to Kirra Point. The quantity of sand pumped is measured using a magnetic flow meter in conjunction with a nuclear densometer.

The system also provides for moving sand from the bar from time to time using trailer suction dredges. The frequency of such dredging will depend on the overall efficiency of the permanent system and the occurrence of storm events, which may overwhelm the jetty sand collection unit and allow some sand to "escape".

4.4. Construction

The jetty was built using land based plant and a cantilevered pile driving rig that moved seaward at the completion of each headstock. The final deck and handrails were completed as the work progressed.

The flume and other pipework were built after the jetty was completed. The jet pumps and control gear were installed last of all.

The pump and control building was built concurrently with the jetty. The site required de-watering, as the pumps are located in a basement. A 400mm polyurethane lined steel pipeline was placed under the Tweed River using horizontal directional drilling technology.

A 150mm borehole was drilled through fine sands and fractured greywacke, and this was reamed out to a final diameter of 750mm. The slurry pipeline and an electrical conduit were then drawn through the tunnel.

The other pipelines were placed in trenches in a conventional manner. Care was taken to bund and treat some material with potential acid sulfate soil properties. Particular care was taken in the construction of the outlet at Snapper Rocks West to ensure that it did not impact on the natural scenic beauty of the area.

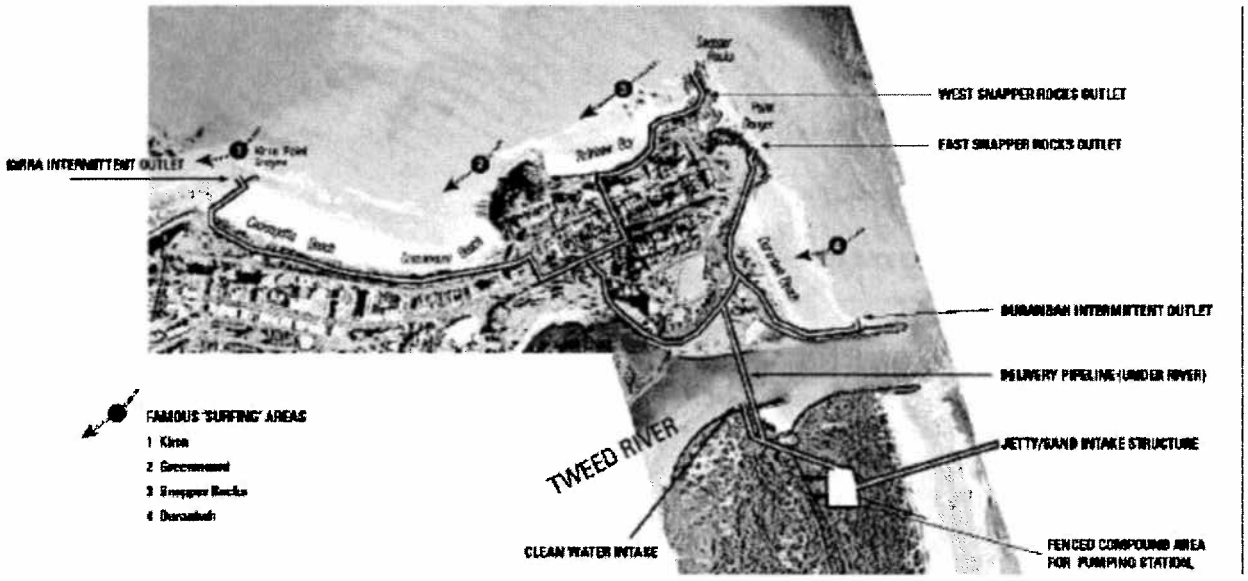


Figure 2 – Layout of Sand Bypassing System

The sand bypassing system pumped its first sand on 27 February 2001. All contract conditions were satisfied in a little over 14 months, which was within the required time period.

The system cost $23.3M. This was paid for with promissory notes, which are redeemable over a 12 year period so long as the system is complying with performance specifications.

Jetty under construction

4.5. Commissioning

Sand was placed at the primary outlet at Snapper Rocks East during the commissioning tests. The contractor was required to pump 120,000 cubic metres in 30 days and 11,500 cubic metres in a 24 hour period. The 30 day quantity was delivered within the time period and the 24 hour test was complied with a few days later. In the first instance, beach sand around the jet pumps appeared to be compacted and did not form cones of the size predicted. This reduced the efficiency of the sand trap, particularly at low tide.

Commissioning was completed on 4 May 2001, after the navigation channel was cleared and operation plans were finalised.

4.6. Operations

If sand passes the collection system and settles in the entrance channel, the operator may be required to dredge the material, but still receive payment at the same unit rate. Hence, the operator is expected to pump as much sand as possible within environmental constraints (mainly the limit on beach retreat at the jetty). Once the beach at the jetty has receded, the operator will pump or dredge an amount of sand equal to the net longshore transport supply. Hence, the system is expected to provide sand at a rate consistent with the natural processes.

The bypass is normally operated at night using a computerised control system, which arranges cycling between jet pumps (and backwashes) using slurry density data measured at each pump.

Most of the sand will be pumped to the primary outlet at Snapper Rocks East, from where it will move under natural processes around Snapper Rocks to the target beaches. However, it is proposed to place sand at Kirra Point and Duranbah Beach during February and March (the peak season for longshore transport) in order to smooth the supply of sand. Following the successful completion of the commissioning tests, 67,000 m^3 of sand was pumped to the temporary outlet at Duranbah Beach, which had been badly eroded by storms.

4.7. Environmental Monitoring

Extensive monitoring is being carried out in a number of areas, as follows:

- Surveys are taken of nearshore areas, beaches and the Tweed River.
- Surf quality at Duranbah and other beaches.
- Offshore wave height and direction is measured, wave activity on training walls is monitored, and breakwaters are monitored to detect any movement in armour stones.
- The tidal range in the Tweed River is measured and analysed to detect any changes.
- Mangroves and wetlands are monitored.
- Little Terns and other avifauna are monitored.

The purpose of this monitoring is to detect any adverse environmental impacts, should they occur, and allow remedial action to be undertaken.

4.8. Public Consultation

The project is extremely important for the communities of the area with interest in boating, surfing, beach recreation and tourism. While the usual consultation process was undertaken during the environmental impact assessment process, of greater importance was the consultation and media involvements once the project became a reality with the construction phase. The pro-active and reactive efforts during this phase were considerable but it can also be said that the outcomes of that process benefited the project in terms of modifications suggested by the public and their greater knowledge, and 'ownership' of the final outcome. Further information on this aspect of the work are in Foster et al, 2001.

4.9. Public Access to Jetty

During the course of construction, some fishermen asked Tweed Shire Council if they could access the jetty when completed. Council approached the NSW State Government, which agreed to assist in financing this development if a number of outstanding issues can be satisfactorily resolved. At the time of writing, public comment had been invited.

5. Conclusions

The project has been complex, because of the multiple objectives, the risk issues and the number of active stakeholders.

Beach nourishment has restored the beaches of the southern Gold Coast to their former glory, and the associated entrance dredging improved navigation conditions.

The uncertainty associated with coastal processes made it difficult to reach a long term agreement with the private sector that was compatible with the multiple objectives of the project, the formal agreements already reached between the two states and the conditions imposed with planning approvals. However, the performance based contract signed by the two state governments and the private sector may be expected to achieve these aims and ensure the efficient management of the sand bypassing system.

The permanent system was constructed and commissioned on time, and is operating well.

The entrance has again been cleared, and navigation conditions are expected to be more reliable now that the sand bypassing system is operating.

The constant supply of sand is expected to keep the southern Gold Coast beaches in good condition.

6. References

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Colleter, G., Cummings P., Aguilar, P., Walters, R. and Boswood P. (2001), *Monitoring of Tweed River Entrance Dredging and Beach Nourishment.* Paper to be presented to Conference on COASTS & PORTS 2001, Gold Coast.

Dyson, A., Murray, R., and Connor, T. (1999), *Sand Bypassing the Tweed River: Insights into Coastal, Approval and Procurement Processes*, Proceedings of the 14th Australian Conference on Coastal and Ocean Engineering, I.E. Aust, Perth.

Foster M., Cummings P., Connor T., Dyson A., Victory S. and McMahon J. (2001), *Community Consultation for the Tweed River Entrance Sand Bypassing Project.* Paper to be presented to Conference on COASTS & PORTS 2001, Gold Coast.

Hyder Consulting Pty Ltd, Patterson Britton & Partners Pty Ltd and WBM Oceanics Australia Joint Venture (1997), *Tweed River Entrance Sand Bypassing Project, Permanent Bypassing System, Environmental Impact Statement - Impact Assessment Study*, Sydney.

Lawson S., McMahon J. and Boswood P., (2001), *Environmental Management of the Construction and Operation of a Sand Bypassing System at the Tweed River Entrance.* Paper to be presented to Conference on COASTS & PORTS 2001, Gold Coast.

APPENDIX D

OBSERVATIONS OF RECREATIONAL USE OF BEACH

DURING NOURISHMENT OPERATIONS

1. Beach Replenishment Underway

2. Beach Replenishment Including Tractor Operations Underway

3. Peninsula Formation Due to Surfzone Disposal

4. Beach Replenishment Underway

5. Pipeline on Beach

6. Pipeline on Beach

APPENDIX E

POTENTIAL MODIFICATIONS

SPECIAL EQUIPMENT

Mud Gas Separator

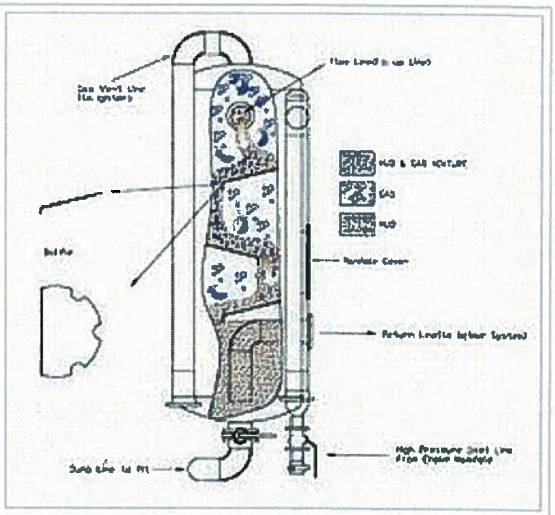
From Wikipedia, the free encyclopedia

Mud Gas Separator is commonly called a **gas-buster** or **poor boy degasser**. It captures and separates large volume of free gas within the drilling fluid. If there is a "KICK" situation, this vessel separates the mud and the gas by allowing it to flow over baffle plates. The gas then is forced to flow through a line and vent it to a flare. A "KICK" situation happens when the annular hydrostatic pressure in a drilling well temporarily (and usually relatively suddenly) falls below that of the formation, or pore, pressure in a permeable section downhole, and before control of the situation is lost.

It is always safe to design the mud/gas separator that will handle the maximum possible gas flow that can occur.[1][2]

Mud Gas Separator capable of handling 1000-1500gpm

Contents



Process Flow Diagram For Mud Gas Separator

Types of Mud/Gas Separators

The principle of mud/gas separation for different types of vessels is the same.[3]

- Closed bottom type
- Open bottom type
- Float type

According to pedestal or base type there are

- Fixed type
- Elevating type

Poor boy degasser in China is usually named according to vessel diameter.So the type also including

- FLQ800 or ZYQ800
- FLQ1000
- FLQ1200
- FLQ1400

Usually, the degasser type or configuration is customizable

Principle of operation

The principle behind the **mud gas separator** is relatively simple. On the figure, the mud and gas mixture is fed at the inlet allowing it to impinge on a series of baffles designed to separate gas and mud. The free gas then is moved into the flare line to reduce the threat of toxic and hazardous gases and the mud then discharges to the shale shaker and to the tank.

See also

- Mud systems

Notes

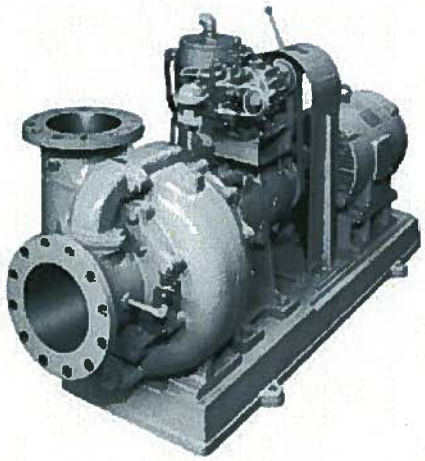
1. ^ Dilling Fluids Processing Handbook ISBN 0-7506-7775-9
2. ^ Mud Equipment Manual ISBN 0-87201-614-5
3. ^ SPE Drilling Engineering, December 1991

Enhanced Self-Priming Pump
UPM, UPS types (PAT.)

YOKOTA

Top page
& Site map
Contact us

Suction and transfer of liquid containing foam or high viscosity liquid



Patented in Japan, U.S.A., other

Bore 50-250mm
Total head 10-60m
Capacity 0.1-8m^3/min

The YOKOTA Enhanced Self-Priming Pump is a volute pump with an interlocked water-air separating impeller and a vacuum pump.
The mixture of water and air gathered in the center of the volute pump is centrifugally separated by rotation of the water-air separating impeller and only the air is drawn out by the vacuum pump. Therefore the volute pump always operates under the highest vacuum condition, and shows stable and supreme pumping performance without being blocked by the incoming air or cavitation.
It is probably the only horizontal shaft type volute pump in the world which is capable of continuous suction and transfer of liquids containing high viscosity sediment materials and air (i.e., gas-solid-liquid multiphase flow).

UPM type: Vacuum pump built-in type
UPS type: Vacuum pump mounted type
UPS type: Vacuum pump separate type

Unique features

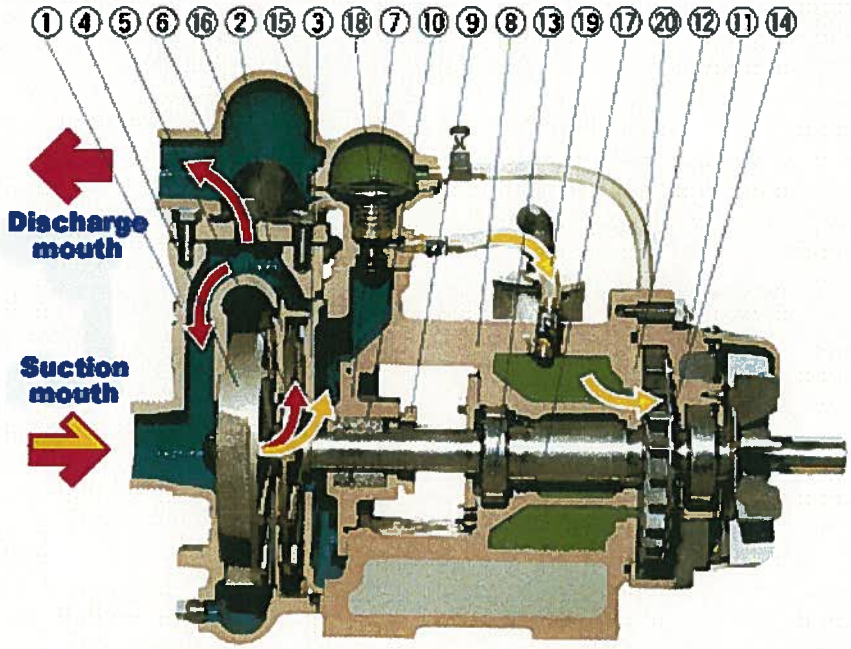
- Capable of continuous suction and transfer of liquids containing high viscosity sediment materials and air (gas-solid-liquid multiphase flow).
- Universal pump which is also capable of continuous suction and transfer of liquids containing solid, such as food materials, muddy water containing gravel, and sewage containing empty cans.
- Enhanced self-priming type which needs no priming even at initial operation after installation.
- The intake piping can be constructed in many ways such as with waved pipes or across embankments, and so on.
- Due to rational construction, the pump is highly reliable, maintenance is easy, and economical automatic operation is possible.

A wide variety of materials are available, including FC, CAC, SCS and YOKOTA's corrosion and

wear resistant special stainless steel casting (YST), to meet the needs of various kinds of liquid.

Principle (PAT.) ..... Try and see its excellent performance.

UPM type



4 : Main impeller
5 : Water-air separating impeller
6 : Return passage
14 : Vacuum pump impeller

The water-air separating impeller 5 is installed between the volute pump and the vacuum pump.

When operation is started, the main impeller 4 races and the vacuum pump 14 operates, eliminating the air in the suction pipe.
When the air is eliminated and a vacuum level close to the suction head is reached, the pumping liquid flows into the pump casing, and is discharged by the main impeller 4.

The mixture of water and air in the center is drawn by the vacuum pump 14, goes behind the main impeller and reaches the water-air separating impeller 5.
The water-air separating impeller separates the water from the air by centrifugal force.
The water returns to the suction mouth through the return passage 6, and only the air gathered in the center is drawn out by the vacuum pump 14.

Therefore the volute pump always operates under the highest vacuum condition, and is not blocked by the incoming air at the pump suction mouth or the main impeller.

Applications

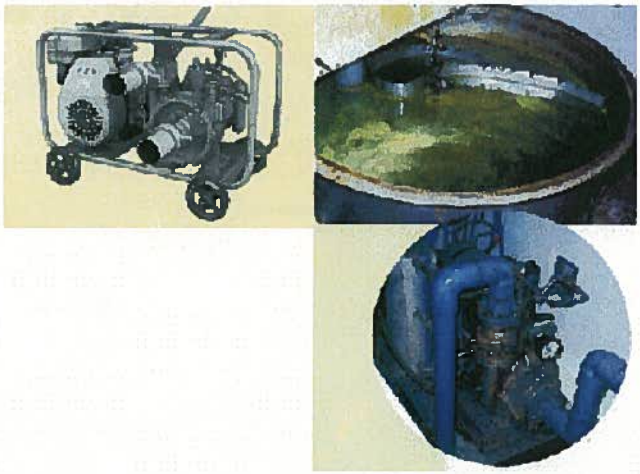
Transferring food materials:	Sauce, Soy sauce, Stock, Ketchup, Unrefined sauce, Liquor, Seaweed, Fluid of other raw materials, other
Transferring chemical liquids:	Phosphate slurry, Formalin, Ammonia, Caustic soda, Light oil, Heavy oil, Concentrated sulfuric acid, Ketone, Acrylic ester, Volatile liquids such as ethylene glycol, Gas-containing liquid, Polypropylene powder,

	Pellets, other
Loading and unloading for tankers:	Aniline, Nitrobenzene, Acetic acid, Nitric acid, other (cargo oil pumps for cargo transfer and stripping for tankers, ballast pumps, bilge pumps)
Sludge drainage:	Sludge, Pulp waste water, Muddy water, Human waste, Pulverized coal sludge, Sewage, other
Earth excavation:	Muddy sand, Seawater, Muddy water containing gravel, other (pumps for reverse circulation, non-clogging dredging pumps, sand pumps)
Sealed (Vacuum) tank extraction:	Pure water, Chemical liquid, other
Defoaming air-containing liquid:	Foam latex liquid, Foam starch liquid, Normal paraffin fermenter liquid, Lubricants, hydraulic oil, cutting oil, other
Other:	Hydropower snow transport (For details, please refer to "Current Topics: Snow Removal and Snow Melting".)

Example applications and installations

For transferring food

More details >



For defoaming

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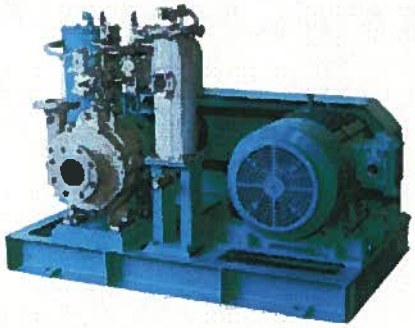

For chemical tankers

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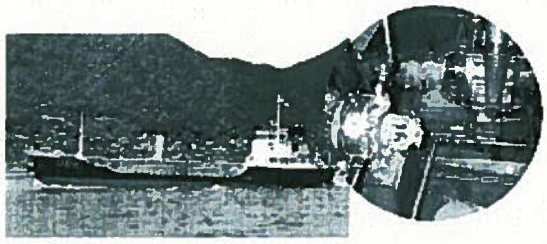

For reverse circulation

More details >

For sewage

More details >

Defoaming and degassing pumps with intensified water-air separation capability are also available. For details, please refer to
Defoaming Pump, Defoaming Equipment UPSA type
Degassing Pump, Degassing Equipment ASP type

Features | Structure | Technical data | Selection & Dimensions | Inquiry form

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