FINAL

SANTA CRUZ HARBOR DREDGE MANAGEMENT PLAN

Prepared for
MONTEREY BAY NATIONAL MARINE SANCTUARY

Prepared by
STRELOW CONSULTING
In association with
SANTA CRUZ PORT DISTRICT

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EXECUTIVE SUMMARY

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STUDY PURPOSE

The Santa Cruz Port District was formed in 1950 to develop harbor facilities in the Santa Cruz area. Since its completion in 1964, dredging the Harbor **entrance** became necessary almost immediately and **inner-harbor** dredging also has been required periodically.[1] Dredging and disposal of dredge materials are regulated and permitted by the U.S. Army Corps of Engineers, California Coastal Commission, and the California Regional Water Quality Control Board.

The Harbor is located adjacent to the Monterey Bay National Marine Sanctuary (MBNMS). Dredging of harbors and their channels is exempt from MBNMS regulations, but disposal of dredged materials into the Sanctuary is subject to MBNMS authorization. Most recently, the MBNMS provided authorization for proposed changes in disposal in both January and December 2006 as approved by the California Coastal Commission. The MBNMS also authorized harbor demonstration projects in February 2001 and October 2005.

The Port District has requested an increase in the annual allowable disposal volumes of fine-grained sediment content based on the positive results of site specific demonstration dredging projects. However, the Sanctuary staff has requested that this report be prepared before considering such action. Pursuant to recommendations from the MBNMS staff, this report provides an overview of dredging within the Santa Cruz Harbor, including a review of existing permits, dredging and disposal history, sediment sources, effects of dredge disposal, and potential alternatives to current disposal of dredged materials. Based on this review, future dredging and disposal needs have been estimated, and a preliminary dredge management plan outlined.

[1] This document analyzes both dredging of the federal channel **"entrance"** and the **"inner harbor,"** consisting of the north and south marinas. Because the nature of dredging characteristics differs markedly between the two areas of the harbor, the terms **entrance, inner harbor, north harbor** and **south harbor,** are shown in bold print to clarify which area is being described.

SUMMARY OF ISSUES

Dredged materials are currently disposed east of the harbor or in a nearshore location. In the past fifteen years, the regulation standard had been that sediment had to be 80% sand or greater to qualify for nearshore disposal. All materials dredged from the harbor **entrance** and channel meet this specification. However, sediments originating from the Arana Gulch watershed and entering the **inner-harbor** at its northernmost point contain finer-grain sediments. Currently, nearshore ocean disposal for **inner-harbor** sediments is limited by the grain size of the dredged sediments. Current Santa Cruz Harbor permit provisions allow nearshore disposal of only 3,000 cubic yards (cy) per year of material with 50 to 79% sand content. No limit is placed on **inner-harbor** sediment with 80% or greater sand content.

The Port District is requesting that all clean sediment be considered for nearshore disposal when science can demonstrate the benefit of such disposal.

The upper harbor received an average of 6,200 cubic yards of sediment per year from the Arana Gulch watershed during years 1998 to 2007, with a sand content ranging from less than 50% to over 80%. **Inner-harbor** sedimentation has become a growing concern of the Port District because the sediments are largely fine-grained and less than 80% sand content. Dredged sediments that do not meet the sand ratio under current permitting must be dewatered and trucked to an upland location such as a landfill or a designated offshore disposal area (SF-14) one mile from Moss Landing, which has never been used by Santa Cruz Harbor.

During the 2005-06 winter season, which included a period of exceptionally high rainfall, the **north harbor** received over 40,000 cubic yards of sediment from Arana Gulch. Much of this sediment had collected in the **north harbor** and had rendered portions of the area unusable to boats. Until November 2007, 46 berths were unusable due to damage resulting from shoaled conditions. The **north harbor** sedimentation has been the largest physical problem facing the Port District. It threatens the operability of a large section of the marina. Sediment excavated and taken to an upland site, or SF-14, costs $80 to $100 per CY – the cost for an average year ranges from $240,000 to $600,000.

FINDINGS

1. Dredging of the Santa Cruz Harbor **entrance** has increased in volume since dredging began in 1965 due to both cyclical weather conditions and the current dredging practices that allow the Harbor **entrance** to remain open year-round. The current annual dredging average of approximately 270,000 cubic yards (cy) per year is well within the range of littoral drift predicted in the 1958 harbor feasibility study (30,000 to 300,000 cy per year) and within the conclusion of the 1978 Moffat and Nichol "Santa Cruz Harbor Shoaling Study" (300,000 to 500,000 cy per year). There are no major issues at this time with any regulatory agency, including the Monterey Bay National Marine Sanctuary.

2. Annual average dredging of the **inner-harbor** has fluctuated between approximately 2,400 cubic yards and 6,200 cubic yards. The largest influx of sediment recorded during storm events in 2005 when approximately 40,000 cy of sediment entered the harbor.

3. Dredged material from the harbor **entrance** is typically composed of 80% or more sand, whereas dredged material from the **inner-harbor** often contains more fine-grained materials, with a composition range of 20-98% sand. Sediment in the Santa Cruz Littoral Cell is sorted into two basic categories at a cut-off grain diameter of 180 microns. Sediments larger than 180 μm (microns) consist of fine-sand and larger-grained sand; sediments smaller than 180 μm are categorized as fine sediment (silt and clay). According to the Wentworth classification scale, silt and sand are differentiated at a diameter of 63 μm.

4. The Port District has conducted two formal peer-reviewed demonstration projects (2001 and 2005) to assess effects of disposal of fine-grained sediments in the nearshore environment. The analysis of sediment samples collected on the beaches and nearshore benthic habitats indicate that silt and clay released from the harbor into the surf zone did not cause any significant changes in sediment sample mean grain-size of silt and clay. Silts and clays were not deposited on beaches between the San Lorenzo River mouth and Blacks Point, nor did they alter or impact marine benthic habitats.

5. The results of the demonstration projects indicate that: a) fine-grained material, when placed in the nearshore environment at the correct time of year, transit to and replenish soft bottom areas seaward of the nearshore (Monterey Bay mid-shelf mudbelt); and, b) that local wave and current energy are more than capable of efficiently transporting silt and clay sediment away from the immediate disposal area.

6. Fine clay and silt sediments are transported offshore to the continental shelf where they are deposited along the Monterey Bay midshelf mudbelt that extends from south of Santa Cruz to north of Half Moon Bay. Clean mud from riverine and submarine canyon sources are beneficial for recharging offshore mud habitats. The benthic invertebrate communities living on the shelf and upper slope of the Monterey Bay area have one of the highest number of benthic species and diversity in the world. The high diversity depends on a high production, which depends on continuing sources of iron in mud (Oliver, 2008).

7. Nearshore disposal of **entrance** sediment has not resulted in adverse effects on benthic and marine habitats, special status species, water quality or public access and recreation. Odor issues associated with hydrogen sulfide have been addressed through implementation of Air District protocols and a reconfigured disposal pipeline that allows further extension and depth for underwater disposal. A review of harbor dredging operations from 2003 to 2006 conducted by the California Department of Health Services found no public health hazard related to hydrogen sulfide emissions from harbor dredging activities. Odor issues are associated only with **entrance** dredging (kelp), and not with **inner-harbor** sediment.

8. Based on Santa Cruz Harbor's demonstration projects, the nearshore ocean currents have an excess carrying capacity for silts and clays in winter months, October to April. A more scientific approach to management of fine-grained sediment would be to set a daily volume limit for fine-grained material irrespective of whether that volume was accompanied by sand.

9. The alternatives to nearshore disposal are upland and deep ocean disposal. Deep ocean disposal meets no identified environmental objectives. Upland disposal can have a benefit as daily cover at municipal landfills, or as a constituent in environmental restoration projects.

DREDGE DISPOSAL MANAGEMENT GOAL

The Port District seeks to change permits for disposal of dredged clean **inner-harbor** sediments to allow nearshore disposal based on studies and scientific data which demonstrates that all clean sediment, regardless of grain size, can have beneficial environmental impact on the ocean. This approach is consistent with federal and state legislation including provisions of the recently enacted federal Water Resources Development Act of 2007, the California Ocean Protection Plan, and 2007 beneficial re-use guidance manuals published by the Environmental Protection Agency and U.S. Army Corps of Engineers. The results of the demonstration projects suggest that the Santa Cruz Bight could accommodate and utilize a larger volume of **inner-harbor** dredge sediment than is currently permitted (Sea Engineering, May 12, 2006).

It is the goal of Santa Cruz Port District to collaborate with MBNMS in treating all clean dredged material as a resource to be managed carefully and beneficially. Accordingly, the Port District proposes the following for nearshore disposal:

- Unlimited annual and daily dredging/disposal of **inner-harbor** sediments with greater than 80% sand content, consistent with recent California Coastal Commission permit amendments.

- That all **inner-harbor** sediment that is less than 80% sand content, and which is otherwise qualified for "unconfined aquatic disposal" be managed as follows:
  - Maximum **yearly** limit of dredging and disposal of sediment that is classified silt or clay (less than .0625 mm = 63 microns) be set at 10,000 CY/yr.
  - Permit a daily limit of sediment that is classified silt or clay (less than .0625 mm = 63 microns) be set at 550 CY/day (24-hour period).

- The Port District's Total Daily Load disposal recommendation includes the following provisions:
  - Nearshore disposal limited to October to April each year;
  - Any human contact with dredged material on recreational beaches be limited, managed and mitigated;

- Inner-harbor sediment must pass all chemical and biological tests set forth by COE / EPA "Inland Testing Manual."

Under this protocol, the Port District would manage each geographic section of approved dredging on a daily basis. Each day's episode would be managed so that the total daily load of **silts and clays** would not exceed 550 CY. Thus, if inner-harbor material was 40% **sand**, as tested, then the maximum **total** volume for that day's episode would be 917 CY in order to stay below 550 CY of silts and clays.

1. INTRODUCTION

IN THIS SECTION:

- **Harbor Background**
- **Purpose of Study**
- **Project Location**
- **Harbor Uses**

1-1 HARBOR BACKGROUND

The Santa Cruz Port District was formed in 1950 to develop harbor facilities in the Santa Cruz area. In 1958, the U.S. Army Corps of Engineers and the Port District completed plans to develop Santa Cruz Harbor at Woods Lagoon in the lower end of Arana Gulch (U.S. Army Corps of Engineers, September 2002). The project was presented to Congress, and feasibility documents were prepared (House Document 357-1958).[2] The 1958 feasibility study set the parameters of design, predicted the range of shoaling, and identified the benefit of the project. The Santa Cruz Small Craft Harbor was justified on the basis of providing: a harbor of refuge; a commercial fishing port; and recreational boating service.

The Santa Cruz Small Craft Harbor (Harbor) was constructed from April 1962 through January 1964 as a joint venture between the Santa Cruz Port District and the U.S. Army Corps of Engineers (ACOE). The Harbor officially opened in 1964 with 360 berths and a launching ramp. The Harbor was subsequently expanded into the upper portion of the former Woods Lagoon in 1972. Permanent jetties placed along the east and west sides of the Harbor's **entrance** channel provide year-round access to the Pacific Ocean (California Coastal Commission, November 2, 2006).

Since its construction, the Harbor has experienced extensive shoaling of the harbor **entrance** after episodic storm events and seasonal periods of high surf. The ACOE maintained the harbor channel by contract dredging services from 1965 through November 1986. The Port District assumed operational dredging responsibility for the Santa Cruz Harbor in 1986 and now owns and operates its own dredging system. In addition to the harbor **entrance**, dredging of portions of the **inner-harbor** has been necessary at times. Harbor dredging and disposal activities are regulated by a number of federal, state, and regional agencies.

[2] 1958 HD 357 – 85th Conference, was the enabling federal legislation. It set forth a cost sharing agreement for the construction of the jetties and the navigation channel. The legislation, with authority under the Rivers and Harbors Act, provided for a federal project to serve as a harbor of refuge, commercial fishing harbor and recreational harbor.

1-2 PURPOSE OF STUDY

Pursuant to recommendations from the Monterey Bay National Marine Sanctuary (MBNMS) staff, this report provides an overview of dredging within the Santa Cruz Harbor, including a review of existing permits, dredging and disposal history, sediment sources, effects of dredge disposal, and potential dredge disposal alternatives. Based on this review, changes to **inner-harbor** dredging and disposal are proposed, and a preliminary dredge management plan outlined. The review considers both **inner-harbor** and harbor **entrance** dredging needs and is based on review of existing data. The assessment will be reviewed with MBNMS and other regulatory agencies to determine if the port district's fine-grained sediment proposal can be accommodated.

This document analyzes both dredging of the federal channel **"entrance"** and the "**inner harbor,"** consisting of the north and south marinas. Because the nature of dredging characteristics differs markedly between the two areas of the harbor, the terms **entrance, inner harbor, north harbor** and **south harbor,** bold print will be used to clarify which area is being described.

1-3 PROJECT LOCATION

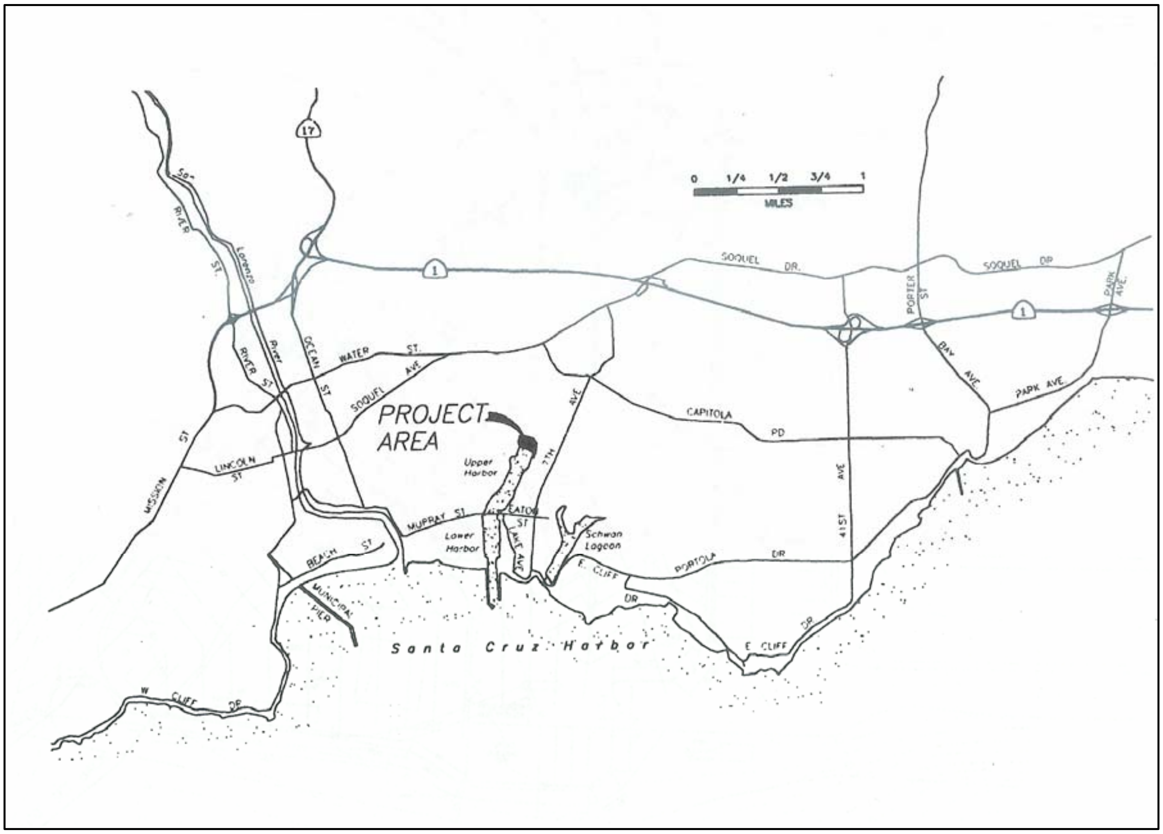
The Santa Cruz Small Craft Harbor, managed by the Santa Cruz Port District, is located within the City of Santa Cruz at the northern tip of Monterey Bay. It is bordered by Seabright Beach, Harbor Beach and Twin Lakes Beach on the south, residential development on the east and west, and the Arana Gulch greenbelt, owned by the City of Santa Cruz on the north (see Figure 1). The Harbor is located approximately 3,000 feet east of the San Lorenzo River mouth.

The Santa Cruz Harbor is located adjacent to the Monterey Bay National Marine Sanctuary (Sanctuary) which extends south from a point in Marin County to Cambria Rock in San Luis Obispo County, and extends from high tide seaward typically about 35 miles offshore. The Sanctuary is the nation's largest marine sanctuary, protecting marine resources that include the nation's most expansive kelp forests, the world's second deepest submarine canyon, and the closest deep ocean environment to the continental United States. The Harbor **entrance**, including the rubble-mound jetties, lie outside of the Sanctuary; however the dredge disposal pipelines and disposal areas, are located within the Sanctuary.

1-4 HARBOR USES

The Santa Cruz Harbor, a major topographic and visitor-serving facility in the area, encompasses approximately 38 acres of land and 52 acres of water. The harbor is a federal and state harbor of refuge. The Harbor supports approximately 920 berths and dory ties for commercial and recreational boats, 3.3. acres of sandy beach area on both sides of the jetties fronting the harbor mouth, various commercial uses, and over 1,000 parking spaces that support marine related uses. Overall, the Harbor facilitates ocean-related functions include boat-launching, berthing for commercial vessels and recreational boats, boat repair areas, marine-related retail/commercial businesses, restaurants, sailing programs, a yacht club and boat sales. The harbor also accommodates non-profit foundations, such as the O'Neill Sea Odyssey, Save Our Shores, Coastal Watershed Council, and Arana Gulch Watershed Alliance. The vast majority of boat use at the Harbor is for recreational purposes with commercial fishing being less than 4% of use. In its multiplicity of uses, it functions as an authentic gateway to the national marine sanctuary.

FIGURE 1: Harbor Location



2. PERMIT HISTORY

IN THIS SECTION:
- *Dredging Overview*
- *Dredge/Disposal Sites & Equipment*
- *Summary of Existing Permits*
- *Permit Provisions*

2-1 DREDGING OVERVIEW

Shoaling of the harbor **entrance** (federal channel) was evident from the time the Harbor opened in 1964 as was predicted by the project feasibility documents. Littoral drift at the harbor site was estimated at between 30,000 and 300,000 cubic yards per year (Santa Cruz Port District, 2003). In the spring of 1965, the U.S. Army Corps of Engineers (ACOE) authorized their first contract for dredging the Harbor **entrance**. Since that time, permits have also been required from the California Coastal Commission and the California Regional Water Quality Control Board. The Monterey Bay National Marine Sanctuary does not regulate dredging, but the disposal of dredged materials into the Sanctuary is subject to MBNMS authorization.

Dredging of portions of the **inner-harbor** also has been necessary at times. Santa Cruz Harbor began experiencing significant **inner-harbor** shoaling after opening the **north harbor** in 1972. The **inner-harbor** shoaling rate varies widely, depending on annual rainfall and storm activity that result in erosion from the watershed areas outside of the Harbor which then drain into the Harbor. To help address this issue, the Port District and various stakeholders joined together in 1997 to form the Arana Gulch Watershed Alliance (AGWA) to develop and implement erosion control projects to prevent sedimentation into the Harbor. This is further discussed in Chapter 4.

2-2 DREDGE/DISPOSAL SITES & EQUIPMENT

DREDGE SITES AND EQUIPMENT

The current Harbor dredging sites include: 1) the harbor's **entrance** channel, which extends from the jetties to the fuel dock; and 2) the **inner-harbor**, which consists of all portions of the harbor located north of the fuel dock. The **inner-harbor** consists of two subareas: the upper (or north) harbor, which includes all harbor facilities located north of the Murray Street Bridge, and the lower (or south) harbor, which includes harbor facilities located between the fuel dock and the Murray Street Bridge (see Figure 2).

The objectives of the harbor **entrance** dredging are to: (1) maintain the federal **entrance** channel in a safe and passable condition; (2) provide maximum sand replenishment of downcoast beaches; (3) minimize environmental impact on beach users and neighbors; and (4) operate the dredging system as cost effectively and fuel efficiently as possible.

The current dredging system for the harbor **entrance** consists of a floating hydraulic dredge system that is owned by the Santa Cruz Port District and was placed into operation in November 1986. It has operated continuously since 1986, from November to April of each year by Port District crews. Santa Cruz Harbor has the only permanent sand bypassing system on the West Coast. As part of its dredging and disposal operations, the Port District has used (and will continue to use) a tractor to position the disposal pipe. A tractor is also used to protect the dredge pipeline switches from erosion and wave run-up (California Coastal Commission, November 2006).

The Port District utilizes a smaller hydraulic dredge in the **north harbor**. Recent **north harbor** dredging also used a multi-phase dewatering and drying system, as well as other excavation equipment for upland disposal.

AQUATIC DREDGE DISPOSAL SITES

Dredged materials from the harbor **entrance** and federal channel are primarily disposed onto the beach east of the harbor or in the adjacent nearshore location. Depending on the composition of the material dredged from the **inner-harbor**, disposal occurs nearshore, offshore and/or at designated upland locations. These locations are summarized below and described further in Chapter 3.

1. Onshore Disposal occurs on the beach or under the surfline along Twin Lakes State Beach from the east harbor jetty to approximately 12th Avenue via a pipeline that connects to the floating dredge. The Port District temporarily connects additional piping to route dredge materials to the surf line.
2. Nearshore Disposal occurs via a movable pipeline that can extend approximately 200 feet seaward of the water-line. Various discharge points between 5th Avenue and 12th Avenue can be accessed to best utilize wind and wave conditions.
3. Offshore Site SF-14 is an EPA / U.S. Army Corps of Engineers' designated disposal site approximately one mile from Moss Landing Harbor. The Santa Cruz Port District has never used this disposal site.
4. Upland Disposal for dredged material that does not meet the permitted sediment-sand composition has typically been trucked to the Marina Landfill in Monterey County, approximately 35 miles south of the Santa Cruz Harbor. Another potential upland site includes a wetland restoration project at Elkhorn Slough which is still in the formative stages.

The nearshore and offshore disposal areas are 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; a permit for use is issued to the Port District.

FIGURE 2: Harbor Areas

2-3 SUMMARY OF EXISTING PERMITS

Existing permits required and obtained for dredging the Harbor **entrance** (and federal channel) and **inner harbor**, as well as for disposal of dredged materials, are summarized below. Permit provisions are outlined in section 2-4 and summarized in Table 1.

FEDERAL CHANNEL – ENTRANCE DREDGING PROGRAM

Santa Cruz Harbor, under a 1986 Memorandum of Agreement ("MOA") 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
- California Regional Water Quality Control Board
- State of California Department of Parks and Recreation
- Monterey Bay Unified Air Pollution Control District
- 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 pump all sediment dredged from the federal channel and dispose of it east of the harbor onto the beach or in the surf-line (underwater). The limit on volume is 350,000 cubic yards per year (cy/yr) and the sediment must have a minimum 80%+ sand content. This volume has been exceeded only once (1997-98).

INNER-HARBOR DREDGING PROGRAM

Various permits regulate **inner-harbor** dredging, depending on the type of dredging and/or disposal utilized, e.g., clamshell dredging with upland disposal, hydraulic dredging with nearshore disposal, etc. **Inner-harbor** dredging requires regulatory permits from:

- U.S. Army Corps of Engineers / U.S. Environmental Projection Agency
- California Coastal Commission
- California Regional Water Quality Control Board
- 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.
- Monterey Bay Unified Air Pollution Control District

Current permits allow the following dredge disposal options: nearshore, upland or offshore disposal. All permits currently allow up to 3,000 cy/yr of **inner-harbor** material with 50% to 79% sand content to be disposed nearshore. Coastal permits allow for nearshore disposal of an unlimited volume of **inner harbor** sediments with 80% or greater sand content, and 35,000 cy/yr of volumes over 3,000 cy with 50-79% sand content and all sediment less than 50% sand can only be disposed at an upland site or offshore (SF-14).

2-4 PERMIT PROVISIONS

U. S. ARMY CORPS OF ENGINEERS (ACOE)

The U.S. Army Corps of Engineers (ACOE), in accordance with its mandate for maintaining navigable harbors and inland waterways, as defined in Section 10 of the Rivers and Harbors Act, has authority over and responsibility for maintaining the federal channel at the Santa Cruz Harbor. Beginning in 1965, the ACOE was the first agency to conduct dredge operations at Santa Cruz Harbor. However, the ACOE transferred its responsibilities to maintain the federal channel to the Port District in 1986. Thus, the Port District is now responsible for dredging both **entrance** channel and **inner-harbor** areas until the year 2014, under an agreement between the Port District and ACOE. The ACOE is the responsible agency for authorizing beach and nearshore disposal of dredged materials pursuant to Section 404 of the Clean Water Act.

In December 2001, the ACOE issued the current Permit 25179S that authorized dredging of approximately 360,000 cubic yards (cy) of sediment per year from the Santa Cruz Harbor over a 10-year period (December 2001-December 2011) with approximately 350,000 cy from a two-acre area at the harbor **entrance** channel and approximately 10,000 cy from a 28-acre area in the **inner harbor**. Disposal of materials with 80%+ sand content is permitted within the intertidal zone adjacent to the Harbor, whereas materials with less than 80% sand content must be taken to an offshore location (SF-14) or to an approved upland location, with the exception that 3,000 cy of clean sediment that is between 50% and 79% sand content can be disposed in the nearshore. (Upland disposal is not regulated by the ACOE.)

The permit allows both the **entrance** channel and **inner-harbor** areas to be dredged hydraulically, using suction dredges. Permitted disposal consists of pumping the dredged material through a submerged 16-inch pipe that runs most of the length of the harbor to the beach and near-shore discharge locations between 5th and 12th Avenues or taken to the offshore SF-14 site. The ACOE permit also specifies dredging depth limits and that it shall occur only from November 1 to February 28 during daytime hours in the **north harbor**, and to April 30 in the **south harbor** for steelhead protection. Dredging in the **north harbor** also was authorized for evening hours during October in 2005,

A permit amendment request is pending before the Army Corps of Engineers that include the following and would conform to other regulatory permits when issued.

- Increase the amount of coarse grained material (at least 80% sand)dredged from the **inner-harbor** that can be deposited in the nearshore from 10,000 to 20,000 cy/year;
- Authorize dredging in the **inner-harbor** during the month of October and authorize the nearshore disposal of material dredged from the south section of the **inner-harbor** through April 30th; and
- Authorize use of a newly configured non-anchored pipeline to transport the material from the harbor to approximately 25 yards offshore (U.S. Army Corps of Engineers, April 15, 2007).

Each annual maintenance dredging episode is authorized by the ACOE pursuant to Permit 25179S. In April 2008 the ACOE approved authorization for episodic maintenance dredging of approximately 4,653 cubic yards of material with nearshore disposal. The authorization specifies dredge volumes per location. Approximately 73% of the authorized volume is comprised of sediment consisting of 50 to 80% sand (approximately 3,380 cy). In approving the authorization, the ACOE noted that concurrence by appropriate agencies had been reached that the material proposed for dredging in this episode is suitable for unconfined aquatic disposal in accordance with all applicable permits.

MONTEREY BAY NATIONAL MARINE SANCTUARY (MBNMS)

The Monterey Bay National Marine Sanctuary (MBNMS) regulations prohibit disturbance of the seabed. Dredging of harbors and their channels is exempt from these regulations, and the MBNMS does not regulate the act of dredging. (The Santa Cruz Harbor is not located within MBNMS boundaries.) However, the disposal of dredged materials into the Sanctuary is subject to MBNMS review under its authority defined at 15 CFR Sections 922.49 and 922.132. Disposal of dredged materials is prohibited in Sanctuary waters except for disposal sites authorized by the U.S. Environmental Protection Agency (CFR Section 922.132). The only authorized disposal site for the Santa Cruz Harbor is the offshore SF-14 site. CFR Section 922.49 allows a prohibited activity if such activity is authorized by any valid Federal, State or local lease, permit, license, approval or other authorization issued after the effect date of Sanctuary designation. Under the provisions of this section, the Sanctuary Director must be notified of pending applications and/or amendments and upon review must notify the applicant and authorizing agency whether there is an objection to issuance of the permit or authorization. The Director may request additional information deemed reasonably necessary to determine whether to object to issuance of an authorization and may amend terms and conditions deemed reasonably necessary to protect Sanctuary resources.

Additionally, CFR Section 922.47 indicates that prohibited uses do no apply to any activity authorized by a valid lease, permit, license, approval or other authorization in existence on the effective date of Sanctuary designation.[3] The Santa Cruz Port District has continuously maintained dredging permits from the U.S. Army Corps of Engineers, the California Coastal Commission, and 401 certifications from the California Regional Water Quality Control Board since the first maintenance dredging operation in 1966. These have included the **entrance** channel and **inner-harbor** dredging authorizations for nearshore disposal. The **inner-harbor** element of the 1985 401 certification (of the Corps of Engineers' CWA 404 permit) was for an average of 3,000 cubic yards per year, with a maximum of 10,000 cubic yards per year. Grain size was not limited (Waste Discharge Order 85-06; January 11, 1985.)

[3] The Monterey Bay National Marine Sanctuary was designated in 1992.

TABLE 1: Summary of Existing Permits

AGENCY	PERMIT DATES	DREDGE LOCATION & PERMITTED VOLUMES	PERMITTED DREDGE COMPOSITION & DISPOSAL	DREDGE TIME LIMITS
U.S. Army Corps of Engineers (ACOE) PERMIT 25179S	December 2001 – December 2011	**ENTANCE:** 350,000 CY/YR **INNER HARBOR:** 10,000 CY/YR 10-YEAR MAXIMUM: ~3,600,000 CY	▪ 80%+ sand composition from **entrance** disposed in inter-tidal zone to the east of the harbor. ▪ Limit 3,000 cy with 50%-79% sand content from inner harbor with nearshore disposal. ▪ All other disposed at offshore location (SF-14) or an approved upland location.	**North harbor:** November 1 to February 28 during daylight hours for steelhead protection. **South harbor:** November 1 to April 30
Monterey Bay National Marine Sanctuary (MBNMS) AUTHORIZATION LETTER MBNMS-205-038-A4	Same as California Coastal Commission CDP 3-05-065A2			
California Coastal Commission (CCC) CDP 3-05-065	2005-2010	**ENTANCE:** 350,000 CY/YR 10-YEAR MAXIMUM: ~3,600,000 CY	▪ **Entrance:** 80%+ sand composition of materials disposed nearshore or on the beach.	**South harbor (Entrance):** November 1 to April 30.
CDP 3-05-065A2, November 2006		**INNER HARBOR:** 3,000 CY/YR to unlimited volumes depending on sand content 35,000 CY/YR for disposal at upland site or SF-14	▪ Unlimited amount of nearshore disposal of **inner-harbor** materials with 80%+ sand; 3,000 cy with 50-79% sand limit for nearshore disposal retained. ▪ Disposal at upland site or SF-14 for up to 35,000 cy with less than 50% sand **for inner-harbor** materials or materials dredged during July, August, and September. ▪ Nearshore disposal of suitable **inner-harbor** materials: Upper (north) harbor – Oct. 1st-Feb.28th; Lower (south) harbor – Oct. 1st-Apr 30th. ▪ Nearshore disposal of inner-harbor materials during October may be during day or evening hours. ▪ Modification of dredge pipeline configuration.	**North harbor:** July 1 to February 28. **South harbor:** July 1 to April 30.
California Regional Water Quality Control Board (RWQCB) TECHNICALLY CONDITIONED WATER QUALITY 401 CERTIFICATION with amendments. Amended up to 6-07		**ENTANCE:** 350,000 CY/YR **INNER-HARBOR:** Same as Coastal Commission CDP 3-05-065A2 10-YEAR MAXIMUM: ~3,600,000 CY	▪ **Entrance:** 80%+ sand composition of materials disposed nearshore. ▪ **Inner-Harbor** 20,000 cy of sediment that is grater than 79% sand can be disposed nearshore; up to 3,000 cy with 50-79% sand may be disposed nearshore. Up to 35,000 cy of material may be disposed at upland or SF-14 sites.	No conditions.
California Department of Parks & Recreation (CDPR)	October 2005-October 2010	Incorporates provisions of California Coastal Commission's CDP 3-05-065	Permits 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.	No conditions.
Monterey Bay Air Pollution Control District (MBUAPCD) PERMIT TO OPERATE (10247B & 11427A)	N/A	Permits operations of its stationary dredge equipment, and specify fuel usage, allowable daily hours of operation, and engine operations.		No conditions.

The MBNMS reviews the composition of the sediment, volumes, grain size, and any possible associated contaminant load to determine if the dredge sediments are appropriate for disposal in the ocean and comply with the provisions of the National Marine Sanctuaries Act (U.S. Department of Commerce, October 2006). The MBNMS works with other agencies to ensure that MBNMS resources are protected during dredge disposal, including coordination with the California Coastal Commission, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, California Regional Water Quality Control Board, California Department of Fish and Game, National Marine Fisheries Service, and U.S. Fish and Wildlife Service.

The MBNMS provided authorization for proposed changes in disposal in both January and December 2006 as approved by the California Coastal Commission. The MBNMS also authorized harbor demonstration projects in February 2001 and October 2005. The Port District has requested an increase in the annual allowable disposal volumes and silt and clay content based on the positive results of demonstration projects and based, as well, on historical permit volumes from the U.S. Army Corps of Engineers / California Regional Water Quality Control Board. However, the Sanctuary staff has requested that this report be prepared before considering such action.

The Draft Management Plan prepared for the MBNMS in 2006 includes several strategies to work with harbors regarding dredge disposal to include:

- Continue to authorize other agency's permits for dredge disposal and consider improving the interagency review process, including potential issuance of multi-year authorizations for dredge disposal activities to provide efficiency for both the harbor as well as the MBNMS.
- Review additional sites or modifications to existing disposal sites, including working with the Santa Cruz Port District in reviewing proposal to dispose of dredged material at the Twin Lakes Disposal Site and future applications to modify this disposal area or location.
- Coordinate sediment monitoring and reduction.
- Continue to coordinate with EPA/ACOE the evaluation of sediment disposal suitability related to grain size.
- Evaluate alternative disposal methods and potential beneficial uses of dredged materials.

CALIFORNIA COASTAL COMMISSION (CCC)

Coastal Act Priorities

The Santa Cruz Small Craft Harbor is one of only six harbors located along the Central Coast. Section 30234 of the Coastal Act provides that facilities serving the commercial fishing and recreational boating industries shall be protected and, where feasible, upgraded. Section 30234.5 states that the economic, commercial, and recreational importance of fishing activities shall be recognized and protected. Commercial and recreational boating and fishing are coastal-dependent priority uses that cannot function without sufficient Harbor depths. Hence, the maintenance of adequate berthing and navigational depths in the Harbor is essential, and is considered a high priority under the Coastal Act (California Coastal Commission, November 2006).

Areas that have been subject to dredging in the Harbor include areas where deposition routinely reduces depths in and around navigational channels and berthing areas. During extreme depositional events, vessels must time their maneuvers in and out of the Harbor with the tides. Maneuvering within the Harbor also has proved difficult at times during low tides when many vessels rest on the muddy bottom sediments. This can result in severe impairment of Harbor capacity and risk to vessels if no action is taken. In approving a recent coastal development permit amendment for dredging and disposal activities, the California Coastal Commission (CCC) found that dredging activities (and the temporary installation of an offshore dredge disposal pipeline) to maintain berthing and navigational depth support coastal-dependent uses, and, thus, are integral to such uses and therefore have a priority under the Coastal Act (California Coastal Commission, November 2006). No feasible alternatives to the dredging have been identified (Ibid.).

Coastal Permit History

Dredge operations at the Harbor have been authorized by a series of coastal development permits (CDPs) issued by the CCC. Permits to allow annual or biannual dredging were issued from 1981 to 1996. In order to better facilitate individual dredging episodes, the Commission approved **CDP 3-86-175** for the installation of a permanent onshore dredge disposal pipeline in 1986. CDP 3-86-175 also required the Port District to submit a dredge operation and maintenance manual. The Port fulfilled this condition and has subsequently submitted modifications which have been approved.

In 1995, the Commission authorized a five-year maintenance dredge operation under **CDP 3-95-067**. Since then, the CCC has granted two five-year dredging permits (with amendments) – CDP 3-00-034 and CDP 3-05-065 – and two recent emergency permit as summarized below. The Port District currently operates under the provisions of **CDP 3-05-065** as amended in December 2006.

- **CDP 3-00-034:** In October 2000, the CCC granted a five-year permit (CDP 3-00-034) to the Port District, which authorized the dredging of 10,000 cy of sediment per year from the **inner harbor** and 350,000 cy of sediment per year from the Harbor's **entrance** channel. CDP 3-00-034 authorized disposal of these sediments into the surfline at Harbor Beach/Twin Lakes State Beach, or through the offshore pipeline (approximately 70 yards offshore) when hydrogen sulfide from decaying seaweed was present in **entrance** channel sediments in quantities that would affect beachgoers or adjacent residents if the sediments were placed into the surfline. CDP 3-00-034 required all dredged and disposed sediments consist of at least 80% sand, consistent with ACOE and U.S. Environmental Protection Agency (EPA) guidelines regarding dredging and beach replenishment (California Coastal Commission, November 2006).

In February 2001, the Commission approved an amendment (**CDP 3-00-034-A1**) to the five-year dredging and disposal permit that allowed the one-time dredging of 3,000 cy of sediment from the **inner-harbor**, with disposal by means of the offshore pipeline during February and/or March 2001. This sediment averaged 42% sand and 58% silt/clay and, after chemical and biological testing, was determined by the ACOE and EPA to be suitable for unconfined aquatic disposal. A disposal monitoring program was conducted as part of this "demonstration project" to assess any effects of disposal of finer grain sediments. (See Chapters 3 and 5 of this report for further discussion.)

In August 2003, the Commission approved a second amendment (**CDP 3-00-034-A2**) that allowed for annual nearshore disposal of up to 3,000 CY of **inner-harbor** sediment, consisting of between 50% and 79% sand for the remaining two years of CDP 3-00-034. Requirements for lab testing of the fine-grain dredge material, according to all criteria prescribed by ACOE and EPA regulations, remained in place. Consistent with other approvals, only "clean" dredge material, i.e., material deemed suitable for unconfined aquatic disposal by the ACOE and the EPA, could be disposed of into the nearshore environment (California Coastal Commission, November 2006).

- **CDP 3-05-065:** In October 2005 the Commission approved CDP 3-05-065, which renewed the five-year dredging permit to the year 2010 to allow the following dredging and disposal. CDP 3-05-065 restricted dredging and disposal activities from a start date of November 1st and required all dredging and disposal activities to take place during daylight hours. Key provisions include the following:

  1) Dredging and disposal of up to 350,000 cubic yards of **entrance** channel sediment (80% or greater sand) into the nearshore environment or into the surf line at Harbor Beach/Twin Lakes State Beach, dredging;

  2) Dredging and nearshore disposal of up to 10,000 cubic yards of **inner-harbor** sediment, of which 3,000 cubic yards could consist of materials between 50 and 79% sand; and

  3) Dredging of up to 10,000 cubic yards of **inner-harbor** sediment (which could consist of less than 50% sand) with disposal at an upland site or at a federally approved offshore disposal site, such as SF-14.

In September 2006, the Port District requested an amendment (CDP 3-05-065-A1) to allow dredging and disposal of **inner-harbor** (**north** and **south**) sediments during the month of October, including evenings. The proposed amendment would also have removed the 10,000 cubic yard limit on the dredging of sediment from the **inner-harbor** that could be disposed at an upland site or SF-14. Objections to the amendment were received, and the amendment therefore did not become effective (California Coastal Commission, November 2006). However, these changes were subsequently incorporated into the recent amendment, CDP 3-05-065-A2, as described below.

In December 2006, an amendment to CDP 3-05-065 (**CDP 3-05-065-A2**) was approved by the CCC to:

1) Allow dredging of **inner-harbor** (**north** and **south**) during the months of July, August, September, and October with disposal of sediment dredged during these months at an upland site or at SF-14 (except for October as addressed below);
2) Allow disposal of **inner-harbor** (**north** and **south**) sediments into the nearshore environment during the month of October during daylight or evening hours;
3) Increase the amount of sediment that may be dredged from the **inner-harbor** and disposed of at an upland site or SF-14 from 10,000 cubic yards annually to 35,000 cubic yards annually for sediment with less than 50% sand content;
4) Increase the nearshore disposal volume of **inner-harbor** (**north** and **south**) sediment from 10,000 cubic yards annually to an unlimited amount annually for sediment that consists of at least 80% sand (the amendment retained the 3,000 cubic yard annual maximum for nearshore disposal of **inner-harbor** sediment consisting of between 50% and 79% sand), and;
5) Modify the dredge pipeline configuration at Twin Lakes State Beach to allow multiple discharge points (only one discharge point would be used at a time) with a movable pipe that could extend approximately 200 feet offshore. See Chapter 3 for more details on the pipeline reconfiguration.

The Port District requested the amendment for several reasons. Primarily, runoff from between May 2005 and February 2006 deposited a record amount of sediment (more than 40,000 cubic yards) into the **north harbor** from the Arana Gulch watershed, which exceeded existing permit dredge and disposal limits. Additionally, the use of a single anchored offshore discharge point had become problematic for several reasons. The pipeline disposal point became perennially shallow and the resultant shoaling encroached into the federal navigation channel, causing dredge material to reenter the **entrance** channel after it was disposed of through the offshore pipeline. During the 2005-06 dredging season, the Port District had to cease using the offshore pipe because of unsafe surf and depth limitations in the **entrance** channel. Furthermore, the offshore pipeline had regularly become plugged with heavy sand effluent, making it unusable. Retrieving the pipeline to correct this situation involves a crew of four people entering the breaking surf on a work boat, which is a potentially dangerous condition. Because of the limitations of the offshore pipeline during the past two dredging seasons, the **entrance** channel sandy material was frequently deposited onto the beach through the surf line pipeline. Lastly, dredge material placed on the beach can result in high levels of hydrogen sulfide being released into the atmosphere due to decomposing seaweed present in the dredge material which cause odors. Disposal operations must cease when allowable hydrogen sulfide levels set by the Monterey Bay Unified Air Pollution Control District (MBUAPCD) are exceeded, and the Port District was required to shut down beach disposal operations on 34 days during the 2005-06 dredge season to prevent exceeding allow hydrogen sulfide levels set by the MBUAPCD (California Coastal Commission, November 2006).

The pipeline modification would allow more efficient extension of the pipeline into deep water when needed to meet MBUAPCD emission requirements. In addition, these non-anchored pipelines will be able to place sediment where it will not reenter the harbor mouth, which has been a problem periodically with the anchored offshore disposal pipeline. Sandy sediment disposed of at depths of four to six feet would continue to be available for beach replenishment (California Coastal Commission, November 2006).

- **Special Project and Emergency Permits:**

  → In September 2005, the Commission approved **CDP 3-05-026**, which allowed for the one-time demonstration / research dredging project where 10,000 cy of sediment from the **inner-harbor**, consisting of 50.8% sand and 49.2% silt/clay, was disposed through the offshore pipeline into the nearshore environment during October 2005. This approval also included an extensive monitoring program to evaluate the effects to the beach or local benthic environment due to fine-grain sediment disposal into the nearshore environment, which is discussed further in Chapters 3 and 5 of this report. An estimated 6,596 cubic yards of sediment composed of approximately 31% sand and 69% silt and clay was disposed of into the nearshore environment approximately 50 yards offshore of Twin Lakes Beach. Although, the percentage of sand did not meet the Commission or EPA requirement of at least 50% sand composition for sediment disposed of into the nearshore environment, the monitoring program required as part of this approval determined that there was no significant change in sediment sample mean grain-size or clay percentage beyond the range of normal background conditions (California Coastal Commission, November 2006).

  → On March 1, 2006, the Port District was granted an emergency permit (**CDP 3-06-012-G**), which allowed for the dredging and disposal of a maximum of 3,500 cubic yards of **north inner-harbor** sediment between March 1, 2006 and March 23, 2006. However, this permit was not utilized due to steelhead avoidance concerns.

  → On May 1, 2006, the Port District was granted an emergency permit (**CDP 3-06-025-G**) to allow dredging of the harbor's **entrance** channel through May 31, 2006. (CDP 3-05-065 required **entrance** channel dredging to cease on April 30th each year.) The time extension for dredging was necessary due to severe storms that took place during March and the first half of April 2006. The combination of massive sand transport into the **entrance** channel, mechanical difficulties in using the offshore pipeline, and restrictions on beach disposal due to hydrogen sulfide restrictions left the Harbor with a backlog of greater than 100,000 cubic yards of sand in the **entrance** channel.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

In December 2000, the California Regional Water Quality Board issued a "Technically Conditioned Water Quality Certification" to the Port District for annual maintenance dredging with two amendments authorized in January 2005. The provisions of dredge volumes, disposal and sediment content are essentially the same as those of the California Coastal Commission permit provisions.

In June 2007, the California Regional Water Quality Control Board amended its 2005 401 Certification to be coincident with Coastal Commission permit amendment (CDP-3-05-065A2) in regard to volumes and the various grain size requirements. Additionally, the amendment allows 20,000 cubic yards of material to be dredged from the **inner harbor** and disposed nearshore for sediment with a 80% or more sand content, except 3,000 cubic yards can consist of 50-79% sand and be allowed for nearshore disposal.

As an historical note, in 1985, the California Regional Water Quality Control Board, in its January 11th Waste Order 85-03, certified (to the U.S. Army Corps of Engineers) that **inner-harbor** sediment could be discharged into the nearshore in an average volume of 3,000 cubic yards/year, with a maximum of 10,000 cubic yards/year. Grain size was not limited. Waste Order 88-68 replaced 85-03, and reconfirmed the Port District's permission that 10,000 cubic yards of fine-grained material could be disposed in the nearshore with the proviso that discoloration of the nearshore would not be excessive. Both of these certifications preceded Monterey Bay National Marine Sanctuary designation in 1992, meeting the Sanctuary's requirement that disposing entities have permits that pre-date designation in order to perfect such rights going forward (CFR 922.47).

CALIFORNIA DEPARTMENT OF PARKS AND RECREATION

In 2005, the California Department of Parks and Recreation issued a temporary use permit to the Santa Cruz Port District. The permit 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. The permit is valid from October 2005 to October 2010, and all work is to be carried out in a manner consistent with the California Coastal Commission's Coastal Development Permit 3-05-065.

MONTEREY BAY UNIFIED AIR POLLUTION CONTROL DISTRICT

The Monterey Bay Unified Air Pollution Control District (MBUAPCD) has issued two permits to the Santa Cruz Port District for operation of its two floating dredges for air emission controls. The permits specify fuel usage, allowable daily hours of operation, and engine operations.

The MBUAPCD responds to odor complaints as part of its administration of "nuisance" control. Dredged sediments from the harbor **entrance** often contain seaweed, sea grass and other organic materials, which naturally decompose over time while submerged at the harbor **entrance**. The process produces hydrogen sulfide (H_2S) that is a colorless, flammable gas, heavier than air, which at low concentrations smells like rotten eggs. The hydrogen sulfide can be released into the air when sandy and decaying seaweed from the **entrance** channel material is placed into the surf line for beach replenishment.

Complaints from neighbors and some beach users caused the MBUAPCD to place limits on the emissions from the **entrance** dredging operation. In October 2003, the Air District issued A final hydrogen sulfide protocol, which was appended to the Harbor's dredge operating permits. This protocol was amended as a result of the 2004-05 dredging season. The protocol was adopted to minimize exposure of the public to the release of hydrogen sulfides at levels that constitute a public nuisance. The protocol included installation of a hydrogen sulfide monitoring instrument to operate when the wind direction is onshore, and a wind instrument to provide an indication of wind direction.

The principal tool for suppressing H_2S from **entrance** channel sediments has been the use of an anchored offshore disposal pipe which mitigates hydrogen sulfide by virtue of it being water soluble. However, as previously mentioned, the pipeline gets buried and becomes unusable under certain conditions, and the California Coastal Commission approved modifications to the pipeline configuration in December 2006. The modifications include three pipeline configurations in which offshore pipelines can be installed on a daily basis and be extended into the ocean up to 200 feet. The purpose of the new pipeline configurations is to provide the Port District with the flexibility to respond quickly to changing oceanographic conditions or other factors and to maximize the underwater discharge time in order to comply with the Air Board's H_2S protocol (California Coastal Commission, November 2006).

The institution of the multiple pipe array has resulted in less than 15 protocol shut-down days in two seasons (2006-2008), as opposed to 34 shut-down days in the 2005-06 single season.

3. DREDGING & DISPOSAL HISTORY

IN THIS SECTION:

- *Dredging Operations & Equipment*
- *Dredging History & Volumes*
- *Dredged Sediment Composition*
- *Disposal of Dredged Materials*
- *Demonstration Projects*

3-1 DREDGING OPERATIONS & EQUIPMENT

Dredging the harbor **entrance** and navigation channel is conducted in accordance with an "Operations Plan" that was prepared in 1995 and has been updated through November 2004. The Plan was required and approved by the California Coastal Commission. It provides details of dredge equipment and crew. It also addresses dredging schedules, dredged material, sediment sampling, reporting, and other requirements.

Existing permits allow both the **entrance** channel and **inner-harbor** areas to be dredged hydraulically, using suction dredges. The current dredging system for the harbor **entrance** consists of the floating dredge system that is owned by the Santa Cruz Port District. This system consists of the 16-inch floating hydraulic suction dredge "Seabright," with three internal combustion diesel engines and ancillary equipment and workboat. The system typically is in operation from November to April of each year with Port District crews working an average of 40 hours/week.

In the **inner harbor**, the Port District primarily utilizes the 8-inch hydraulic dredge, "Squirt," which has an output of 2,500 gallons per minute of slurry. Materials not suitable for nearshore disposal are hauled offsite. The **north harbor** dredging that took place in 2007-2008 also utilized a contract dewatering system that separated out sands from other sediments not meeting the permitted sand content, which then had to be taken offsite for disposal. Clear water was returned to the Harbor.

3-2 DREDGING HISTORY & VOLUMES

As previously indicated, sand shoaling of the harbor **entrance** was predicted in the 1958 feasibility studies for the Harbor. Littoral drift at the harbor site was estimated at between 30,000 cubic yards per year and 300,000 cubic yards per year. Dredging of the harbor **entrance** area has occurred since 1965, and periodic dredging of the **inner harbor** has occurred since 1983. A summary is provided below.

ENTRANCE DREDGING

The average annual cubic yards dredged has grown in definitive segments as shown on Table 2 and summarized below. (It should be noted that Port District volumes are based on daily estimates of the dredge leverman using engine temperatures, pump pressures and analysis of the type of material being dug and can vary by ±10%.) Current permits authorize dredging of the **entrance** channel to a design depth of -22 feet mean lower low water (MLLW).

- **1965 to 1976 – 79,300 cubic yards/year:** The Corps of Engineers authorized their first contract for dredging in the spring of 1965. Springtime dredging contracts continued from 1965 through 1977 during which time the harbor would typically close due to shoaling sometime after November and stay closed until approximately March 30. Dredging was usually an 8 to 10-week operation, starting in March and ending April 30 - May 15. Total sediment dredged between 1965 and 1976 averaged 79,300 cubic yards/year, which is less than current volumes. This is due to the formation of a "plug" early in the winter, effectively preventing more sand from entering the harbor over the succeeding months before dredging. The dredging volumes during this period reflect U.S. Army Corps of Engineers' contract volumes for one-time, single phase dredging each spring and represent the total capacity of a filled harbor with a once a year removal.
- **1977 to 1986 – 152,000 cubic yards per year:** In 1976, the Corps of Engineers began approving multi-phase dredging contracts in which the contractor was required to have equipment and personnel available over the course of the winter so that **entrance** closures would be kept to a minimum. With an **entrance** that was now "unplugged" and open to more sand inflow, average volumes increased over this period to approximately 152,000 cubic yards per year. The dredging volumes during this period reflect U.S. Army Corps of Engineers' contract volume for multi-phase (2 to 4) dredging episodes over the winter and spring of each year.
- **1986 to 1996 – 178,000 cubic yards/year:** In the early 1980s, the Port District and the federal government began plans to implement the bypass system set forth in the 1958 feasibility / enabling legislation. The bypass system developed was a floating hydraulic dredge – the same type that had proved successful during Corps' dredging contracts. (See equipment description in Chapter 2 of this report.) The dredging system is operated by Port District crews from approximately November 1 to April 30 each year. The average annual dredging volumes during this approximate 11-year period was 178,00 cubic yards per year and reflect Port District dredging system operations predicated on near continuous bypassing of sand.
- **1997 to 2007 – 270,000 cubic yards/year:** During this recent 10-year period, dredge volumes have averaged approximately 270,000 cubic yards per year. This higher average represents a higher storm index over during this period. Additionally, current dredging operations have resulted in a harbor **entrance** which is open nearly all winter in most years. Given this deep channel condition throughout winter, it is predictable that very little natural sand bypassing can occur because the **entrance** captures nearly all of the sand in suspension.

TABLE 2: Summary of Entrance Dredge Volumes

Year	Volume (CY)	Remarks
1965	70,000	**1964 to 1976:** U.S. Army Corps of Engineers' average/year was based on one-time dredging of the harbor in spring. The harbor was shoaled from November to December each year. The shoaled condition acted as a seal and limited sand from entering the harbor. **Total:** 951,000 cy for 12 years **Annual Average: 79,300 cy/yr**
1966	34,000	
1967	57,000	
1968	60,000	
1969	79,000	
1970	94,700	
1971	108,300	
1972	90,000	
1973	109,000	
1974	60,000	
1975	91,000	
1976	98,000	
1977	199,000	**1977 to 1986:** U.S. Army Corps of Engineers contracted multi-phase dredging – 2 to 4 dredging episodes per year. This kept the **entrance** channel clear for more of the time, but also allowed more sand to enter and settle in the harbor **entrance.** **Total:** 1,518, 700 cy for 10 years **Annual Average: 152,000 cy/yr**
1978	55,000	
1979	162,000	
1980	190,300	
1981	187,700	
1982	138,200	
1983	154,500	
1984	79,500	
1985	145,200	
1986	207,300	
1986-87	206,400	**1986 to 1996:** Santa Cruz Harbor assumes dredging responsibility with continuous dredging from November to April each year. System maximizes open channel and also allows significantly more sand to enter into the deepened channel. **Total:** 1,958, 300 cy for 11 years **Annual Average: 178,000 cy/yr**
1987-88	230,400	
1988-89	214,500	
1989-90	173,600	
1990-91	163,300	
1991-92	220,600	
1992-93	124,300	
1993-94	234,400	
1994-95	170,700	
1995-96	101,900	
1996-97	118,200	
1997-98	399,300	**1997 to 2007:** Santa Cruz Harbor assumes dredging responsibility with continuous dredging from November to April each year. System maximizes open channel and also allows significantly more sand to enter into the deepened channel. More frequent Pacific storms are attributed to the increase in volumes during the 1997-2007 period. **Total:** 2,690,500 cy for 10 years **Annual Average: 269,000 cy/yr**
1998-99	317,900	
1999-2000	262,300	
2000-01	203,050	
2001-02	238,400	
2002-03	346,220	
2003-04	290,800	
2004-05	160,330	
2005-2006	246,220	
2006-2007	225,970	

The increase in the average annual **entrance** dredge amount reflects the changes in dredging operations and schedules that have occurred over time, and represents what is required to have a year-round, safe navigation channel. The upward volume trend is also due to cyclical weather conditions. The recent annual average of approximately 270,000 cy/yr is within the range of annual littoral drift estimated for this area of Santa Cruz (300,000 to 500,000 cubic yards per year - Moffat and Nichol, 1978, "Santa Cruz Harbor Shoaling Study"), and is well within the range of littoral drift predicted in the 1958 feasibility study (30,000 to 300,000).

INNER-HARBOR DREDGING

Dredging of **inner-harbor** areas is authorized to a design depth ranging from -8 to -10 feet MLLW. As shown on Table 3, Santa Cruz Harbor has received between approximately 3,000 cubic yards and 40,000 cubic yards of mixed grained material per year from the upstream Arana Gulch watershed. During the 10-year period from when the Upper Harbor was constructed in 1972 to 1982, sediment removal by dredging averaged 1,500 cubic yards per year (Balance Hydrologics, October 1982. The magnitude and frequency of sediment generating storms during this period were considered close to normal (Ibid.). The 1982 to 1997 harbor sediment load from Arana Gulch averaged 4,200 cubic yards/year (Balance Hydrologics, January 2002). The annual average over the past ten years has resulted in annual average of approximately 6,200 cubic yards.

Sediments originating from the Arana Gulch watershed and entering the **north harbor** at its northernmost point have proved to be the Harbor's most threatening problem in recent times. The largest influx of sediment recorded occurred in 2005-06, during storm events, when approximately 40,000 cy of sediment entered the harbor, which damaged 46 berths and rendered portions of the area impassable to boats. A major dredging effort to remove this material, including obtaining all regulatory approvals, was initiated in 2006 and completed in February 2008. The Port District utilized a combination of contract and in-house dredging operations to return the **inner-harbor** to depths. These included two contracts utilizing land-based crane operations with upland disposal and a sediment dewatering contract utilizing hydraulic dredging with upland disposal of material at the City of Marina landfill. Some sandy sediment was disposed in the nearshore under existing regulatory approvals.

3-3 DREDGED SEDIMENT COMPOSITION

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 sand with a content of 80% or greater sand. Decaying organic material (i.e., kelp) also is found in these sediments, which as previously described, can produce unpleasant odors.

Sand content in sediments dredged in the **inner harbor** range from 20 to 98% sand with clays and silts comprising the difference. The material can contain organics from the upland Arana Gulch areas but not the seaweeds and kelp found at the **entrance**. Thus, this material does not have the same odor problems associated with organic material of **entrance** sand (Santa Cruz Port District, 1995).

TABLE 3: Summary of Upper Harbor Dredge Volumes

Year	Volume (CY)	Remarks
1978 [1]	600-700	**1978 to 1987:** **Total:** 40,000 cy for 10 years **Annual Average: 4,000 cy/yr**
1979 [1]	0	
1980 [1]	900	
1981 [1]	1,800	
1982 [1]	11,600	
1983	10,000	
1984	0	
1985	0	
1986	0	
1986-87	15,000	
1988-89	3,000	**1988 to 1997:** **Total:** 23,500 cy for 10 years **Annual Average: 2,400 cy/yr**
1989-90	3,500	
1990-91	3,000	
1991-92	2,500	
1992-93	5,000	
1993-94	3,500	
1994-95	0	
1995-96	0	
1996-97	3,000	
1997-98	0	
1998-99	3,100	**1998 to 2007:** **Total:** 62,725 cy for 10 years **Annual Average: 6,200 cy/yr**
1999-2000	3,000	
2000-01	3,000	
2001-02	0	
2003	4,000	
2004	875	
2005 (Feb)	5,050	
2005 (Oct)	6,500	
2006 (Feb)	800	
2006 (Nov)	8,900	
2007 (Feb)	3,000	
2007 (Feb)	4,000	
2007 (Oct/Dec)	20,500	
SOURCE: [1] Balance Hydrologics, October 1982		

The level of sand content has been a subject of debate and review with regards to disposal options. Within the last fifteen years, ACOE and CCC permits allowed nearshore disposal of materials with 80%+ sand composition.[4] The 80% "rule of thumb" had been utilized as an informal guideline within the EPA for allowing disposal of dredged materials into the nearshore environment suitable for beach replenishment. Correspondence from the EPA to the Port District in 2000, indicated that this guideline is applied in situations where more detailed information is lacking, but it is not the only appropriate ratio (California Coastal Commission, November 2006). Over the past five years, the EPA and ACOE have significantly liberalized the policy on fine-grained sediment management in the nearshore environment. The "rule of thumb" that sediment must be 80% sand to qualify for nearshore disposal has been superseded on a case-by-case approach.

Inner-harbor sedimentation has become a growing concern of the Port District because the sediments are largely fine-grained and less than 80% sand content. Within the last seven years, the Port District has been authorized on several occasions to dispose of **inner-harbor** sediments into the nearshore for sediments with 50-79% sand content. As part of the regulatory approvals for nearshore disposal of **inner-harbor** sediments with less than 80% sand content, the Port District implemented sediment sampling and testing according to Environmental Protection Agency / U.S. Corps of Engineers' protocols (guidelines are principally contained in the Inland Dredging Manual). Based on the results of the chemical and biological testing, ACOE and EPA determined that the materials were suitable for unconfined aquatic disposal. A disposal monitoring program was conducted as part of these approvals to serve as "demonstration projects" to assess any effects of disposal of finer grain sediments on beach replenishment or offshore habitat. Results of the monitoring program are further described below in Section 3-5 and in Chapter 5 of this report.

As summarized below, **inner-harbor** sediment composition for dredged materials within the last seven years has ranged from less than 50% sand to 85% sand.

- February 2001: One-time dredging and disposal of 3,000 cy of sediment from the **inner harbor** during February and/or March 2001. This sediment averaged 42% sand and 58% silt/clay.
- February and April 2005: 7,050 cy of material was dredged from the **inner harbor** and disposed into the nearshore environment. Of this amount, 4,300 cy consisted of an average of 85% sand and 15% silt/clay. A total of 2,750 cy consisted of an average of 71% sand and 29% silt/clay.
- September 2005: Approval was granted to allow dredging of approximately 10,000 cy of sediment from the **inner harbor**, consisting of 50.8% sand and 49.2% silt/clay with disposal during October 2005 only. An estimated 6,596 cy of sediment composed of approximately 31% sand and 69% silt and clay was disposed of into the nearshore environment offshore of Twin Lakes Beach. Although, the percentage of sand did not meet the Commission or EPA requirement of at least 50% sand composition for sediment disposed of into the nearshore environment, the monitoring program required as part of

[4] The 80% / 20% rule-of-thumb came into use in the early 1990's. It was never a written rule, and only gradually entered into Coastal Commission and other permits. An April 26, 2000, letter from the U.S. EPA to SCPD (attached) acknowledged that the 80%/20% was a "rule-of-thumb" and was not found in any written guidance, or rule, or policy.

this approval determined that there was no significant change in sediment sample mean grain-size or clay percentage beyond the range of normal background conditions (California Coastal Commission, November 2006).

- 2006-2008: The storms of December 2005, were of such an intensity that approximately 40,000 cy of sediment settled in the **inner harbor** from the intense run-off from the Arana Gulch watershed. A FEMA disaster (federal disaster #1628) was declared. Over the next two years, the Port District utilized its matrix of existing permissions and authorizations to dredge over 40,000 cy of material (see Table Three, page 3-5). Most of the material was taken upland by truck. Nearshore disposal either qualified under >80% sand, or was within the 3,000 cy/year limit for material 50% to 79% sand.

3-4 DISPOSAL OF DREDGED MATERIALS

Dredged materials from the harbor **entrance** and federal channel are disposed onto the beach east of the harbor or in an adjacent nearshore location. Depending on the composition of the material dredged from the **inner harbor**, disposal occurs nearshore, offshore and/or at designated upland locations. These locations are described below.

PIPELINE DISPOSAL – GENERAL

When hydraulic dredging using either the 16" dredge "Seabright" or the 8" dredge "Squirt" is utilized, the pipeline is placed underwater on the harbor floor until it reaches the east jetty, where it surfaces and then follows along the beach, either under or over the sand, to various discharge points. At these points, temporary pipes are connected to the main pipeline for either beach or nearshore disposal.

When the harbor dredge encounters coarse sand which is free of kelp (organics), it is sometimes disposed above the surf-line on the dry sand to increase the usable recreational beach. 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.[5] However, in order to protect against hydrogen sulfide odor emissions, even in predictably organic-free sand, the Port District normally disposes sandy material in the nearshore disposal sites over 98% of the time.[6]

TWIN LAKES BEACH AREA DISPOSAL

Dredged materials from the **harbor entrance** and federal channel are entirely disposed onto the Twin Lakes State Beach east of the harbor or in the surf-line (underwater); see footnote #5. The dredge operates between the fuel pier (Station 10+00) and the southern terminus of the federal

[5] Sand placed high on the perched beach acts as a natural seawall. The Port District uses beach disposal only for entrance channel sand. Inner-harbor material is always pumped to the nearshore, no matter what the grain size proportions.

[6] Currently, over 98% of entrance material is disposed in the nearshore for odor control.

channel (USACOE Station 26+00). Dredged material is pumped through a submerged 16-inch pipe that runs most of the length of the harbor to the beach and then along a 1,500 foot stretch of beach from the east harbor jetty to 12th Avenue (see Figure 3). The onshore disposal pipeline connects to the floating dredge barge. The Port District temporarily connects additional piping to route dredged materials to the surf line. This movable plastic pipeline is stored at the base of the beach beneath East Cliff Drive roadway.

NEARSHORE DISPOSAL

From 1997 to 2007, nearshore disposal occurred via an anchored, offshore pipeline, located approximately 70 yards from the shore to the east of the Harbor at Twin Lakes Beach. This was used primarily to mitigate hydrogen sulfide odors from decomposing kelp in the dredge materials. This pipeline allowed the water soluble hydrogen sulfide sufficient residence time to off-gas underwater into its elemental parts of hydrogen and sulfur.

In December 2006, the California Coastal Commission approved a re-configuration of the offshore pipeline that includes three pipeline configurations extending from the east harbor jetty to 12th Avenue. Each of the three configurations has multiple discharge points. Only one pipeline configuration and discharge point is in use at any one time (see Figure 3 for discharge locations). The pipes can be pushed directly into the ocean approximately 200 feet seaward, thereby accomplishing the hydrogen sulfide suppression. The reconfigured offshore pipelines are not be anchored to the seafloor, but are 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 the new pipeline configurations 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 will be able to place sediment where it will not reenter the harbor mouth, which has been a problem periodically with the anchored offshore disposal pipeline. Finally, the new configuration eliminates the down-time caused by the anchored pipe being constantly buried by its own heavy sand discharge.

OFFSHORE DISPOSAL

Dredge disposal is permitted secondarily at an off-shore location known as SF-14 (see Figure 4). SF-14 is an EPA / U.S. Army Corps of Engineers designated disposal site, located approximately 15 miles southeast of the Santa Cruz Harbor and one mile west of Moss Landing Harbor. This site can be used for disposal of various sediment sizes and types. The Santa Cruz Port District has never used this disposal site, and does not anticipate using it since logistical and environmental problems and limited weather windows make it impractical (see Alternatives section).

FIGURE 3: Nearshore Dredge Disposal Sites & Pipeline Configurations

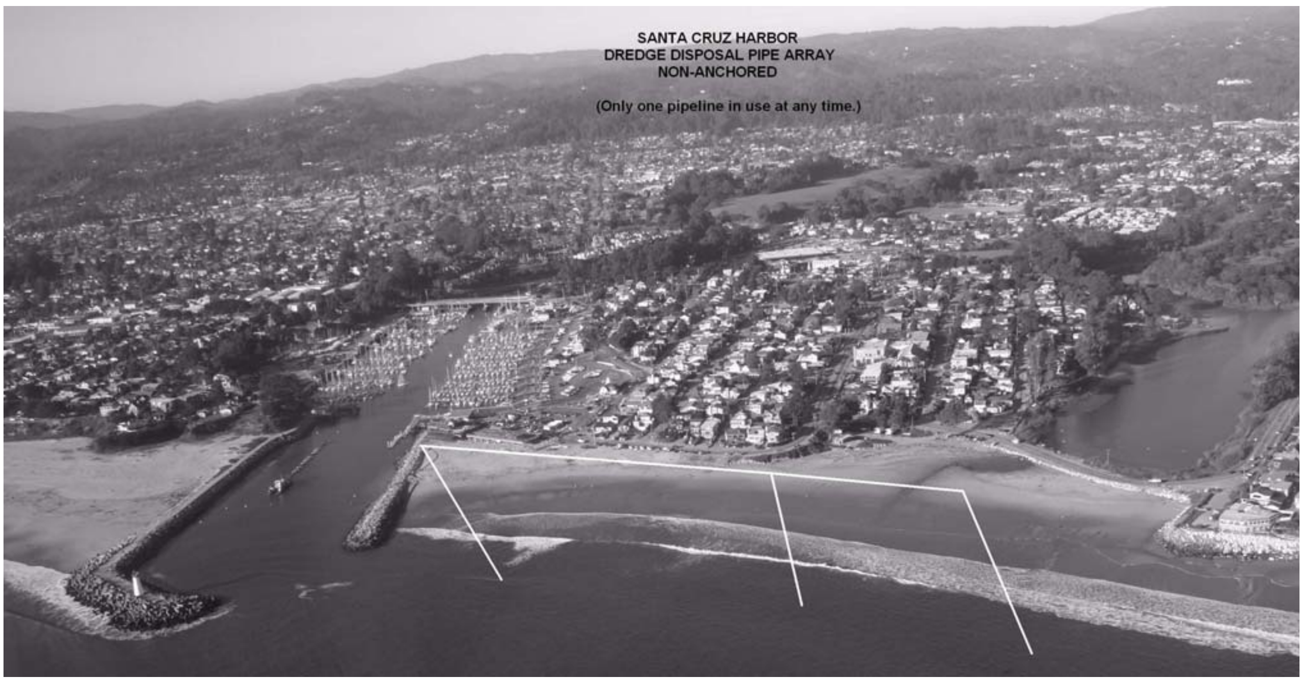
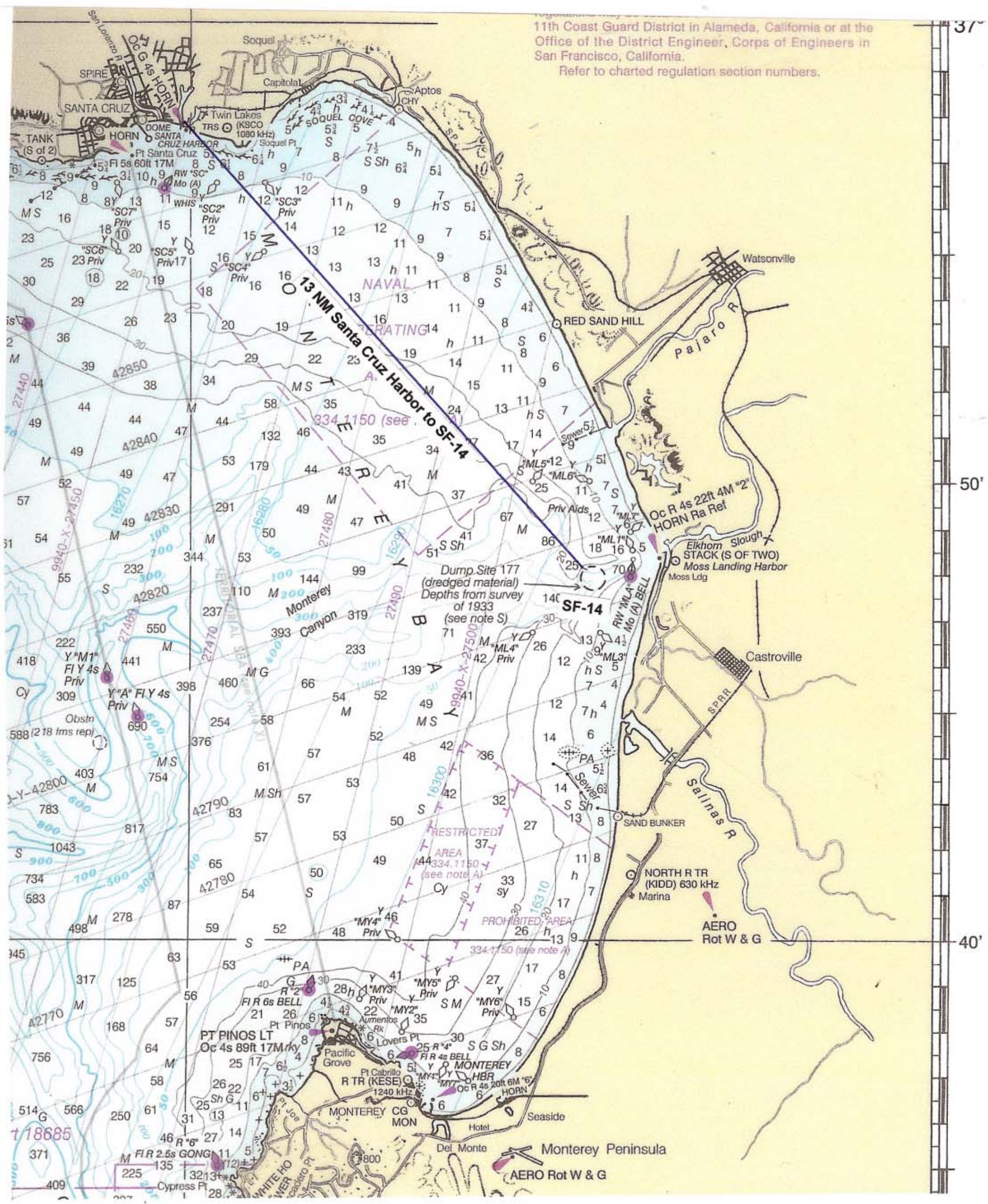


FIGURE 4: Offshore SF-14 Disposal Site Location



UPLAND DISPOSAL

Upland disposal is utilized for dredged material (from the **inner harbor**)that does not meet the permitted sand content. Such dredged material is de-watered onsite and then hauled by truck to an appropriate upland disposal site. Offsite disposal has occurred primarily at the Marina landfill in Monterey County, approximately 35 miles south of the Santa Cruz Harbor. The Elkhorn Slough restoration project may be a beneficial re-use site in the future

3-5 DEMONSTRATION PROJECTS – INNER-HARBOR

The Port District conducted three, fully monitored dredging projects between February 2001 and October 2005 for materials dredged in the **inner harbor** and disposed nearshore. The first monitoring program was conducted by researchers from Moss Landing Marine Laboratories and occurred from March 28 to March 30, 2001. The second inner harbor dredge monitoring program was conducted by Sea Engineering and occurred February 15 to April 7, 2005. The third monitoring program, also conducted by Sea Engineering, occurred between October 12 and October 31, 2005. Two of these projects were peer-reviewed demonstration projects (February 2001 and October 2005). The 2001 project concluded as a peer-reviewed Masters thesis by Steven G. Watt.

The Port District contended that the 80% sand requirement for onshore or nearshore disposal was too restrictive and precluded the beneficial use of otherwise clean sediments, of which a high percentage constitute sandy material. The Port District proposed that approval of the amendment would allow this dredge and disposal event to serve as a "demonstration" project to determine if clean, fine-grain harbor sediments could be disposed of into the nearshore area in a manner beneficial to downcoast beaches and without harm to coastal resources (California Coastal Commission, November 2006).

The dredging programs received approval and authorization from all regulatory agencies. The monitoring program dredge volumes and sedimentary compositions are compared in Table 4.

TABLE 4: Comparison of Monitoring Programs

Monitoring Program	Total Volume	Sand Composition		Silt & Clay Composition	
		CY	%	CY	%
Winter 2001	3,000	1,200	40	1,800	60
Winter 2005	7,050	5,623	80	1,428	20
Fall 2005	6,596	2,034	31	4,563	69
5-year Total	**16,646**	**8,857**	**53**	**7,791**	47

SOURCE: Sea Engineering, Inc., May 2006

DEMONSTRATION PROJECT METHODOLOGIES

The design of all three monitoring programs follow the same basic structure that includes a three phase approach over time to:

1) establish a baseline of existing sedimentary conditions before dredging begins;
2) monitor any potential immediate impacts during dredging; and
3) document the sedimentary conditions after harbor dredging was completed (Sea Engineering, May 2006).

The 2001 monitoring program was designed and implemented by scientists from Moss Landing Marine Laboratories to determine if sedimentary changes occurred on the beaches and nearshore benthic habitats in the vicinity of the Harbor due to the retention of fine-grain dredged sediment. In addition to a comprehensive scientific literature review, a variety of data were collected and analyzed, including stream flow data to calculate sediment discharge estimates and oceanographic swell information to monitor wave conditions and to calculate littoral drift estimates. Other data collection included over 300 water samples to observe changes in turbidity over time and two separate geophysical surveys to describe and quantify benthic habitats and sedimentary changes that may have occurred during the monitoring period. The winter 2005 monitoring program only required beach and offshore sediment sampling and summation of oceanographic conditions (Sea Engineering, May 2006).

The 2005 monitoring program included beach and offshore sediment sampling, water quality measurements, beach monitoring observations, scuba diver observations, evaluation of nearshore waves and currents, multibeam bathymetry surveys (including GIS based benthic habitat maps), and numerical modeling (California Coastal Commission, November 2006). Specifically, the fall 2005 program included collection of a variety of data sets to monitor the dredging event before, during and after dredging to include:

- Waves and currents were recorded near the dredge outfall;
- Local beaches and locations on the seafloor offshore were visually documented and sampled to track potential changes in sediment grain-size;
- Seawater turbidity measurements were recorded offshore;
- Two separate multibeam surveys were conducted and used to produce benthic habitat maps offshore of the SCH before and after dredging; and
- A numerical model was developed to approximate the sediment transport regime offshore of the Santa Cruz Bight while dredging occurred (Sea Engineering, May 2006).

The level of monitoring effort differed between the three monitoring programs. The monitoring effort was greatest for the initial winter 2001 monitoring program and the fall 2005 monitoring program. These two monitoring programs included extensive beach and offshore sediment sample analyses, a summation of oceanographic conditions, beach monitoring, SCUBA dives, seawater turbidity measurements, and before and after dredging multibeam bathymetry surveys.

The winter 2005 monitoring program only required beach and offshore sediment sampling and a summation of oceanographic conditions. The fall 2005 monitoring effort also included the installation of an offshore wave and current meter and numerical modeling.

SUMMARY OF RESULTS

The results of the fall 2005 monitoring program included a comparison of the monitoring programs conducted during each monitoring period. Specifically, comparisons between seasonal weather and oceanographic patterns, beach and offshore sediment sampling, and benthic habitat were made using the winter 2001 and fall 2005 data.

The two winter (2001 and 2005) and one fall (2005) monitoring programs represent two distinct climates: one dominated by high-energy winter storm conditions and the other dominated by lower-energy summer conditions (Sea Engineering, May 2006). In general, the two winter monitoring programs both experienced episodic high-energy storms that produced strong winds, high surf, heavy rainfall and significant inputs of silt and clay sediment from the San Lorenzo River. During the winter storms, conditions were ideal for sediment transport. Conversely, the fall 2005 monitoring program occurred during mild, dry summer conditions that lacked strong winds, high surf, any rainfall, or sedimentary inputs other than those contributed by inner SCH dredging. The lack of high-energy conditions during this period provided potentially ideal conditions for silt and clay sediment to deposit (Ibid.).

Despite the drastic difference in the sediment transport conditions between the fall 2005 monitoring program and the two winter monitoring programs, silt and clay released during **inner -harbor** dredging did not cause significant changes in sediment sample mean grain-size or silt and clay percentage beyond the range of normal background conditions for any monitoring program (Sea Engineering, May 2006). Based on the results of the 2001 monitoring program, it was concluded, after complete integration and analyses of all the data types collected during the monitoring period, that the fine-grain material released into the nearshore environment did not significantly change, alter, or impact the beaches or nearshore marine benthic habitats in the study area (California Coastal Commission, November 2006; Sea Engineering, May 2006). The fall 2005 monitoring program study results determined that there was no significant change in sediment sample mean grain-size or silt and clay percentage beyond the range of normal background conditions (Sea Engineering, May 2006; California Coastal Commission, November 2006). The highest silt and clay percentages in sediment samples occurred in the same general locations for all three monitoring programs. The locations most often sampled with relatively high silt and clay percentages were positioned in deeper water waters directly offshore of the San Lorenzo River (Sea Engineering, May 2006)..

The findings state that there is strong evidence collected in the three monitoring programs, which indicates that "the Santa Cruz Bight is a high-energy coastline that does not support the deposition of silt and clay sized particles" (Sea Engineering, May 2006). The evidence includes:

- The absence of increasing or relatively high silt and clay percentages in sediment samples collected in either summer or winter months.

- Wide spread shifts in the spatial distribution of benthic habitats, including migrating scour features.
- The possibility of a net sediment deficit in the local system.
- Sediment bed shear stress calculations indicating that the deposition of particles < 63 μm is unlikely even under low wave conditions.

The analysis of sediment samples collected on the beaches and nearshore benthic habitats indicate that silt and clay released from the harbor into the surf zone did not cause any significant changes in sediment sample mean grain-size or silt and clay. Silt and clay were not deposited on beaches between the San Lorenzo River mouth and Blacks Point, which were composed of greater than 99% sand in all three monitoring programs (Sea Engineering, May 2006). The overall results indicate that fine-grained material, when placed in the nearshore environment at the correct time of year, transit to and replenish soft bottom areas seaward of the nearshore (Steve Watt, 2002; Sea Engineering, May 2006). The results further indicate that local wave and current energy are more than capable of efficiently transporting not only silt and clay sediment away from the Santa Cruz Harbor, but sand-sized material as well. This implies that a larger volume of **inner-harbor** dredge sediment could be disposed offshore than is currently permitted (Sea Engineering, May 2006).

It is the Port District's contention that the demonstration projects show that harbor sediments placed in the nearshore during October to April, mimic the San Lorenzo River some 3,000 feet to the west of the harbor. The San Lorenzo River discharges an average of 272,695 cubic meters per year into the same nearshore environment. Approximately 73% of that discharge is silts and clays, none of which have been detected on the adjacent Seabright Beach or in the adjacent nearshore (GeoSea Oceanographic Consulting, "Sediment Trend Analysis (STA)," September 1999).

Further discussion of the effects of **inner-harbor** dredging and disposal are presented in Chapter 4.

4. SEDIMENT SOURCES

IN THIS SECTION:

- *Sediment Transport in Northern Monterey Bay*
- *Harbor Sediment Sources*

4-1 SEDIMENT TRANSPORT IN NORTHERN MONTEREY BAY

The Santa Cruz Small Craft Harbor lies within the Santa Cruz Littoral Cell, which extends from the Golden Gate Bridge in San Francisco 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, May 2006).

Nearshore sediment transport in the northern Monterey Bay is driven by waves and wave induced currents (Sea Engineering, May 2006). Sediments entering the ocean are sorted by the forces of waves and currents based on differences in grain-size, density, and shape. Sediment in the Santa Cruz Littoral Cell is sorted into two basic categories at a cut-off grain diameter of 180 microns. Sediments larger than 180 μm (microns) consist of fine-sand and larger-grained sand; sediments smaller than 180 μm are categorized as fine sediment (silt and clay). According to the Wentworth classification scale, silt and sand are differentiated at a diameter of 63 μm (Sea Engineering, May 2006).

Sediments larger than 180 microns travel in the littoral drift or are deposited on beaches in the Santa Cruz area. Estimates indicate that an average of approximately 262,000 cubic yards of sand are transported southeastward past the Santa Cruz Harbor every year in littoral drift (Sea Engineering, May 2006). Fine clay and silt sediments are transported offshore to the continental shelf, where they are deposited in abundance along a midshelf mudbelt. The mudbelt extends from Moss Landing to the south of Santa Cruz, northwest to Half Moon Bay. It is up to 30 meters thick on the continental shelf offshore of the San Lorenzo River (Sea Engineering, May 2006). It is the largest sink of silt and clay sediment on the northern Monterey Bay shelf (Watt and Greene, December 2002). The rate of silt and clay accumulation offshore of the San Lorenzo River along the mudbelt is 2.3 mm per year (Sea Engineering, May 2006).

The San Lorenzo River, located approximately 3,000 feet west of the Harbor, is a major contributor of sediment to northern Monterey Bay (Sea Engineering, May 2006). The river has released an estimated average of 212,500 cubic meters of multi-grain annually to the Santa Cruz shelf over a period of decades and possibly centuries (Watt and Greene, 2002). Even with this amount of multi-grained sediment discharge, a high percentage of silt or clay was not found within the dredge disposal area during the monitoring periods conducted as part of the "demonstration projects." The high-energy nature of the coastline (especially in the winter months from November to April) must be of sufficient magnitude to suspend the majority of silt and clay sediment delivered to the study area by any source, including harbor dredging. The silt and clay is most likely transported to deeper waters offshore, outside the study area, and deposited on the midshelf mudbelt, which had been found to the largest sink of silt and clay sediment on the northern Monterey Bay shelf (Watt and Greene, December 2002; Sea Engineering, May 2006).

Based on the results of the winter 2001 and fall 2005 dredge disposal monitoring programs, an evaluation of sediment shift patterns that occurred over the approximate 4.5 year period was made by Sea Engineering. The review indicates that the Santa Cruz Bight has undergone more areal erosion (17%) than areal deposition (14%) during this period. Using the Santa Cruz Harbor as a central divide between the western and eastern sections of the Santa Cruz Bight, 71% of the total areal erosion took place in the eastern Santa Cruz Bight while 69% of the total areal deposition occurred in the western Santa Cruz Bight. Large scour features in the southwest corner of the Bight appear to have migrated northeasterly by more than 100 meters, an average rate of over 20 meters per year. This implies that net sediment transport is traveling from west to east around Point Santa Cruz. The indication of a higher percentage of areal erosion in general in the Bight suggests that the amount of sediment (sand, silt and clay) entering the Santa Cruz Bight from the west (or from the San Lorenzo River) is less than the amount being transported out of the Santa Cruz Bight to the east, a net sediment deficit in this localized system (Sea Engineering, May 2006).

Two notable bathymetric features imaged on the Santa Cruz Bight seafloor may play significant roles in trapping, diverting, or enhancing sediment transport (Watt, 2003). Ledges and low-lying troughs present in the exposed, fractured, and eroded bedrock of the Pleasure Point fault offshore of Soquel Point may trap and partially obstruct sediment transport downcoast around Soquel Point (Watt, 2003). Another bathymetric feature which may affect sediment transport is the irregularly shaped rock outcrop shelf extending southwestward offshore of Blacks Point. The ledge is ~ 2 m above the surrounding flat sandy seafloor and may act as an obstruction to predominantly southeastward traveling littoral drift from Twin Lakes Beach or may impact nearshore currents. The densest kelp forests found in the Santa Cruz Bight are associated with the above two bathymetric features which may also affect sediment transport in these areas (Sea Engineering, May 2006).

4-2 HARBOR SEDIMENT SOURCES

HARBOR ENTRANCE CHANNEL

The **entrance** channel receives sediment primarily from littoral ocean drift at the harbor mouth. Shoaling of the harbor mouth **entrance** can only be corrected by regular maintenance dredging.

INNER HARBOR

Inner-harbor siltation occurs from two sources: 1) ocean sediment pushed in by wave action; and 2) sediment emanating from erosion in Arana Gulch watershed to the north of Santa Cruz Harbor. The **north** harbor receives sediment primarily from the Arana Gulch watershed, while the **south** harbor receives a combination of sediment from the **entrance** channel, as well as, the Arana Gulch watershed.

Ocean-driven sediment affects the **south harbor**. These are a combination of sand and lighter fractions of silts and clays. Berthing areas from the fuel pier area north to the “F” and “T” dock areas can be affected. Generally, the siltation rates in the **south harbor** are much slower than in the **north harbor**. An estimated 2,000 cubic yards per year accumulate in the **south harbor** as a rough average (Santa Cruz Port District, April 2003).

The north (upper) portion of the **inner harbor** is situated at the lower reaches of the Arana Gulch watershed. Arana Creek flows through a culvert at the northern end of the Harbor and is discharged into the upper harbor waters. The Arana Gulch watershed drains a 3.5 square mile area between the City and County of Santa Cruz (see Figure 5). Arana Gulch has historically sustained steelhead spawning and rearing. Major sources of sediment in the Arana Gulch watershed are summarized in Table 5.

Sediments originating from the Arana Gulch watershed have proved to be the most problematic for the Harbor in recent times. The **north harbor** sedimentation has been the largest physical problem facing the Port District, which threatens the operability of a large section of the marina. Sedimentation has caused waves to break because of shallow depths and docks to break as they sit on the bottom at low tide, which has had a financial impact as removal is estimated to cost from $400,000 to $500,000 per year.

The Port District has been working with other agencies and entities to aggressively address this problem through erosion prevention and sediment interception. The Port District and other agencies and entities joined together in 1997 to form a Coordinated Resource Management Program (“CRMP”) known as the Arana Gulch Watershed Alliance (AGWA). AGWA is comprised of a volunteer group of stakeholders which includes the City of Santa Cruz, County of Santa Cruz, Santa Cruz City School District, and landowners.

In association with AGWA, the Santa Cruz County Resource Conservation District (SCRCD) prepared the “Arana Gulch Watershed Enhancement Plan” in 2002. The Plan includes an assessment of current sediment and salmonid fisheries conditions and recommends a series of prioritized restoration projects to repair/reduce erosion at individual sites, improve habitat, or address constraints in the Arana Gulch watershed. The Plan's objectives are to improve, protect, and increase accessibility to and use of steelhead habitat throughout the Arana Gulch watershed and to reduce erosion and sedimentation throughout the watershed. The Plan identified and prioritized 19 project sites for watershed improvement and enhancement efforts, including twelve erosion control / sediment management projects and 4 sediment retention basins. Design and implementation of these projects are taking place as funding is obtained. Further discussion and details of these projects are included in Chapter 6 – section 6.4 of this report.

Concurrent, but separate from the watershed enhancement plan by AGWA, is a U.S. Army Corps of Engineers Section 905(b) Reconnaissance Study, which was completed in Fall 2002. This study determined that there is continuing interest in this watershed by the United States' government. The findings recommended that the project go on to the feasibility stage which would also identify a restoration plan for the gulch. The feasibility phase of the study has not been funded.

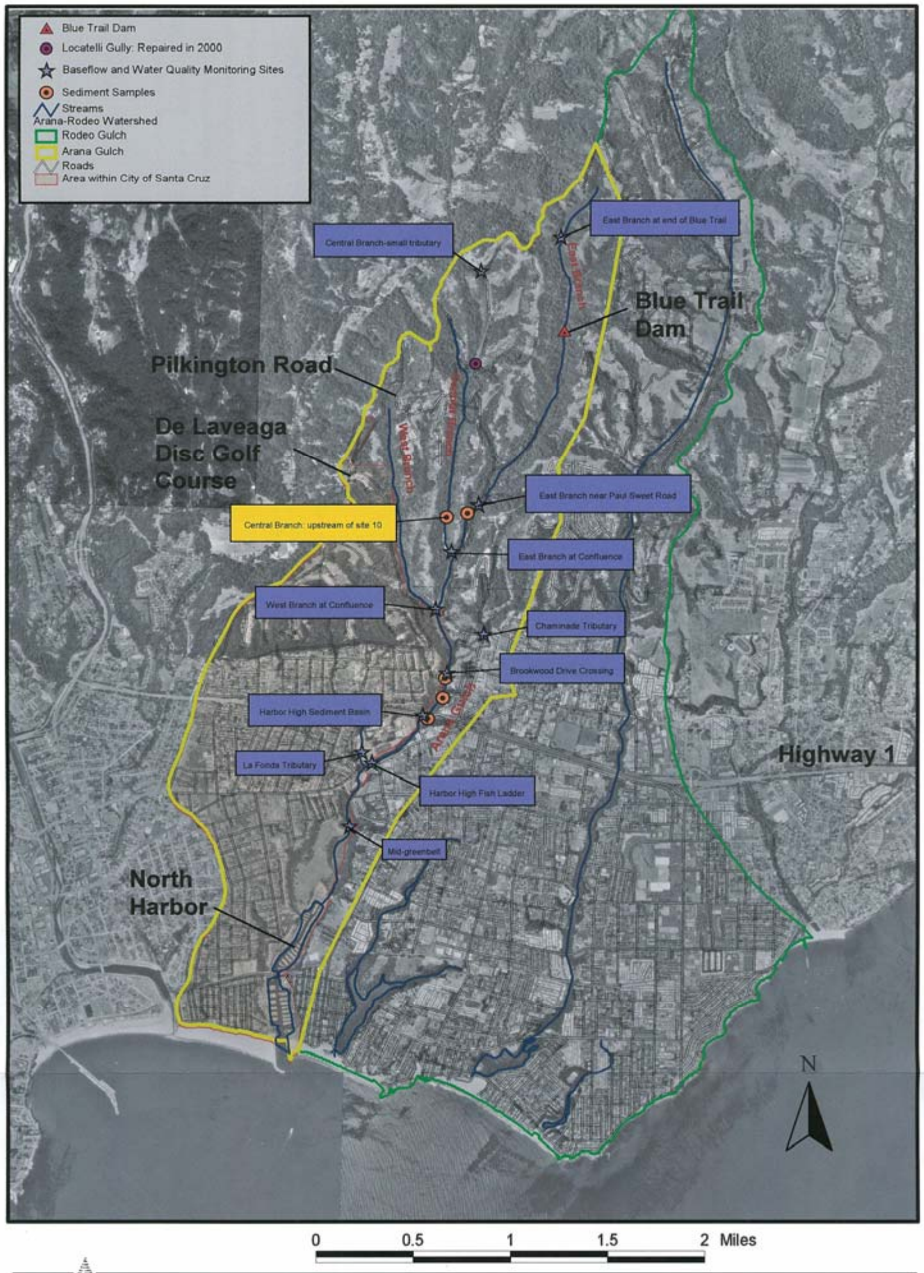
TABLE 5: Major Sources of Sediments in Arana Gulch

Project Site #	Site Name	Repair Priority	Volume Lost (cy)
Accelerated Erosion of Hillslopes			
3	Blue Trail Gullies	High	9,000
14	Disc Golf Course	High	3,300
15	Large Gully below Disc Golf Course	High	1,800
13	Pilkington Road Drainage	Medium	1,500
2	Right Bank meanders below Blue Trail Dam	Medium	400
16	Tributary from west at Lower Service Road	Medium	400
1	Blue Trail Dam	High	2,000
Channel Bank Instabilities			
18	Greenbelt Gully	-	
19	Tidal reach bank failures	-	5-10% of sediments deposited in the harbor

NOTE: While the numbered erosion sources are major contributors of sediment, there is also general erosion in the tributary system of Arana Gulch that contributes to the overall sediment load. This is due to a number of factors, principally the steep natural terrain that rises from sea level to a 600 ft elevation in just three miles' distance.

SOURCE: U.S. Army Corps of Engineers, September 2002 based on Arana Gulch Enhancement Plan, Balance Hydrologics, Inc., 2002

FIGURE 5: Arana Gulch Watershed



Balance Hydrologics, Inc.

Figure 3.1: Basemap of Arana Gulch. Major tribuatries in the upper watershed are noted as well as the location of the Santa Cruz Harbor, historic water qaulity and base flow monitoring sites, channel bed and bank composition sampling sites and other key locations in the watershed.

Note: All basefiles were provided by the Santa Cruz County GIS Department (EMIS Database)

5. EFFECTS OF DREDGE DISPOSAL

5-1 MONTEREY BAY OVERVIEW

The Santa Cruz Small Craft Harbor is connected to the Monterey Bay National Marine Sanctuary, which encompasses over 5,300 square miles of protected marine waters that includes a diverse complex of marine habitats including deep sea, open ocean, kelp forests, sandy beaches, rocky seashore, estuaries and sloughs. These habitats support a variety of marine life including more than 345 species of fish, 94 species of seabirds, 26 species of marine mammals, 450 species of algae and one of the world's most diverse invertebrate populations (California Coastal Commission, November 2006). Monterey Bay's natural resources include the nation's largest contiguous kelp forests, one of North America's largest underwater canyons and the closest-to-shore, deep ocean environment off the continental United States. It is home to one of the most diverse and productive marine ecosystems in the world (U.S. Department of Commerce, October 2006).

Monterey Bay also includes one of four major coastal upwelling regions in the world. Coastal upwelling occurs along the western edges of continents, where winds moving from the poles to the equator drive oceanic surface waters away from shore due to the Coriolis effect. These shallow, warm waters are replaced by deep, cold and nutrient rich waters driving high primary productivity, allowing phytoplankton to bloom, which in turn support zooplankton, providing a key prey resource for higher-order predators such as fishes, birds, and whales. Globally, these upwelling regions rival the productivity of tropical rain forests, and account for nearly 95 percent of the annual global production of marine biomass, in spite of only representing 0.1 percent of the ocean's total surface area (U.S. Department of Commerce, October 2006).

Most of the ocean floor in the MBNMS is covered with sand or mud. The lack of hard substrate and the shifting sand prevents algae from settling. There are two broad zones, including a shallow region dominated by crustaceans and a deeper area dominated by more sedentary polychaete worms. The crustacean zone continues up into the surf zone and intertidal beach zone, areas where sediment is constantly moving around. The main crustacean groups include those that burrow into the sand and those that are active on the surface of the sandy floor. All burrow into the seafloor and flourish in wave disturbed sandy bottoms (U.S. Department of Commerce, October 2006).

5-2 BEACH & OFFSHORE SEDIMENT CHANGES

As discussed in Chapter 3, three inner harbor dredge and disposal "demonstration" and monitoring projects were conducted between 2001 and 2005 with two winter periods and one fall period. As indicated, the two winter and fall 2005 monitoring programs describe two distinct climates in the Santa Cruz Bight. One is dominated by high-energy winter storm conditions and the other dominated by low-energy summer like conditions. In general, the two winter monitoring programs both experienced episodic high-energy storms that produced strong winds, high surf, heavy rainfall and significant inputs of silt and clay sediment from the San Lorenzo River. During the winter storms, conditions were ideal for sediment transport. Conversely, the fall 2005 monitoring program occurred during mild, dry summer conditions that lacked strong winds, high surf, any rainfall, or sedimentary inputs other than those contributed by inner Santa Cruz Harbor dredging. The lack of high-energy conditions provided potentially ideal conditions for silt and clay sediment to deposit during the fall 2005 project.

Despite the drastic difference in the sediment transport conditions between the fall 2005 monitoring program and the two winter monitoring programs, silt and clay released during **inner -harbor** dredging did not cause significant changes in sediment sample mean grain-size or silt and clay percentage beyond the range of normal background conditions for any monitoring program (Sea Engineering, May 2006). The range of grain-size parameters from sediment samples collected during the three monitoring programs are shown on Table 6.

TABLE 6: Comparison of Grain-Size Analyses of Sediment Samples Collected During Demonstration Projects

Grain-size parameters	Fall 2005	Winter 2005	Winter 2001
Mean Grain Size			
Before Dredging	86-780 μm	82-433 μm	90-530 μm
During Dredging	105-393 μm	82-485 μm	80-560 μm
After Dredging	98-486 μm	77-444 μm	70-530 μm
Wentworth Classification			
Before Dredging	very-fine to coarse-sand	very-fine to medium-sand	very-fine to coarse-sand
During Dredging	very-fine to coarse-sand	very-fine to medium-sand	very-fine to coarse-sand
After Dredging	very-fine to coarse-sand	very-fine to medium-sand	very-fine to coarse-sand
Percent Silt & Clay			
Before Dredging	0-42%	0-30%	0-26%
During Dredging	0-19%	0-31%	0-25%
After Dredging	0-19%	0-35%	0-26%

Sediments larger than 180 μm (microns) consist of fine-sand and larger-grained sand, while sediments smaller than 180 μm microns are categorized as fine sediment (silt and clay), the Wentworth classification scale differentiates silt and sand at a diameter of 63 μm (Sea Engineering, May 2006).

SOURCE: Sea Engineering, Inc., May 2006

Beach and offshore sediment sampling events were conducted over the fall 2005 monitoring period. Each of the three events (before, during, after dredging) consisted of fourteen offshore sediment samples and eight beach sediment samples for a total of 22 samples per event and 66 total samples. Local beaches were monitored concurrently with beach sediment sampling events on beaches spanning from the San Lorenzo River mouth to Blacks Point before, during and after dredging took place. Beaches from the east jetty at Twin Lakes Beach to Moran Beach were monitored twice daily.

Stream flow at the San Lorenzo River (the most significant contributor of silt and clay to the Santa Cruz Bight during the winter) was never more than a thin, shallow stream meandering westward up Beach and Boardwalk Beach during the 2005 monitoring program, and thus no significant amount of sediment was input by the San Lorenzo River during the monitoring period. Coastal lagoons (Schwan, Corcoran, and Moran Lake) remained ponded behind summer beach berms. Therefore, the potential increases in silt and clay concentration in sediments over the monitoring period would likely be a result of harbor dredging and not the San Lorenzo River.

Additionally, wave conditions during the fall 2005 monitoring program were milder than those occurring in the previous monitoring programs conducted in the winters of 2001 and 2005. No high-energy winter storms occurred in the Monterey Bay during the fall 2005 monitoring program. Only three swells produced wave heights over 3m offshore of Monterey Bay during the monitoring period, two while dredging occurred and the largest after dredging took place. Mild surf during the fall 2005 monitoring period was not of sufficient magnitude to significantly alter beach morphology, indicating that sediment transport rates in the Santa Cruz Bight littoral zone during the monitoring program were low. Low-energy conditions provided the best possible opportunity for silt and clay sediments to be deposited on the beaches or offshore of the Santa Cruz Harbor (Sea Engineering, May 2006).

Major changes in beach morphology did not occur at any Santa Cruz beaches monitored from the San Lorenzo River to Moran Beach over the fall 2005 monitoring period. Lack of high surf or rainfall preserved the beach morphologies in summer profile, meaning beaches were consistently wide, cuspate, and gently sloping near the waters edge (Sea Engineering, May 2006). Every beach sediment sample collected between the San Lorenzo River and Blacks Point during the fall 2005 monitoring program had a mean grain diameters between 346-612 μm (medium- to coarse sand), and the samples were composed of 99% sand or greater throughout the fall 2005 monitoring program. Only trace amounts of silt and clay sediment were detected on these beaches over the monitoring period. Samples indicate that silt and clay sediments were not deposited on these beaches at any time during the monitoring period (Sea Engineering, May 2006).

The ranges of grain-size parameters in offshore sediment samples were more variable than beach sediment sample parameters. Offshore sediment sample statistics had a broader range of mean grain-sizes and silt and clay percentages than beach sediment samples. Offshore sample means ranged from 86 to 780 μm (very-fine to coarse sand) and silt and clay percentages ranged from 0.7 to 41.8%. Sediment samples containing over 20% silt and clay concentrations were rare (~ 3%) and were collected only from two offshore sample locations before dredging took place. These locations are likely locations for silt and clay to deposit in the Santa Cruz Bight because they are positioned in deeper waters (~ 15 m) away from the shoreline, shallow water wave influence, and directly offshore of the San Lorenzo River. These areas also had the highest silt and clay concentrations during the winter 2001 and winter 2005 monitoring programs (Sea Engineering, May 2006). In general, mean grain-size decreases with increasing distance away from the shoreline and with increasing water depth. No evidence of consolidated silt or clay deposits were observed during SCUBA dives. The seafloors observed at the five dive locations were generally sandy or contained eroded, low-relief sedimentary rock outcrops encrusted with marine invertebrates and/or kelp holdfasts (Ibid.).

The findings of the demonstration projects state that the strong evidence collected in three monitoring programs between 2001 and 2005 indicates that "the Santa Cruz Bight is a high-energy coastline that does not support the deposition of silt and clay sized particles" (Sea Engineering,, May 2006). The evidence includes the absence of increasing or relatively high silt and clay percentages in sediment samples collected in either summer or winter months. Additionally, sediment bed shear stress calculations indicating that the deposition of particles < 63 μm is unlikely even under low wave conditions (Ibid.). The results further indicated that local wave and current energy are more than capable of efficiently transporting not only silt and clay sediment away from the Santa Cruz Harbor, but sand-sized material as well. this implies that a large volume of **inner-harbor** dredge sediment could be disposed offshore than is currently permitted (Ibid.).

5-3 BENTHIC AND MARINE HABITATS

BENTHIC HABITAT

The subtidal environment off the Santa Cruz Harbor is affected by seasonal swells, sediment transport and deposition, substrate characteristics and turbidity. The affected benthic environment includes ocean bottom flora and fauna of the **inner-harbor** area and also the sandy subtidal and intertidal areas off Harbor Beach/Twin Lakes State Beach. The substrate of the nearshore benthic environment in the Port District's nearshore dredge disposal locations consists of sandy beach and/or a sandy ocean bottom. These environments are dynamic and contain ever-changing habitats for a variety of benthic species (California Coastal Commission, November 2006). During fall and winter when natural sand deposition is greatest, algae were less present. Macro-invertebrates are more abundant on mudstone outcops than in sand channels (Goldberg, et.al., 2000.).

A review of benthic habitats at the Port District's nearshore dredge disposal sites was conducted by scientists from the Moss Landing Marine Lab (MLML) in January 2001, which included four research dives to examine the habitat and substrate conditions in the vicinity (Watt and Greene, December 2002). The purpose was to develop an inventory of the organisms associated with various marine benthic habitats near the Santa Cruz Harbor to use as a comparison in future studies. Additional dives were conducted as part of the "demonstration" dredge disposal projects conducted in 2005.

Four benthic habitats were identified in the Harbor study area, which are described below (Sea Engineering, May 2006).

- **Flat Sand:** Flat, unconsolidated sediment ranging from very-fine sand to medium-sand with occasional coarse sand, pebbles and shell fragments.
- **Scours and Depressions:** Scours or sedimentary depressions revealing flat exposed bedrock or unconsolidated coarse sediment.
- **Sediment Covered Subcrop:** Patch rock outcrops draped in most areas by an estimated 0-15 cm of unconsolidated, very-fine sand to very-coarse sand, pebbles and shell fragments.
- **Exposed Rock Outcrop:** Flat to low relief (2 m) exposed rock outcrops and boulders. Some have fractures, folds and faults. Patchy kelp forests are associated with most outcrops.

Comparison of benthic conditions between winter 2001 and fall 2005 indicates that the percent of the benthic habitat types are variable by as much as 7.6%. These changes are a function of many factors including changes in seasonal weather patterns and oceanographic conditions which control regional sediment inputs and sediment transport rates (Sea Engineering, May 2006).

Regulatory agency concerns have largely centered on the potential for adverse environmental effects to benthic habitats due to dredging, as well as disposal of dredged material. The primary impact to biological resources resulting from dredging occurs through the disturbance, transport, and destruction of benthic organisms on and in the material to be dredged. Dredging also may remove prey species used by other fish species. However, re-colonization by these organisms would occur over time.

Sediment deposition can smother invertebrates and prevent algal spore settlement. While, dredge material disposal may induce turbidity and cause stress on planktonic larvae and filter feeder organisms (e.g., worms and shellfish), such stress would be temporary (California Coastal Commission, November 2006), and benthic recovery would be expected within several months to years for the offshore SF-14 site (National Marine Fisheries Service, December 2007). Furthermore, as described below, the nearshore disposal site at Twin Lakes State Beach is a high-energy, turbulent environment, and the benthic community in this area has adapted to a highly disturbed environment, and therefore, is expected to recover quickly from disturbance (Ibid.).

Studies and reviews conducted by and for the Port District within the last ten years have found no adverse effects of disposal of dredged materials on benthic and marine habitats. Beginning in 1999, a sediment transport study found that sediment transport pathways and dynamic behavior of the littoral sediments strongly suggest that mud would be rapidly dispersed and have little deleterious effect (GeoSea Consulting, February 2000). A review in 2000 by the Monterey Bay Sanctuary Research Advisory Group (RAP) indicated that the release of a “relatively small (less than 12,000 cubic yards) of muddy sediment into the coastal offshore waters should have little or no discernible or lasting influence on bottom or beach sediment texture. . . as the discharge would be distributed over a winter-long series of large-wave and run-off events, in which case the natural contribution of fine-grain material to the nearshore environment will greatly exceed the amount from the harbor discharge" (Strelow Consulting, January 2001). Correspondence from Gary Griggs, Director of the UCSC Institute of Marine Sciences, to Kaitlin Gaffney of the Center for Marine Conservation, indicated that based on his study and knowledge of nearshore processes in the area, it is "clear that neither silt nor clay will remain in the nearshore zone (depths less than 25 feet or so) because of the high wave energy," and as a result of disposal during winter months, fines (silt or clay) "will be rapidly winnowed out and moved offshore in suspension" (Ibid.).

Dredge disposal monitoring studies conducted in 2001 and 2005 ("demonstration projects" described in Chapter 3 - Section 3.5) concluded that fine-grained material have little or no discernable or lasting influence on the bottom or beach sediment texture. Monitoring of the surf-zone dredge disposal site for 56 days from February to April 2001 concluded that dredged upper harbor sediment released into the surf zone did not significantly change, alter or impact the beaches or nearshore marine benthic habitats in the study area (Watt and Greene, December 2002). Beach grain size and compositional parameters changed little over the course of the monitoring period, even while the beaches were in the rebuilding stage. Descriptive statistical grain size, diversity, evidence of sediment deposition and erosion were identified offshore over the course of the monitoring period to remain within the same ranges as baseline or natural conditions. In addition, the geophysical surveys indicate that the same basic geometric shape, diversity and distribution of benthic habitats established in the pre-disposal phase persisted throughout the monitoring program (Ibid.).

During the fall 2005 monitoring period, wave conditions were milder than those occurring in the previous monitoring programs, indicating that sediment transport rates were low. Low-energy conditions provided the best opportunity for silt and clay sediments to be deposited on the beaches or offshore (Sea Engineering, May 2006). However, despite the drastic differences in the wave and current energy between the fall and winter monitoring programs conducted between 2001 and 2005, the outcome was the same: no significant changes in sediment sample mean grain-size or silt and clay percentage beyond the range of normal background conditions (Sea Engineering, Inc., May 2006). The data collected in the three monitoring programs indicates that Harbor disposal area is in a high-energy coastline that does not support the deposition of silt and clay sized particles (Ibid.).

Benthic habitats that were mapped before and after dredging had nearly identical spatial geometries and spatial distributions (Sea Engineering, Inc., May 2006). The comparison of the 2001 and 2005 benthic conditions indicated that approximately 89% of the seafloor habitats had not changed, 5% had undergone sediment deposition, and 6% had been eroded of sediment in the month before the two surveys (Sea Engineering, Inc., May 12, 2006). (See Figures 6 and 7). It was noted that ledges offshore of Soquel Point and an irregularly shaped rock outcrop offshore of Blacks Point may obstruct sediment transport downcoast, as well as dense kelp forests associated with these features (Ibid.).

FIGURE 6: Benthic Habitat Before Dredging

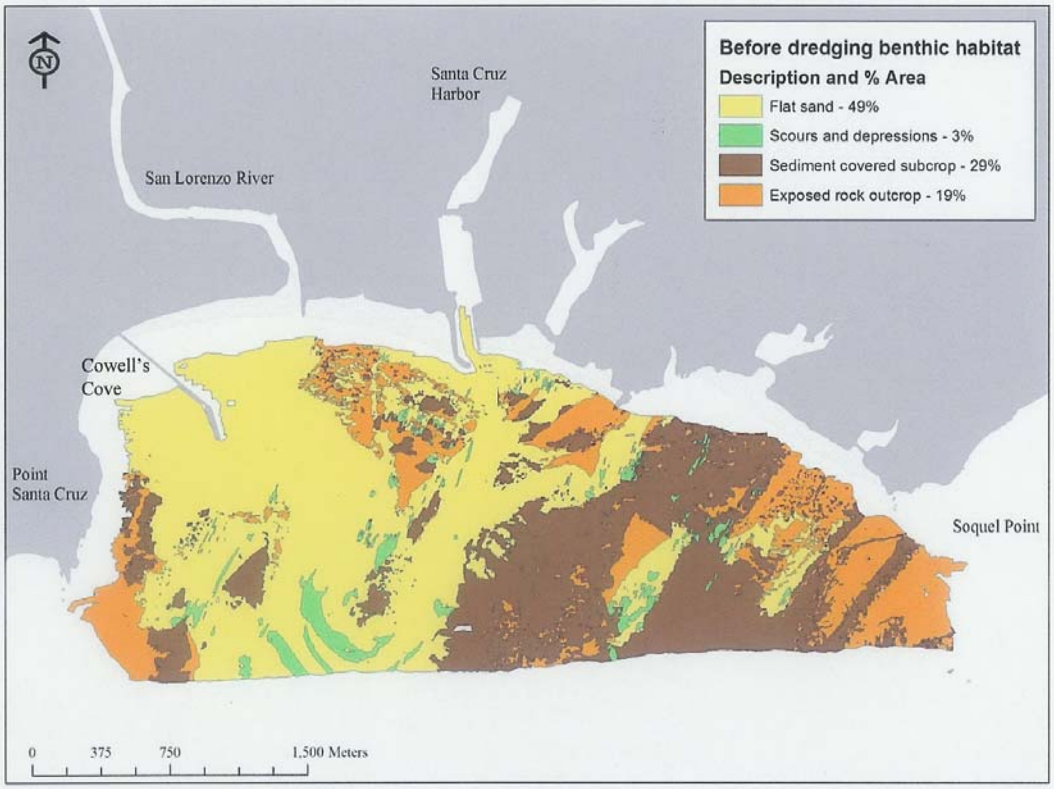


Figure 30. This benthic habitat map was produced in GIS by visually interpreting multibeam bathymetry and backscatter imagery collected before dredging took place offshore of SCH (see Figures 27, 28, and 29). The interpreted habitats were verified using offshore sediment samples (section 3.2) and SCUBA diver observations (section 3.3).

SOURCE: Sea Engineering, Inc.

FIGURE 7: Benthic Habitat After Dredging

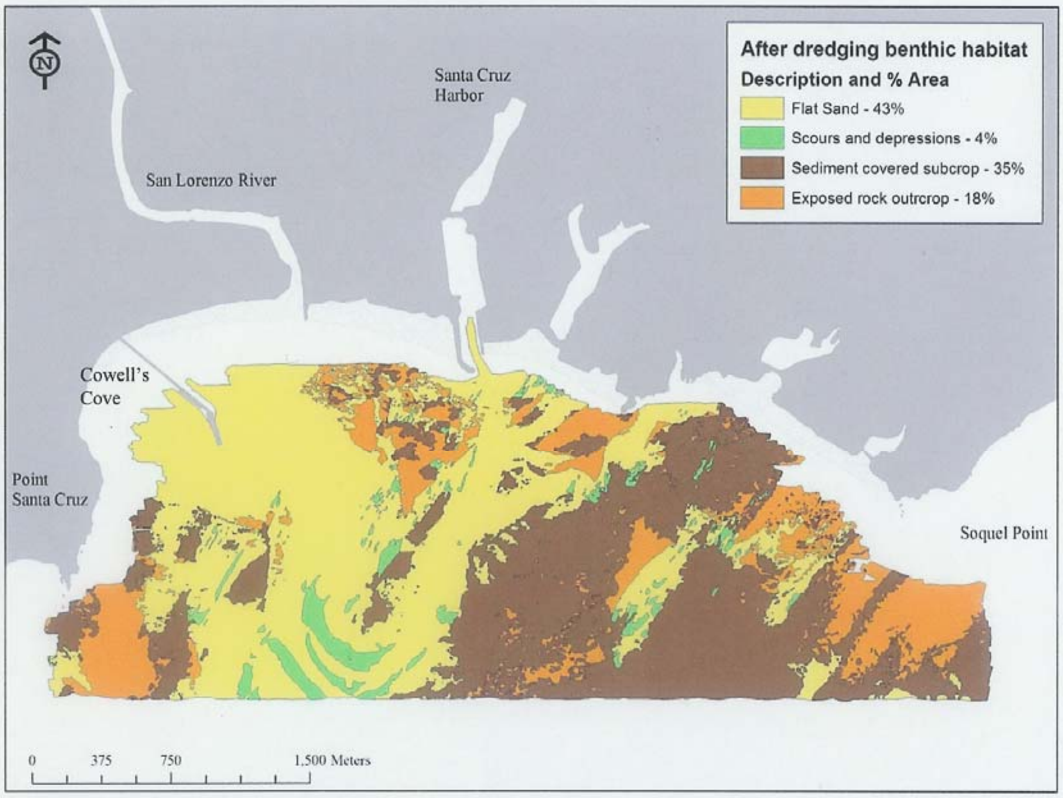


Figure 34. This benthic habitat map was produced in GIS by visually interpreting multibeam bathymetry and backscatter imagery collected after dredging was completed offshore of SCH (see Figures 32 and 33). The habitats were verified using offshore sediment samples (section 3.2) and SCUBA diver observations (section 3.3).

SOURCE: Sea Engineering, Inc.

Recent studies have shown that a thick band of mud (Monterey Bay mid-shelf mudbelt) is sandwiched between the shelf slope break and inner shelf including the surf zone and sandy beach, and this mud supplies iron that has been found to be a critical nutrient for benthic productivity (Oliver, 2008). Fine sediments, including some muds from disposal of dredged materials, are transported from the regional watersheds into the ocean. The closest major depositional sinks for this mud are the outer continental shelf and the upper slope, especially on the walls of submarine canyons (see Figure 8). A thick band of mud is sandwiched between two erosional environments: the shelf-slope break and the inner shelf including the surf zone and sandy beach (Oliver, 2008).

An important discovery in modern oceanography is the critical role of iron for benthic productivity. Iron is deposited in the mud band and in deeper water and is remobilized by bioturbation (animals mixed sediment) and bottom currents. Monterey Bay and the continental shelf to the north receive large inputs of fine sediment from several major rivers, draining large watersheds. The shelf is wider and the middle and outer shelf are covered with a thick band of mud, which supplies the iron that fuels the high production center in Monterey Bay and to the north. The benthic invertebrate communities living on the shelf and upper slope of the Monterey Bay area have one of the highest number of benthic species and diversity in the world (Oliver, 2008). The mud band and shelf break are a region of high diversity, despite major changes in the bottom communities from the depositional mud band to the erosional shelf edge (Ibid.).

The primary productivity of coastal upwelling centers is dependent on iron eroded from land, bound to mud, and deposited in benthic sinks. Without mud, there would not be the complex, diverse food webs that characterize productive upwelling systems. Benthic invertebrate communities live in the sediment, and are strongly influenced by spatial and temporal variations in water column production. Monterey Bay has the highest benthic diversity in the world, and the animals live in muddy deposits along the outer continental shelf. The high diversity depends on a high production, which depends on iron in mud (Oliver, 2008).

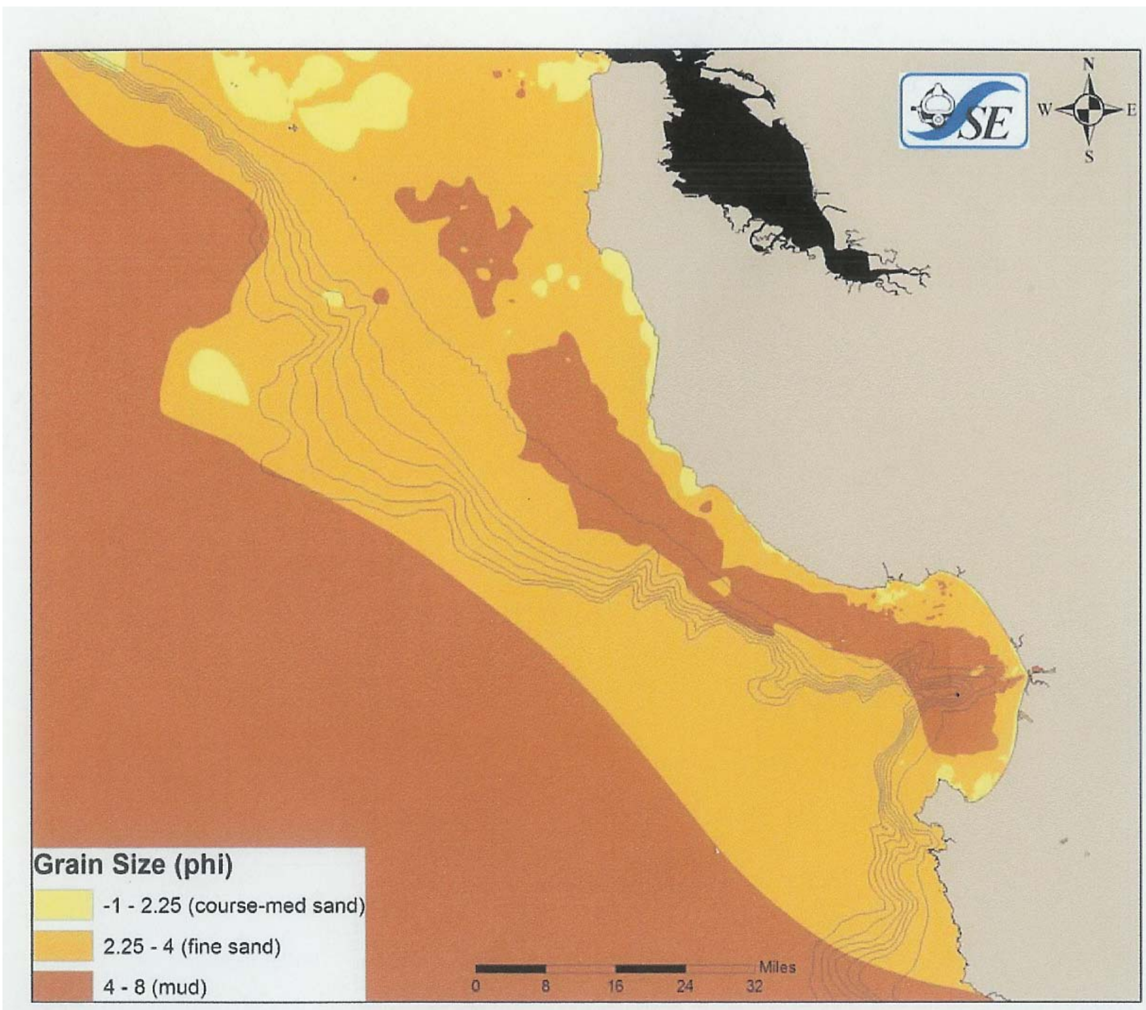
Inner-harbor sediments emanate principally from the Arana Gulch watershed and are high in iron content reflecting the general geology of the region. Before the construction of the harbor (1962), all Arana Gulch watershed sediment traveled down gradually to the former Woods Lagoon (now the harbor), and then to the ocean.

FISH HABITAT

Information from the National Marine Fisheries Services indicates that the Harbor and dredge disposal areas are located within an "essential fish habitat" (EFH) for various life stages of fish species managed with the following Fishery Management Plans (FMP) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA):

- Pacific Groundfish FMP – various rockfish, sole and shark
- Pacific Salmon FMP – Chinook salmon
- Coastal Pelagic FMP – northern anchovy, Pacific sardine.

FIGURE 8: Offshore Mud Shelf



Additionally, the area is within a designated "Habitat Areas of Particular Concern" (HAPC) for various federally managed fish species within the Pacific Groundfish FMP. HAPC are subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially ecologically important or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under MSA, but federal projects with potential adverse effects to HAPC areas are more carefully scrutinized during the consultant process (National Marine Fisheries Service, December 2007).

The removal of sediment from dredge areas could have short-term, adverse effects on fish and fish habitats by temporarily increasing the total suspended sediments in the water column and possibly decreasing dissolved oxygen levels during dredge operations. However, the continued use of the existing hydraulic dredge, which removes and transports dredged material as liquid `slurry, minimizes disturbance and re-suspension of sediments at the dredge site. This will minimize adverse environmental effects to marine and wildlife habitats and water circulation during dredging (California Coastal Commission, November 2006). Additionally, fish are generally expected to move out of areas of high suspended sediment, and the sediment concentration at the disposal site is anticipated to dissipate quickly out of the area due to the highly dynamic nature of the area (National Marine Fisheries Service, December 2007). Furthermore, the harbor has a history of dredging, and the U.S. Army Corps of Engineers considers the habitat to be disturbed (U.S. Army Corps of Engineers, May 2007). Fish species would be presumably using the area for feeding and would be able to find ample and suitable foraging areas in adjacent areas during dredging, and the fish would return as the infaunal community recovers after dredging (Ibid.).

KELP FOREST

Hugging the rocky coastline just beyond breaking waves, several species of kelp are found in the Monterey Bay area. Although some individual kelps 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. During the following spring, the next generation takes advantage of the thin canopy cover and increase in available light to grow rapidly. The measured productivity (per square foot of sea floor) of a kelp forest is among the highest of any natural community in the world (U.S. Department of Commerce, October 2006).

Kelp forests provide refuge for various species of fish, invertebrates, marine alga and marine mammals (Watt, December 2003). Areas around Blacks Point and Soquel Point, southeast of the Twin Lakes State Beach disposal area, support dense areas of giant kelp (*Macrocystis pyrifera*). The Port District's onshore disposal site is located approximately 1,200 feet from the existing Blacks Point kelp field. Kelp canopies are designated HAPC and provide an important structural habitat for fish as well as a surface for attachment of fish eggs (National Marine Fisheries Service, December 2007).

It has been theorized that the offshore habitats could be at risk of being impacted by dredge sediment because of their location downcoast from the harbor. The dredged materials could result in potential accumulation of sediment over the exposed rocky outcrop habitat near Blacks Point that could prevent kelp spore attachment to the substrate, cause smothering, or scour microscopic sporophytes (National Marine Fisheries Service, December 2007). This, in turn, the theory continues, could lead to a decrease in the growth, productivity and/or survival of kelp plants in the area (Ibid.). However, the results of the dredge monitoring programs indicate that disposal of fine-grained sediments resulted in no significant changes in sediment against background levels and that this segment of high-energy coastline does not support the deposition of silt and clay-sized particles.

At the request of the ACOE (through consultation with the National Marine Fisheries Service), the Port District initiated a kelp monitoring study in 2008. The objective of the study is to verify that proposed increases in dredging and disposal activities are not significantly impacting the distribution and abundance of giant kelp areas that within the path of sediment transport (including Pleasure Point offshore of Soquel Point and the rock outcrop shelf extending southwestward of Blacks Point) through monitoring of kelp density and abundance.

The three-year monitoring program will be conducted in the summer when kelp forests are denser with the first monitoring effort conducted in the summer of 2008. The summer 2008 monitoring selected four kelp forests at Steamers (Point in Santa Cruz) East and West, Blacks Point (near Twin Lakes Beach), and Pleasure Point (Soquel). The Blacks Point and Soquel Point kelp forest sites are down current of the historic dredge disposal and were chosen as the monitoring sites; The Steamers sites were surveyed as control sites (Sandoval and Associates, October 2008). Historical aerial photos were reviewed and analyzed in addition to data collection via scuba surveys.

The scuba survey results suggest that the control sites and impact sites are similar in relative kelp abundance and robustness. The historic aerial photo review revealed that the kelp canopy surface areas were different among the sites, and if canopy is an indication of suitable kelp habitat, persistent kelp habitat may be less at the impact sites compared to the control sites. This was evident at the Blacks Point site, but less evident at the Pleasure Point site. The baseline data suggests that the kelp forests at all sites are robust but that the available and suitable habitat may be small or decreasing. However, most researchers suggest a long-term monitoring program before evaluating the condition of these ecosystems (Sandoval and Associates, October 2008). Two more years of monitoring and data analysis will be conducted in 2009 and 2010.

5.4 SPECIAL STATUS SPECIES

Several endangered or threatened species are found in the harbor area or just offshore, including: California brown pelican, steelhead, butterfly, and Southern sea other. Sea otters that have been observed swimming in harbor waters. Brown pelicans have been observed in the disposal area, and steelhead have been found moving through the harbor. Habitat for the tidewater goby is not present in the Harbor.

According to previous correspondence received from the California Department of Fish and Game, the state and federally listed California brown pelican has been documented at the offshore disposal site. The underwater disposal of dredge material in the area of the proposed non-anchored pipeline configuration is not expected to create excessive vibration, noise, or surface turbulence that would affect birds in the area (California Coastal Commission, November 2006).

Steelhead trout (Oncorhynchus mykiss) is a federally and state listed threatened species. Arana Gulch has supported steelhead passage, and steelhead have been found within Harbor waters. Upstream migration season for steelhead is generally between December and April, and the downstream migration season generally peaks from March through May. Steelhead smolts migrate out of the **inner-harbor** by the end of June each year (California Coastal Commission, November 2006). Previous reviews conducted for the Santa Cruz Port District with regards to dredging operations indicated that there would be negligible effects on steelhead population in Arana Gulch if these activities were conducted outside of smolt out-migration and adult migration periods (Alley, 2001).

Informal consultations with the National Marine Fisheries Service (NMFS) in October 2002, and January 2005, resulted in timing restrictions for dredging of the **inner-harbor** areas to protect salmonids. Specifically, a February 28th deadline for cessation of **north** harbor suction dredging is included to protect steelhead smolts, which transit the Arana Gulch area and **north harbor** area during the spring months of March, April, and May. This condition also required limiting all **inner-harbor** dredging to the daytime hours during the periods when adult steelhead are present in the harbor to limit effects to steelhead, which migrate at night (California Coastal Commission, November 2006). The recent Coastal Commission approval to allow **inner-harbor** dredging during July, August, September, and October would not impact steelhead as they are not present in the harbor during this period.

The southern sea otter (*Enhydra lutris nereis*) is federally listed as threatened, and State-listed as "California Fully Protected." The species is also protected under the Marine Mammal Protection Act (MMPA). Individual sea otters have been observed swimming in the open harbor waters. Under existing ACOE permits, the potential for injury or mortality was found to be very low, and monitoring during dredging is required.

The tidewater goby (*Eucyclogobius newberryi*) is federally listed as endangered and state listed as a species of special concern. Tidewater gobies were thought to live within Woods Lagoon in 1984, however, the U.S. Fish and Wildlife Service data appears to have been inaccurate. There have been no recent sightings. According to a review of site conditions by fishery biologist, Donald Alley, past sampling and existing conditions in Arana Gulch indicate that the tidewater goby no longer inhabits Arana gulch and that habitat for the species is lacking. Constant tidal contact between the harbor mouth and Arana Gulch Creek prohibits development of a closed lagoon, which is essential for tidewater goby breeding and long-term colonization success (Strelow Consulting, November 2007).

Additionally, the predominantly saltwater, developed portions of the Harbor were not identified by the CDFG as potential goby habitat. This species requires relatively closed habitat where daily tidal fluctuations are reduced or absent. The majority of the Harbor experiences tidal influences, especially in the Lower Harbor. The U.S. Fish and Wildlife Service reviewed surveys and data regarding presence of tidewater gobies in Harbor waters, and concurred that tidewater gobies do not inhabit Harbor waters (Strelow Consulting, November 2007). The Upper Harbor water salinity level is in excess of what could support the tidewater goby (Letter to Port District from California Department of Fish and Game in March 1993).

5-5 WATER QUALITY

Under existing permit provisions, dredged sediments must be tested for a variety of chemical, physical and biological characteristics according to the requirements of the ACOE and U.S. EPA and that the sediment meet standards for unconfined aquatic disposal. Requirements for lab testing of the fine-grain dredge material, according to all criteria prescribed by ACOE and EPA regulations, remained in place. These criteria included testing for 1) metals; 2) pesticides and PCBs; 3) butylins; 4) organotins; 5) total and water soluble sulfides; 6) total solids/water content; 7) total volatile solids; 8) total organic carbon; and 9) grain size distribution.

Under provisions of the Port District's existing Coastal Development Permit, the suitability of proposed dredge material for disposal in aquatic locations is evaluated by an interagency group consisting of representatives from the Army Corps of Engineers, U.S. Environmental Protection Agency, the Central Coast Regional Water Quality Control Board, California Coastal Commission, and Monterey Bay National Marine Sanctuary. Advisory to this interagency group are the U.S. Fish & Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish & Game.

For **entrance** channel sediments, which have consistently been composed of approximately 90% sand, the required testing is done on a rotational basis, i.e., periodic physical (grain size) and chemical testing be intermittent, with occasional years of no testing if the previous two years of testing have shown adequate grain size and no chemical contamination California Coastal Commission, November 2006). Chemical testing is not as critical for sandy sediments because chemical contaminants are much more likely to adhere to fine-grain sediments than sandy sediments (Ibid.), and the **entrance** has no history of chemical "hits" of any kind

Pursuant to existing permits, all **inner-harbor** sediments proposed for unconfined aquatic disposal require annual physical and chemical testing, as well as occasional biological testing. **Inner-harbor** sediment that is determined to be less than 50% sand requires upland disposal, which does not require chemical or biological testing under existing ACOE and EPA permits Disposal at these sites require some form of dewatering and testing to meet RWQCB standards for solid waste disposal (California Coastal Commission, November 2006)

Potential water quality effects of dredging and disposal occur through variables such as dissolved oxygen (DO), pH, salinity, total suspended solids (TSS), and turbidity. Turbidity near the dredging and disposal sites would increase because of additional TSS in the water column.

DO levels in the water column would decrease during disposal events due to increased turbidity. Long-term changes in turbidity and dissolved oxygen also can have an adverse effect on kelp beds found offshore. However, the monitoring studies conducted on past dredge disposal operations indicate that the pre-dredge-operation ambient water quality condition should return shortly after each dredging episode. This is supported by the findings of the 2001 dredge demonstration, which included nearshore disposal of fine-grain sediments. A strong turbidity signature was not identified in the water samples taken during the demonstration dredging event. Furthermore, scuba diver observations and turbidity profiles from 14 sample offshore locations indicate that turbidity caused by harbor dredging could not be differentiated from normal background turbidity conditions. Turbidity was the greatest near the seafloor due to resuspension of sediments by waves and currents, as well as near the sea surface due to algal blooms (Sea Engineering, May 2006). Anecdotally, the San Lorenzo River, some 3,000 feet to the west of the harbor, has an annual discharge of 227,695 cubic meters (26.8% sand [74,422 CM], 73.2% [2-3.273 CM] silts and clays), which would seem to blanket, mask and diminutize the harbor dredging contribution to turbidity and subsequent impact on kelp.

The Coastal Commission's approval of an amendment (December 2006) to the Port District's five-year dredging and disposal plan concluded that increased dredging and disposal may cause some short-term adverse effects on water quality, including a temporary increase in turbidity and a decrease in dissolved oxygen levels. However, although expected to be adverse in the short-term, the impact would be minor in magnitude and scope. Pre-dredge water conditions should recur shortly after each dredging and disposal episode. Additionally, permit conditions require submission of specific dredge plans for each dredging episode to be undertaken during the term of this permit that include written evidence that the ACOE, RWQCB, EPA, and the Sanctuary have reviewed and approved the dredging operations or that no such approval is required. The conditions will ensure protection of water quality and marine resources.

No evidence of consolidated silt or clay deposits were observed during SCUBA dives. The seafloors observed at the five dive locations were generally sandy or contained eroded, low-relief sedimentary rock outcrops encrusted with marine invertebrates and/or kelp holdfasts. Diving visibility was poor near the sea surface due to algal bloom and was worse near the seafloor due to resuspended sediments. Resuspended sand, silt and clay sediments were common near the seafloor and in the water column throughout the monitoring program. SCUBA diver observations compliment turbidity profiles from 14 sample locations offshore of SCH. Turbidity values were highest near the seafloor. The highest recorded seafloor turbidity value was 11.5 NTU offshore of Corcoran Beach a week after dredging had ceased.

5-6 AIR QUALITY

The Harbor's winter dredging program replenishes beach sand via disposal of specified dredge materials at Twin Lakes State Beach east of the Harbor. However, in the last several years, neighbors have submitted complaints to the Monterey Bay Unified Air Pollution Control District (MBUAPCD) regarding hydrogen sulfide odors associated with organic material which becomes entrained in the **entrance** sediment. The majority of this problem is resolved by pumping material offshore through the underwater pipe, where hydrogen sulfide is dissolved into its harmless components

As previously indicated, hydrogen sulfide (H_2S) is colorless, heavier than air, and at low concentrations smells like rotten eggs. Residents in the harbor area have complained that the odor is a nuisance.

Hydrogen sulfide is produced in nature primarily through the decomposition of dead plant and animal matter by anaerobic sulfur bacteria. Because it is heavier than air, hydrogen sulfide can accumulate in low-lying areas and in enclosed spaces. In **entrance** channel sediments, hydrogen sulfide is produced by decaying seaweed and is released into the air when the sandy **entrance** channel material is placed into the surf line for beach replenishment. Some **entrance** channel sediments contain a low concentration of seaweeds and thus produce little or no hydrogen sulfide odor when placed into the surf line. Other **entrance** channel sediments may contain a high concentration of seaweeds, resulting in higher amounts of hydrogen sulfide being released into the air when these sediments are deposited into the surf line.

As previously indicated, the Monterey Bay Unified Air Pollution Control District (MBUAPCD) responds to odor complaints as part of its administration of "nuisance" control. In October 2003, the MBUAPCD issued the final hydrogen sulfide protocol for the Port District, which was appended to the Harbor's dredge operating permits. The protocol included installation of a hydrogen sulfide monitor to operate when the wind direction was onshore, and a wind instrument to provide an indication of wind direction.

During the 2003-04 dredging season, the Port District used the offshore pipeline to dispose approximately 90% of the **entrance** channel sediments, and the surf-line beach pipeline was used only approximately 10% of the time. This resulted in reduced hydrogen sulfide emissions and very few, if any, complaints from neighbors or surfers about odors during the 2003-04 dredging season (California Coastal Commission, November 2006). However, during the 2004-05 dredging season, there were unusual currents and wave conditions allowed the Port District to use the offshore pipeline only 58% of the time. During this season, pockets of hydrogen sulfide-producing materials were repeatedly encountered that resulted in odorous emissions. Numerous complaints regarding hydrogen sulfide were received by the Port District, Commission staff, and the Air District during the 2004-05 dredging season (Ibid.).

In November 2005, the MBUAPCD amended the protocol that requires implementation of the following measures when onshore winds exist and disposal of **entrance** channel sediments is taking place in the surf line:

- Reduction of the air sampling interval from two minutes to one minute;
- Cessation of dredging when the air monitor records 15 ppb of hydrogen sulfide for four successive readings, or any single reading of 60 ppb or more;
- No restart after cessation until the following day;

- Adding a new "not to exceed" limit of 30 ppb for a one-hour average (State Air Board's existing standard for hydrogen sulfide). Violation of this limit would be enforced through the imposition of civil penalties.

Continued problems with burying of the "offshore anchored pipe" caused the harbor to shut down beach disposal operations on 34 days during the 2005-06 dredge season to prevent exceeding allowable hydrogen sulfide levels set by the Air District. This is a serious conflict. The inability of the harbor to dredge consistently caused a closure of the harbor **entrance** in January 2006. Fishing boats were grounding out on the shoals; the U.S. Coast Guard 47 foot rescue craft damaged its propulsion gear on entry into the harbor and had to remain for several days while repairs were made. It could only escape the harbor at high tide condition. In the interim, it was not able to respond to several emergency calls, and the only available rescue vessel that could render assistance were the State Parks' lifeguards on personal watercraft.

At one point, in January 2006, in an effort to dredge out the **entrance**, the harbor exceeded state hydrogen sulfide nuisance emission standards. This precipitated a complete re-evaluation of the offshore pipe and the eventual establishment of the three-point, non-anchored pipeline array described in this section. The institution of the multiple pipeline configuration has resulted in less than 15 protocol shut-down days in two seasons (2006-2008), as opposed to 34 shut-down days in the 2005-06 single season.

The principal tool for suppressing H_2S from **entrance** channel sediments has been the use of the offshore disposal pipe. Pursuant to recent Coastal Commission approvals, the pipeline has been reconfigured to provide for three possible configurations with multiple discharge points, although only one pipeline configuration and discharge point would be in use at any one time. The pipelines are not anchored to the seafloor, but are installed on a daily basis and the discharge point is monitored and adjusted throughout each day of operation with the tractor to ensure adequate water depth. This provides the Port District with the flexibility to respond quickly to changing oceanographic conditions or other factors and to reduce the amount of beach discharge to a minimal amount. The procedure facilitates compliance with the Air Board's H_2S protocol. The new offshore discharge configuration increases offshore capacity and thereby can reduce, or eliminate altogether, emergency beach discharge, which will reduce or eliminate hydrogen sulfide effects from **entrance** channel sediments. Air District staff expects that the new non-anchored pipeline configuration will reduce H_2S emissions sufficiently, with the end result being a marked improvement in air quality at the beach (California Coastal Commission, November 2006).

The California Department of Health Services (CDHS), through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry, responded to a request from the Santa Cruz County Health Services Agency to assist the Monterey Bay Unified Air Pollution Control District with evaluation of the risk to hydrogen sulfide exposure from the Port District's dredging and disposal from the fall of 2003 to spring 2006. In summary the CDHS found the Port District's protocols and non-emergency action levels to be adequate in protecting residents and beach visitors while beach disposal is occurring. CDHS also found that during 97.7% of the time dredging occurred on the beach within the three-year period, the levels of H_2S were below the screening level of 30ppb. Levels within this range would not be expected to cause health concerns. H_2S levels were above screening levels for periods greater than one hour on several occasions in late 2005 and early 2006. However, CDHS found that given the limited time that these high emissions occurred and a dilution that would occur from the monitoring station to the nearest beach visitor or resident, it is not possible to connect health effects to the observed H_2S emissions. In conclusion, the CDHS found no apparent public health hazard related to hydrogen sulfide emissions from harbor dredging activities (California Department of Health Services, June 2007).

Based on its review, the CDHS made the following recommendations, which are being implemented by the Port District:

- Port District compliance with the H_2S protocol and establishing a clear understanding with dredging contractors that dredging should stop for the day when the action levels are exceeded;
- Continued H_2S sampling;
- With the assistance of other regulatory agencies, ensure that dredging is performed offshore and under water as much as possible to dissipate the H_2S;
- Post additional signs on the beaches, warning of possible health implications during dredging;
- Creation of a better delineation around the discharge area;
- Requiring dredging crew to indicate on their field notes when the operations on the beach are being conducted under emergency conditions or emergency variance.

5-7 PUBLIC ACCESS / RECREATION

The Port District's harbor **entrance** program is a navigation and a beach nourishment project. Coastal Act Section 30233(b) requires that dredge material suitable for beach replenishment be transported for such purposes to appropriate beaches. The California Coastal Commission's 2006 CDP amendment approval permitted the increase in the volume of **inner-harbor** sediment eligible for nearshore disposal from 10,000 cubic yards per year to an unlimited amount annually for sediment that consists of at least 80% sand and meets aquatic disposal standards. Disposal of sandy, clean sediment into the nearshore environment will allow the sandy sediment to become available to nearby beaches within the Santa Cruz Littoral Cell, consistent with Coastal Act policies (California Coastal Commission, November 2006). Sandy sediment disposed of at depths of four to six feet will continue to be available for beach replenishment.

According to the Port District's dredging "Operation Manual," there is a physical impact of 8,000 to 10,000 gallons/minute of sand / water slurry at the point of discharge of dredged materials. During these periods, signage, cone markers and a beach monitor advise users that such activity is taking place.

Harbor dredging does not affect public access to the coast. In some limited situations, access around the **north** harbor is restricted during periods of temporary dredging when a staging area is created for the dredge equipment and sediment dewatering. This has not result in elimination of access, but at times, detours around existing sidewalks have been installed.

On the positive side, harbor dredging operations of over 200,000 cubic yards of sand replenishes the winter beach at Twin Lakes State Beach so that it is available to the public on a year-round basis. The wide winter beach also provides a thick barrier of sand to protect roads and coastal structures. This is the coastal protection favored by the California Coastal Commission.

5-8 UPLAND DISPOSAL

In the fall of 2007, and winter of 2008, the Port District dredged and trucked away 27,000 cubic yards of mixed grain harbor sediment (average 40% sand – 60% silt and clay). This was clean material per USACOE / EPA Inland Testing Manual guidance (physical, chemical, biological), and was deemed "suitable for aquatic disposal" except for grain size. Because the grain size was less than 80% nearshore disposal was not allowed. In one dredging episode, material was delivered hydraulically to a dewatering plant and then trucked to a municipal landfill (City of Marina), 40 miles south by truck hauler. Effects from dewatering and hauling dredged sediments offsite include:

- Air Quality: Dust generation associated with loading and transport, although this can be mitigated with use of covered trucks or wetted soils.

- Traffic: Temporary increase in vehicle trips. The recent upper harbor project resulted in approximately 1,400 daily round trips to the City of Marina landfill.

- Water Use: approximately 100 gallons per minute are required for mixing with the flocculent process that requires polymer additives.

- Disruption of Access: The walkways and landscape around the temporarily erected dredge site were disrupted over several months.

- Emissions and fuel use associated with 1,400 truck trips.

In view of these effects, the Port District would suggest that nearshore disposal be liberalized, relative to the current limitations on disposal of fine-grained sediment (See "Alternatives" section).

6. ALTERNATIVES

IN THIS SECTION:

- ***Structural Alternatives Considered***
- ***No Action***
- ***Dredge Disposal Location Alternatives***
- ***Sediment Reduction and/or Reuse Options***

6-1 STRUCTURAL ALTERNATIVES CONSIDERED

The Sanctuary has asked for a review of possible structural changes in the federal channel system that could be implemented that would reduce the amount of dredging required for Santa Cruz Harbor. Santa Cruz Harbor has been the subject of several formal Corps of Engineers' studies (1958, 1978, 1992). The June 1978 Corps "Santa Cruz Harbor Shoaling Study for U.S. Army Corps of Engineers," completed by Moffat and Nichol, Engineers, compared 16 different options for dealing with the recognized shoaling problems of the harbor. Of the 16 options that were presented, six were structural changes to the jetty system, four were bypass systems (upcoast of the harbor), and six were maintenance dredging systems. The conclusion of the report was that no physical changes to the jetty system were deemed to be cost effective. Additionally, it was determined that no physical change in the jetty systems, be it extension of the breakwater, or a detached breakwater, or some variation thereof, would prevent the need for a sand bypassing system.

Ultimately, the solution came down to which type of a bypass system would best accommodate the shoaling situation at Santa Cruz Harbor. A major factor in the analysis was that the harbor was subject to much sea borne debris in the winter process of shoaling. Sea grass and kelp, and a variety of organic material such as brush, trees, stumps, branches, and bushes come down the San Lorenzo River in winter storms (see river location on Figure 1). All of this material can, and does, find its way to the harbor **entrance**, where any material which has a specific gravity greater than saltwater settles in the relatively deep harbor **entrance**. This material has been problematic for fixed bypass systems installation in other places. The developed solution was a floating hydraulic dredge which had unlimited flexibility in moving to the sand. The final design included a chopper device at the nozzle to break up the solid debris that can clog other hydraulic systems (Santa Cruz Port District, April 2003).[7]

[7] An experimental fixed installation sand bypass system was actually built at Santa Cruz Harbor in 1977, by the USACOE Waterways Experiment Station. It was a "crater-sink" type bypass experiment and it showed some promise. But, it was dismantled after two seasons because it was too small for the volume of sand present at Santa Cruz Harbor. Constant clogging of the system by organic debris was a major problem. A follow-up experimental bypass system by the Waterways Experiment Station in Oceanside Harbor, California also proved to be unable to effectively overcome organic material. It was also unable to adjust to shifting shoal conditions. The high cost of system maintenance was also a factor in not continuing with this project.

The conclusion from the 1978 report was that a hydraulic dredge was the most affordable and the most reliable alternative, and had the highest chance of predictable success. The harbor, although it does close from time to time due to the most severe storms, has had a navigable channel over 95% of the last 20 years. The Port District does not believe that there is another system which could have provided a better track record (Santa Cruz Port District, April 2003).

A 1992 Corps of Engineers' reconnaissance study further evaluated seven primary alternatives:

1. No action
2. East jetty sealing
3. Pipe line extension (onshore)
4. **Entrance** channel sand trap
5. Offshore sand trap
6. Fixed jet pump
7. Mobile jet pump

The 1992 U.S. Army Corps reconnaissance study provided an exhaustive analysis of alternatives from physical structures and the operating dredging systems. The study concluded that there were no satisfactory structural or operational modifications which would reduce shoaling or be operationally more effective than the current floating dredge now employed. It was concluded that the alternatives (#2-#7) were not deemed financially feasible by the federal government, so the Corps selected the "no action" alternative.

Some alternatives did show promise in that they could improve the operability of the harbor by capturing sand prior to it shoaling the harbor **entrance**; however, no such modification was deemed affordable. Alternative #5 did eliminate 100,000 cubic yards of pumping to the beach area, but substituted a Hopper dredge which would dump sand somewhere downcoast (30th Avenue). No system reduced the ultimate amount of sand that had to be bypassed on an annual basis. In regard to improvements in dredging technology, there was no clear prescription (Santa Cruz Port District, April 2003). The conclusion was that there was no foundation on which to base a federal interest in funding any change to the Harbor structure or dredging equipment. Although some of these reconfigurations could have benefited the operability of the harbor, the Corps of Engineers could not justify participation in such options (Santa Cruz Port District, April 2003).

The 1992 review offered three relatively small improvements that could be made to the dredging protocol :

1. Dune planting on the west jetty to reduce Aeolian sand transport into the harbor. This has occurred naturally over the last 17 years, and a substantial segment of the dunes from Station 10+00, to 16+00 have groundcover stabilization.

2. Extending the discharge pipeline to the east. The harbor uses a series of discharge sites to accomplish best management of hydrogen sulfide emissions, as well as most beneficial beach replenishment (see Figure 10 in Chapter 7). However, placement farther east of 12th

Avenue is deemed impractical and even counter to control of hydrogen sulfide which has become a higher priority over the past years since the 1992 report.

3. Creating in channel sand traps is a reduced version of Option #4, entrance channel sand traps. The harbor has not implemented this option, but it remains a potentially beneficial concept, creating storage areas to absorb sand driven in by big storm events.

6-2 NO ACTION

The Port District seeks to amend existing permits to allow disposal of a larger amount of sediment with lower sand content into the nearshore disposal area. This is based on the studies that have been prepared to date that demonstrate that fine-grained materials do not remain in the nearshore environment. Under a "No Action" alternative, the Port District would continue to dredge within the provisions of existing permits. This has not been a problem for **entrance** dredging where permitted volumes are adequate, but high volumes of finer-grain sediments in the **north** harbor have been problematic, especially in the last two years. If the harbor experiences another high volume event in the **inner-harbor**, the existing permits would provide only ineffective, high cost and environmentally weak alternatives.

6-3 DREDGE DISPOSAL LOCATION ALTERNATIVES[8]

UPLAND DISPOSAL

The Port District has conducted a number dredging operations using upland disposal. This entails mechanically dredging the harbor using a clamshell crane. The material is dug, lifted and swung over to a disposal area where it is dewatered. Depending on the time of year, the material may need to be amended with sand to get it to drain fully. It is then scraped up by front-end loader and placed into 10 or 20-yard trucks and hauled to the Marina landfill, via Highway 1. The Marina landfill has been the preferred disposal point because they need daily cover for their refuse and although they have not previously charged a fee that has recently changed to $10/CY of dry material. Other landfills, such as Santa Cruz County and Santa Cruz City, charge $40 to $60 per cubic yard of disposed material. The total cost for disposing inner-harbor material at the Marina site is between $80 to $100 per cubic yard, depending on how much drying time and how much sand amendment is needed.

The disadvantages of upland disposal include:[9]

1. It wastes any sand material contained in the sediment. This can be as high as 79%.
2. Upland disposal results in other adverse effects, such as traffic and emissions and fuel use.

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[8] For purposes of disposal options, all dredged sediment is deemed to be free of any disqualifying toxic material and therefore suitable for aquatic disposal. (Any non-qualifying sediment must be dealt with using alternative disposal criteria.)

[9] A detailed matrix (Table 6) of upland disposal using a dewatering system is included at the end of this section.

3. Clamshell (bucket) dredging causes visible turbidity in the harbor (more than hydraulic dredging).
4. It has runoff issues that must be dealt with since the material is dried landside.

Other upland sites may become available in the future for disposal of dredged fine-grained **inner-harbor** sediments. The Elkhorn Slough Tidal Wetland Project, initiated in 2004, is a collaborative effort to develop and implement strategies to conserve and restore estuarine habitats in the Elkhorn Slough watershed. Fifty percent, or 1,000 acres, of Elkhorn Slough's salt marshes have been lost over the past 150 years due to human actions, which have altered the tidal, freshwater and sediment processes that are essential to support and sustain Elkhorn Slough's estuarine habitats. This has included an annual loss of almost 72,250 cubic yards of sediment from Elkhorn Slough into Monterey Bay. The *Elkhorn Slough Tidal Wetland Strategic Plan* identifies strategies to conserve and restore the slough's estuarine habitats, which include the addition of sediment to rebuild marshes (Elkhorn Slough Tidal Wetland Project, March 2007).

In regions of Elkhorn Slough that have never been diked, approximately 200 acres (81 hectares) of marsh vegetation has been lost. In many cases, the erosion of several inches of sediment has occurred in regions of Elkhorn Slough after the vegetation has died because the plant roots are important for holding sediment in place. The addition of thin layers of sediment may need to be considered in combination with implementation of other to promote plant growth. The addition of sediment to the channel near new openings or structures could also create more gradual elevation changes and minimize scouring (Elkhorn Slough Tidal Wetland Project, March 2007)..

According to the Elkhorn Strategic Plan, the application of thin layers of sediment to restore marsh vegetation has been successful in restoring estuarine marshes in areas such as Jamaica Bay, New York. The Plan indicates that sediment from the Moss Landing or Santa Cruz Harbor dredging or the Pajaro River projects could be used to rebuild marsh areas if the characteristics (size, texture, non-polluted) were appropriate. Meetings need to be held with regulatory agencies to discuss and develop sediment standards for restoration efforts to restore marshes in Elkhorn Slough. Currently, specific guidelines to permit sediment additions to estuarine sites in the Central Coast Region are lacking (Elkhorn Slough Tidal Wetland Project, March 2007).

Thus, upland disposal at Elkhorn Slough may be an option in the future, although much more work needs to be completed to determine the suitability of dredged sediments for placement at Elkhorn Slough. Even if determined suitable at some unknown time in the future, effects associated with dredging, dewatering and transporting the sediment would remain as with disposal at a landfill.

OFFSHORE DISPOSAL AT SF-14 FEDERAL DISPOSAL SITE

As previously indicated, offshore disposal site SF-14 is an EPA/U.S. Army Corps of Engineers' designated disposal site located approximately one mile offshore from Moss Landing Harbor, and approximately 15 miles from the Santa Cruz Harbor. This would require transportation of the dredged material via barge to the offshore disposal area. This has never been attempted by the Santa Cruz Port District, although it remains an option for fine-grained material.

This process would require the use of hydraulic or mechanical dredging into a barge (suitable size for small inner-harbor fairways). The hydraulic option requires some type of dewatering and filtration for excess water. Alternatively, the material would be loaded onto a barge and towed through the harbor and the offshore site via a tugboat. Either of these methods could only be utilized in the summer when ocean conditions would allow a small barge to safely navigate Monterey Bay, (July – September). The April – June timeframe would not be available due to steelhead fish avoidance windows. A comparison of dredging techniques with offshore disposal is shown on Table 7 at the end of this section.

The cost of disposal under this alternative is estimated at $80 to $100/cubic yard, which is comparable upland dredging. Potential adverse effects include danger of spillage during transport, danger of overturning barges, turbidity at disposal site could interfere with recreational activities, in the July – September timeframe. Table 7 at the end of this section presents a matrix analyzing this alternative.

6-4 SEDIMENT REDUCTION AND/OR RESUSE OPTIONS

It is likely that almost all of the sediment in the upper harbor comes from the upstream Arana Gulch watershed (U.S. Army Corps of Engineers, September 2002). The restoration projects in Arana Gulch and the construction of sediment basins will help both in the near and long-term. However, it is unrealistic to think that dredging will not be needed in the **north harbor**. Arana Gulch has steep, naturally eroding terrain and some sedimentation of the harbor will continue to occur in the foreseeable future.

The 2002 *Arana Gulch Watershed Enhancement Plan* identifies 12 restoration projects in Arana Gulch (see Figure 9 at the end of this section and Table 5 in Chapter 4 of this report). Several of the identified projects (Sites 1, 3, 14, 15, 16) were identified as major sediment contributors. One of the high priority projects, the Blue Trail Gullies (#3) project, was completed in Fall 2007. Balance Hydrologics estimates that the repair will reduce sediment accretion by 1,000 cubic yards/year,. Additional high priority projects involve reduction of concentrated runoff and downstream erosion and gullying at the City's disc golf course (Sites 14, 16). These have an engineering plan from Balance Hydrologics and have been funded for construction by the California Coastal Conservancy. Table 8 summarizes the current status of these projects.

The Watershed Enhancement Plan also envisions use of sediment basins. One existing sediment basin at Harbor High School collects from 300 to 400 cubic yards of material each year and is cleared each fall. Material is disposed at an upland site (Santa Cruz Port District, April 2003). The California Department of Fish & Game has previously granted a 5-year permit to the Port District for regular clearance of this sediment basin, and the District is applying for a 5-year extension. The Port District is applying to FEMA for a "Hazard Mitigation Project" to expand this sediment basin's capacity by a factor of 3 to 4 times.

There are three other sites, one on each of the three tributaries of the upper Arana Creek; however, the most beneficial first step would be to expand the existing sediment basin since it catches all these tributaries and has room for expansion. The Port District is filing for a FEMA Hazard Mitigation Project, since it would meet standards for the federally assisted program.

Since 1997, approximately $1 million has been dedicated to Arana Gulch erosion control, including studies, engineering and actual projects, including completion of one road restoration project to prevent further bank destabilization and erosion (Site 11).

Concurrent, but separate from the watershed enhancement plan by AGWA, is a U.S. Army Corps of Engineers Section 905(b) Reconnaissance Study, which was completed in Fall 2002. This study determined that there is continuing interest in this watershed by the United States' government. The findings recommended that the project go on to the feasibility stage which would also identify a restoration plan for the gulch in coordination with local efforts. The Port District will continue to work with all entities to develop a comprehensive plan that is not redundant in terms of studies, but is cooperative in terms of projects. The immediate benefit in having the Corps involved is that they are very interested in project sites 1, 2, 14, 15 and 16 under "Continuing Authorities" (Section 206 of the Corps Regulations). The Port District is optimistic that within the next several years, these projects can be addressed through the Corps as the lead agency. At this writing, the current federal Administration has not funded the feasibility stage so that phase of work is on hold.

FIGURE 9: Proposed Arana Gulch Watershed Enhancement Projects

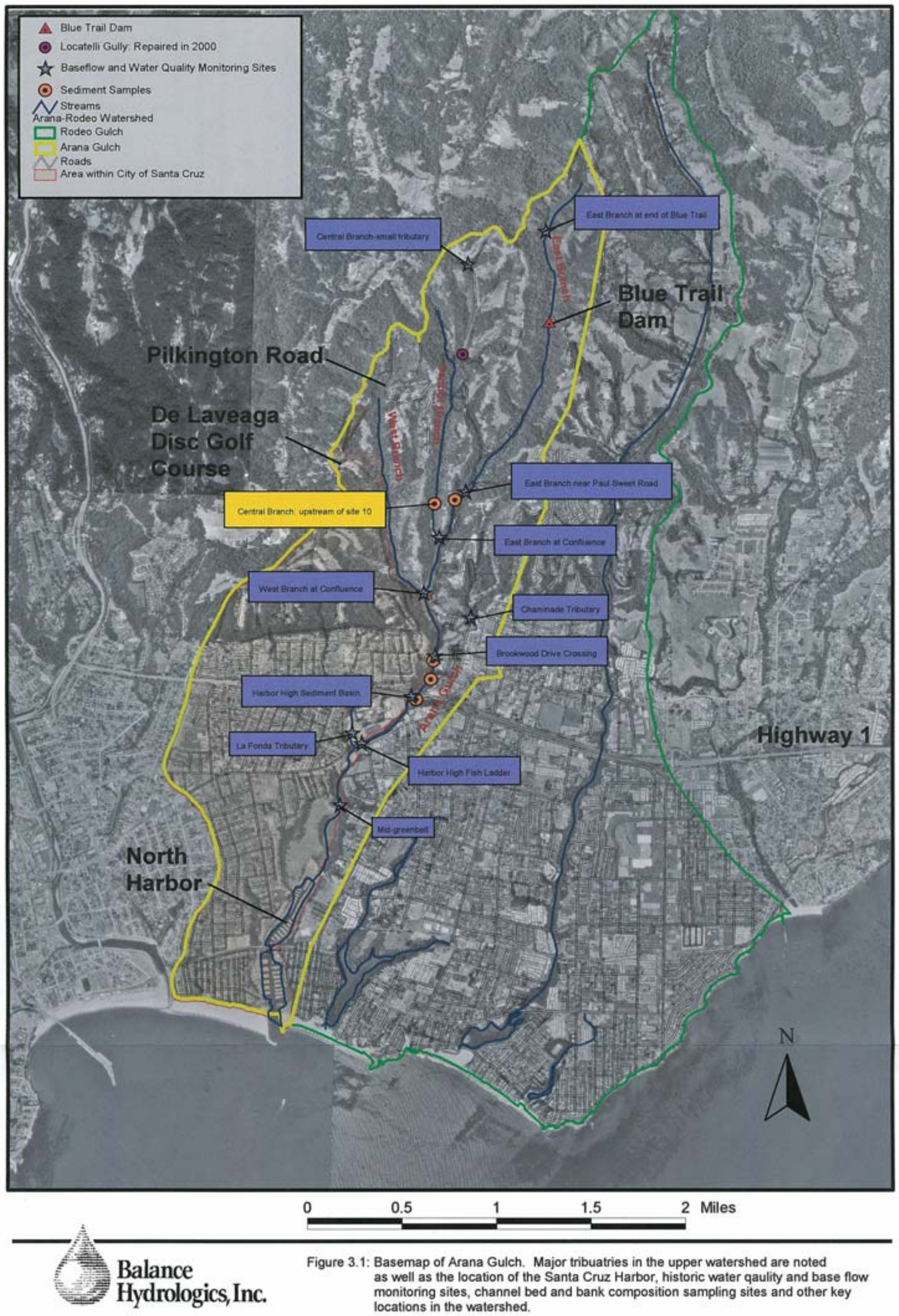

Figure 3.1: Basemap of Arana Gulch. Major tribuatries in the upper watershed are noted as well as the location of the Santa Cruz Harbor, historic water qaulity and base flow monitoring sites, channel bed and bank composition sampling sites and other key locations in the watershed.

Note: All basefiles were provided by the Santa Cruz County GIS Department (EMIS Database)

TABLE 7: Alternative Dredging Options for Santa Cruz Inner-Harbor Mixed-Grain Sediment

Based on 10,000 Cubic Yard Project

	A	B	C	D
	Clamshell crane excavation with barge disposal at SF-14	**Hydraulic dredging of sediment with pipeline transmission to large barge staged in entrance area. Dewatering by contract. Tow barge to SF-14 for disposal**	**Hydraulic dredging of sediment with harbor-operated 8" dredge; nearshore disposal**	**Hydraulic dredging of north harbor material with dewatering phase. Material taken to upland disposal site by truck**
General Description	10,000 CY inner-harbor mixed-grained sediment project utilizing 60'x200'x8' clamshell crane on floating barge. Excavation rate approx. 40 CY/hr, filling 2 small barges which would be rotated and unloaded at the entrance area by another clamshell crane into the long transport barge. The large barge would be filled every 5 days and transported to SF-14 by tug. Total of 5 trips to SF-14.	10,000 CY inner-harbor mixed-grained sediment project utilizing hydraulic dredging;, with pipe-line transmission to large, 60'x200' barge staged in entrance area. Dewatering by contract. Tow barge to SF-14.	10,000 CY inner-harbor mixed-grained sediment project utilizing hydraulic dredging with harbor-operated 8" dredge. Disposal into nearshore (5th Avenue to 12th Avenue).	10,000 CY inner (north) harbor hydraulic dredging with sediment dewatering phase. Material transported to upland site by truck.
Annual Timing of Operation	Limited to July 1 – September 30 due to weather window in harbor entrance. 60'x200'x8' barge is not safe for transit through harbor entrance except in low-energy, summer wave environment.	Limited to July 1 – September 30 due to weather window in harbor entrance. 60'x200' barge is not safe for transit through harbor entrance except in low-energy, summer wave environment.	October 1 to February 28; limited to high wave energy time and steelhead avoidance window in north harbor	July 1 to February 28; limited by steelhead avoidance window in north harbor
Equipment	• Clamshell crane mounted on barge (40'x100') • Small barges (2 ea, 20'x60', 30 CY) for transport of material to entrance channel areas • Small tender / tug (2 ea, 30') for transport of small barges to entrance channel • Barge mounted clamshell crane (40'x100') for transfer of material from small barges to large barge • Large barge (60'x200') to tow material to SF-14 • Tug for towing barge to SF-14 (50')	• Hydraulic dredge, 8" cutter suction, 400 hp • Electric booster pump, 350 to 400 hp • Dewatering barge, 60'x200' with contract dewatering system and conveyor • Receiving barge 60'x200' • 1 large tug • 1 small dredge tender	• floating, 8" cutter suction dredge, "Squirt" • 350 hp electric booster pump located next to bridge • 8" plastic disposal pipeline into nearshore at 5th Avenue to 12th Avenue	• floating, 8" cutter suction dredge, "Squirt," operated by harbor crews • contract, land-based sediment drying / dewatering plant (several types) • 2 each, front end loaders, operated by harbor crews • 2 each, 10 CY transfer dump trucks • contract haulers; 20 CY trucks for disposal to: o municipal landfill; or, o wetland restoration
Production	400 CY/day 10,000 CY material = 25 total days	300 CY/day 10,000 CY material = 33.3 total days Hydraulic dredge limited by speed of	600 CY/day 10,000 CY material = 16.6 total days of dredging	400 CY/day 10,000 CY material = 22.2 days of dredging

TABLE 7: Alternative Dredging Options for Santa Cruz Inner-Harbor Mixed-Grain Sediment

Based on 10,000 Cubic Yard Project

	A	B	C	D
	Clamshell crane excavation with barge disposal at SF-14	**Hydraulic dredging of sediment with pipeline transmission to large barge staged in entrance area. Dewatering by contract. Tow barge to SF-14 for disposal**	**Hydraulic dredging of sediment with harbor-operated 8" dredge; nearshore disposal**	**Hydraulic dredging of north harbor material with dewatering phase. Material taken to upland disposal site by truck**
		dewatering equipment		
Cost (Not including environmental costs)	$1,044,250 Cost per CY for 10,000 CY = $104.47	$1,212,650 Cost per CY for 10,000 CY = $121.30 Note: This cost could be reduced if mechanical drying / settling can be used instead of drying equipment. This would reduce cost by $385,000, or $38.50 per CY. Reduced cost for 10,000 CY = $82.77	$93,652 Cost per CY for 10,000 CY = $9.37	$824,700 Cost per CY for 10,000 CY = $82.47
Beneficial Re-use:				
- **Beach Replenishment (Sand)**	None	None. Possible separation of sand fractions / conveyance method to beach not identified.	Yes	Possible if sand can be separated effectively and taken to a suitable receiving beach (permit and beach use issue)
- **Benthic Habitat Replenishment (Soft Bottom – Monterey Bay Mid-shelf Mudbelt or other)**	No habitat replenishment identified	No habitat replenishment identified	Yes	None
Disposal Plan Meets National or CA State Sediment Management Goals:				
- **2007 EPA / COE Beneficial Use Manual Recommendations (EPA 842-B-07-001)**	No	No	Yes	Yes. Disposal at landfill can be used as daily cover. Disposal at a restoration project can be beneficial
- **WRDA 2007 Section 2037 (Restoration of Aquatic Habitats)**	No	No	Yes	No

TABLE 7: Alternative Dredging Options for Santa Cruz Inner-Harbor Mixed-Grain Sediment
Based on 10,000 Cubic Yard Project

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- **California Ocean Protection Plan – Implementation of the CA Coastal Sediment Management Plan**	No	No	Yes	No
Fuel Use / Air Emissions	1.09 gallon per CY 10,370 gallons	.78 gallon per CY 7,824 gallons	.22 gallon per CY 2,158 gallons	.80 gallon per CY 7,959 gallons
Effects:				
- **At Dredge Site**	Temporary visible turbidity (more than with hydraulic dredging) 25 days	Turbidity at dredge point minor compared with Option A 33.3 days	Turbidity at dredge point minor (same as Option B, but for half the days) 16.6 days	Same as Options "B" and "C" 22.2 days
- **At Disposal Site**	Temporary visible turbidity at SF-14 (2,000 CY dump loads)	Same as Option A	Temporary turbidity in disposal plume; however October to February timeframe has background turbidity from rivers and creeks	
- **Navigational Traffic**	Barge traffic on Monterey Bay	Barge traffic on Monterey Bay	Minor disruption, only at dredge site	
- **Road / Highway Traffic**	None	None	None	500+ truck round trips
- **Other**	• Possible pre-release of material during barge transit to SF-14. • Possible disruption of commercial and recreational fishing during July, August, September at SF-14 area.	• Possible pre-release of material during barge transit to SF-14 • Possible disruption of commercial and recreational fishing during July, August, September at SF-14 area.		

TABLE 7: Alternative Dredging Options for Santa Cruz Inner-Harbor Mixed-Grain Sediment

Based on 10,000 Cubic Yard Project

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Other Comments	• Clamshell crane cannot reach sediment areas under docks. Does not do a complete job of freeing berths. Disruption of harbor entrance traffic during high season.	• Disruption of harbor entrance traffic during high season (2 ea. 200' x60' barges and anchors in 300' wide channel). • Must control polymers in any chemical dewatering operation.	• Least disruption of all harbor areas: dredge site, disposal site, highways and existing structures • Some beach impact on recreation, but at low use time of year and night option in October mitigates all user conflicts	• Dewatering operation is large and heavy • Disruption of harbor road and sidewalk areas • Mud and dust a problem • Must control polymers in any chemical dewatering operation

RANKING ANALYSIS OF OPTIONS				
- **Most effective dredging operation (depths / coverage)**	4	2	1	3
- **Least Time to Complete**	3	4	1	2
- **Least Disruption of Harbor Roads**	1	1	1	4
- **Least Disruption of Waterways**	3	4	1	2
- **Least Emissions, Fuel Use, Overall Environmental Impact (Carbon Footprint)**	4	3	1	2

TABLE 8
High Priority Erosion Problems – Arana Gulch Watershed Restoration Projects

PROJECT NUMBER	PROJECT NAME	ESTIMATED COST	STATUS
1 2	**Blue Trail Dam Structural** **Blue Trail Dam Sediment Trap**	$ 128,000	High priority. State Water Resources Prop 50 funds programmed for project
3	**Blue Trail Gully**	$ 252,000	Completed October 2007
13	**Pilkington Road Drainage**	$ 40,000	Completed 2002
14	**Disc Golf Course Water Diversion and Hole Relocation**	$ 121,000	Engineering plan complete. Prop 50 $121,000 grant for construction; April 2008
15	**Disc Golf Course Gully**	-	Engineering determined that gully is stable
16	**Disc Golf Course Lower Service Road Culvert Replacement**	-	Same project / status as #14 (Engineering plan complete. Prop 50 $121,000 grant for construction; April 2008)
17	**Capitola Road Crossing**		Not programmed as yet
18	**Greenbelt Gully**	$ 40,000	High priority for City of Santa Cruz. Pends Blue Trail litigation
19	**Tidal Reach**	$ 300,000	See project #18 – same priority by City of Santa Cruz

SEDIMENT BASINS

A	**Expand Harbor High School Sediment Basin**	$800,000 to $1,000,000	Project being submitted as a FEMA Hazard Mitigation project
B	**Additional Sediment Basins**	?	Preliminary plans only

7. DREDGE DISPOSAL MANAGEMENT

IN THIS SECTION:
- *Estimated Future Dredging Needs*
- *Proposed Dredge Disposal Changes*
- *Dredge Equipment Modifications*

7-1 ESTIMATED FUTURE DREDGING NEEDS

- **HARBOR ENTRANCE & FEDERAL CHANNEL:** The Port District does not expect substantially increased levels of dredging or change in sediment content for this component of the Harbor. The District expects that future dredging and disposal will be accommodated with existing permit provisions that allow beach or nearshore disposal of up to 350,000 cubic yards/year of sediment per year with a sand content of 80% or greater.
- **INNER HARBOR:** The Port District estimates that on the average, approximately 3,000 to 6,000 cubic yards of material per will continue to flow into the **north** harbor per based on trends in the last ten years, with occasional spikes of much higher amounts. This could be reduced by approximately 50% if all Arana Gulch erosion control and sedimentation projects are implemented. The sand content is expected to be variable as has been in the past.

7-2 PROPOSED DREDGE DISPOSAL CHANGES FOR INNER-HARBOR DREDGING

The Port District has done primary research in the nearshore disposal of sands, silts and clays from the inner-harbor. Results from those peer reviewed research projects indicate that the ocean is capable of distributing all grain sizes to respective, compatible areas, and furthermore, that all grain sizes replenish habitats. This is confirmed by other biological research in Monterey Bay. Accordingly, the Port District proposes the following:

- ❑ Unlimited annual and daily dredging/disposal of sediments with greater than 80% sand content, consistent with recent California Coastal Commission permit amendments.

- ❑ That all **inner-harbor** sediment that is less than 80% sand content, and which is otherwise qualified for "unconfined aquatic disposal" be managed as follows:
  - Permit maximum **yearly** limit of dredging and disposal of sediment that is classified silt or clay (less than .0625 mm = 63 microns) be set at 10,000 CY/yr.

   - Permit maximum daily limit of sediment that is classified silt or clay (less than .0625 mm = 63 microns) be set at 550 CY/day (24-hour period).

- ❑ The Port District's Total Maximum Daily Load disposal recommendation includes the following provisions:
   - Nearshore disposal limited to October to April each year;
   - Any human contact with dredged material on recreational beaches be limited, managed and mitigated;
   - Inner-harbor sediment must pass all chemical and biological tests set forth by COE / EPA "Inland Testing Manual."

Under this protocol, the Port District would manage each geographic section of approved dredging on a daily basis. Each day's episode would be managed so that the total maximum daily load of **silts and clays** would not exceed 550 CY. Thus, if inner-harbor material was 40% **sand**, as tested, then the maximum **total** volume for that day's episode would be 917 CY in order to stay below 550 CY of silts and clays. Numerical examples of daily dredge disposal volumes are shown below.

Maximum Inner-Harbor Dredge Disposal Volumes per Day

Grain size characteristics of section to be dredged (% = less than .0625 mm)	**% Silts/Clays**	**Daily Allowable CY (Silts / Clays)**	**Daily Total Sediment Limit for Sector**
90% sand	10%	550 CY	5,500 CY
50% sand	50%	550 CY	1,100 CY
40% sand	60%	550 CY	917 CY
20% sand	80%	550 CY	687.5 CY

The 550 CY proposed maximum is based on the peer-reviewed findings of the 2001 Demonstration Dredging I project and the 2005 Demonstration Dredging II project, where the following volumes of fine-grained material were monitored and found to not stay in the nearshore:

INNER-HARBOR DREDGING

Demonstration Dredging Project #1, March 2001
Volumes, 3,053 ÷ 3 days = 1,018 CY/day
At 58% volume of silts and clays, was 590 CY/day

Demonstration Dredging Project #2, October 2005
Volumes, 6,596 ÷ 9 days = 733 CY/day
At 69% the volume of silts and clays, was 506 CY/day

Average volume of silts and clays per day for two projects	**548 CY/day**

The Port District contends that the silt and clay volumes monitored within the two demonstration projects represent a daily load that the ocean will distribute in the October to April Pacific ocean energy system. In other words, this represents the proven carrying capacity of the Santa Cruz Harbor nearshore disposal site.

The justification and supporting data for this proposal are as follows:

1. **Demonstration Dredging Projects – Findings.** The winter 2001 and fall 2005 dredging and disposal "Demonstration Projects" have proven that no adverse effects occur when disposing fine-grained sediment into the nearshore. The results of peer-reviewed demonstration dredging projects in 2001 and 2005 show that mixed grained materials, when placed in the nearshore environment at the correct time of year, transit to and replenish soft bottom areas seaward of the nearshore without harm to beaches or benthic habitat and that given the local wave and current energy, silts and clays rapidly move to the Monterey Bay mid-shelf mudbelt. This implies that a larger volume of **inner-harbor** dredge sediment could be disposed offshore than is currently permitted. (See Demonstration Dredging projects cited in this report: #1 Watt/Greene, Moss Landing Marine Lab, 2003; #2 Sea Engineering 2005).

2. **Biological Benefits of Clean Mud in the Ocean.** The conclusions reached by Dr. Ken Bruland and Dr. John Oliver are that where the ocean receives mud, rich in trace minerals (especially Fe) there is a high probability of corresponding biological production.(John Oliver, 2008, Role of Mud in Regional Productivity and Species Diversity) (Ken Bruland, http://es.ucsc.edu/%7Ekbruland/Research/kwbRes.html).

   Monterey Bay is such an area. The Port District contends that **clean, inner-harbor** sediment from the Arana Gulch watershed is part of the recharge system for the Monterey Bay midshelf mudbelt, and has been for 18,000 years since sea level rise. The Arana Gulch watershed is high in free iron (Fe), which is the key bioactive trace metal associated with mudbelt biodiversity (U.S. Geologic Survey, Trace Metal Table for Santa Cruz County).

3. **Beach Replenishment Value of all Sand Fractions.** When clean, mixed grained sediments are rejected for nearshore disposal, **all** sand fractions (10% to 79%) are lost forever to beach replenishment uses. This is a needless waste of a valuable resource. In fact, deep ocean disposal and landfill disposal of clean sediment are contrary to the following state and national goals:

   a) The California Ocean Protection Plan – "Beneficial Reuse Objectives" section;
   b) U.S. Water Resources Development Act of 2007 – "protect, restore… aquatic habitats;
   c) Guidance materials published by USEPA and USACOE, 2007 – EPA 842-B-07-01) on beneficial reuse of sediment;

d) In the case of landfill disposal, harbor sediments should not needlessly fill municipal landfill space – landfills are under RCRA mandate to reduce waste stream and conserve capacity.

The Port District contends that on a case-by-case basis, all sand fractions should be evaluated for beach nourishment. Volumes that are less than 50% sand content should be allowed, if empirical data shows such use is defendable.

4. **The Poor Performance Factor of Other Disposal Alternatives.** See Chapter 6 – "Alternatives" of this report for a discussion effects of other disposal options.

Upland or SF-14 disposal of **clean,** mixed grained sediment:

a) Accomplishes none of the national and California state goals on beneficial reuse, except when used for daily cover in municipal landfills or at a restoration site;

b) Removes sand, silt, clay resources from their respective ocean destination;

c) Has carbon dioxide footprints that are substantially greater than nearshore disposal.

7-3 DREDGE EQUIPMENT MODIFICTIONS

The 1992 U.S. Army Corps of Engineers' study validated that the Port District has the best possible dredging system for the Santa Cruz Harbor, yet the District continues to make improvements:

1. Transitioning to ultra-low sulfur fuel which as reduced air emissions to the lowest possible diesel technology. Implementation of emission scrubber to further reduce NOX;

2. Technical improvement to the chopper system at the intake nozzle to improve declogging function;

3. Implementation of the unanchored nearshore dredge disposal pipe which reduces impact on the beach as well as hydrogen sulfide odor;

4. Various refinements to the pumping technology that has increased production without increasing horsepower (Santa Cruz Port District, April 2003).

The Port District continues to monitor global advancements in dredging, especially bypass systems that are being developed on the north coast of Australia (Gold Coast). That area encounters conditions similar to those at Santa Cruz Harbor. The use of jet pumps as described in the 1992 Corps report have not yet proven their ability to solve organic debris challenges (kelp, brush, etc.). In the next 10 years, the dredge will probably transition to an electrically powered pumping system. Air emission regulations will actually dictate the timing of this transition over the next 10 years(Santa Cruz Port District, April 2003). This may entail the complete replacement of the dredge hull to accommodate such a transition to electric power.

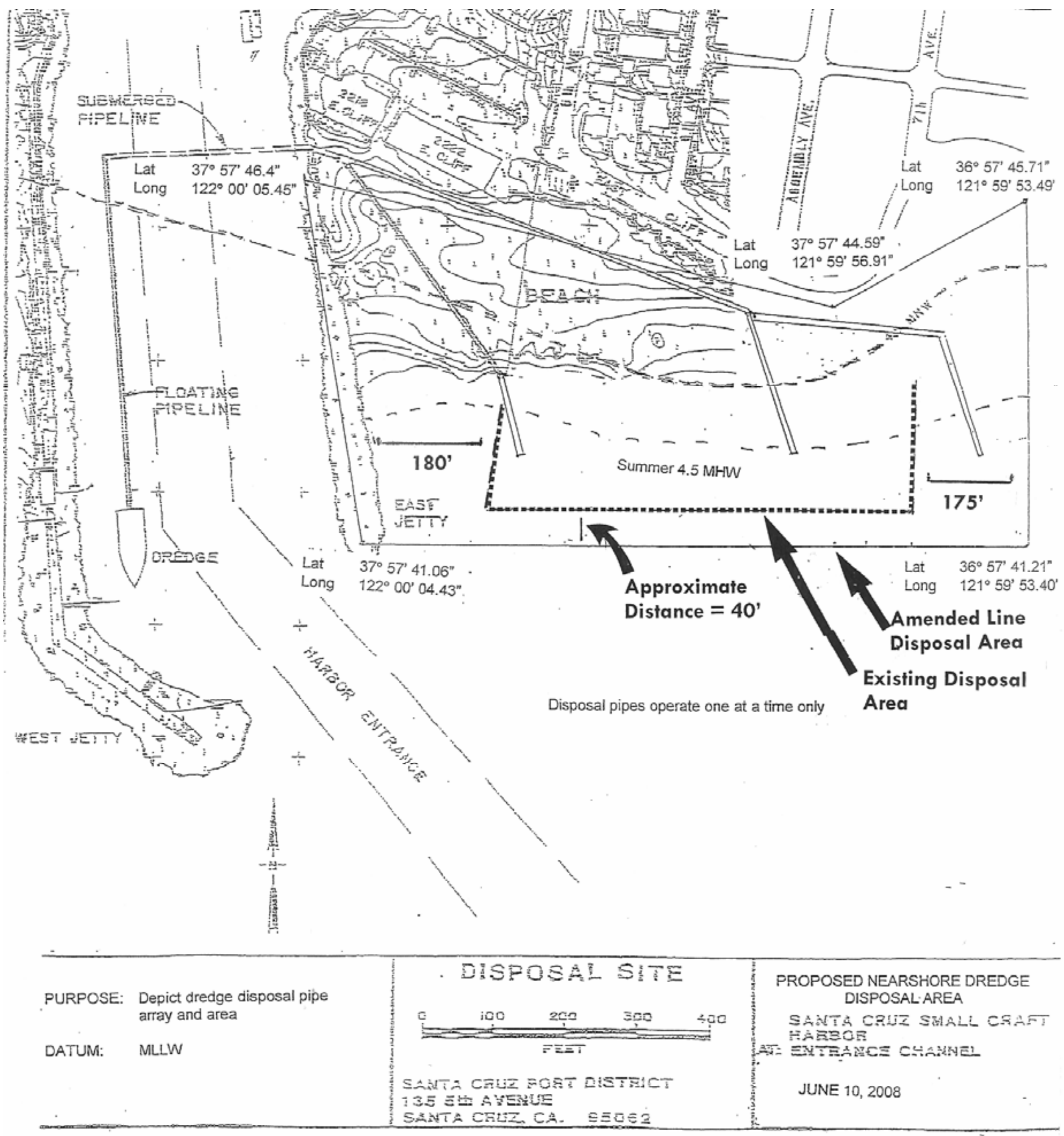
7-4 DREDGE DISPOSAL AREA RECONFIGURATION

The disposal area description has evolved over 43 years of dredging operations (1965 to 2008). The basic area, below the mean high tide line as a rectangle east of the east jetty was depicted in Corps' permits as a generalized, schematic rectangle. The Port District's disposal needs have changed in the past 11 years since hydrogen sulfide emissions became an issue with the Monterey Bay Unified Air Pollution Control District (see Section 2-2 of this report).

Current Monterey Bay Unified Air Pollution Control District emissions standards mandate that the Port District shut-down dredging operations when specific hydrogen sulfide levels are reached. The solution to limiting hydrogen sulfide levels is to push the disposal nozzle as far under water as possible, and allow the water-soluble hydrogen sulfide to be dissolved into its elemental parts (hydrogen and sulfur). The dredge discharge pipe now has multiple nozzles which can be projected into the water from various beach locations from the beach to utilize any favorable wind directions. This has necessitated a modest change in the size of the disposal "rectangle."

The existing and proposed disposal area are shown on Figure 10. The area meets the disposal needs of the harbor, but is still representative of the historic rectangle that has been used since 1965. A read-out in latitude / longitude accompanies the boundary layout prepared by surveyor Cary Edmundson. A cross reference to the State of California coordinate system using 1983 North American datum base is also provided.

FIGURE 10: Proposed Nearshore Disposal Area



8. AGENCY REVIEW & COMMENTS

In August 2008, the Santa Cruz Port District circulated the Draft *Dredge Management Plan* to the following agencies for review and comment. No written comments received, except from Gary Griggs, Director of the Institute of Marine Sciences at the University of California Santa Cruz campus. His letter is included at the end of this section. The reviewing agencies and interested parties included:

- U.S. Army Corps of Engineers
- U.S. E.P.A.
- Monterey Bay National Marine Sanctuary
- California Coastal Commission
- California Regional Water Quality Control Board
- Monterey Bay Unified Air Pollution Control District
- Arana Gulch Watershed Alliance

On December 18, 2008, the following personnel / agencies met at Santa Cruz Harbor to discuss the Draft *Dredge Management Plan* (DMP):

- Debra O'Leary, U.S. Army Corps of Engineers
- Brian Ross, U.S. E.P.A.
- Melissa Scianni, U.S.E.P.A.
- Susan Craig, California Coastal Commission
- Peter von Langen, California Regional Water Quality Control Board
- Deirdre Hall, Monterey Bay National Marine Sanctuary
- Bobbie Haver, Arana Gulch Watershed Alliance
- Toni Danzig, Arana Gulch Watershed Alliance
- Steve Krcik, Red Hills Environmental
- Eric Sandoval, Sandoval and Associates
- Stephanie Strelow, Strelow Consulting
- Dennis Smith,Commissioner, Santa Cruz Port District
- Jeff Martin, Commissioner, Santa Cruz Port District
- Brian Foss, Santa Cruz Port District
- Marian Olin, Santa Cruz Port District
- Rick Smith, Santa Cruz Port District

The general resolutions from that meeting were as follows:

- The Port District would continue to receive comments on the DMP, and incorporate them into the final DMP.

- The DMP would be published as a final document. This would not, in itself, change or affect any permit.

- The Port District would, in 2009, apply for liberalized permits from all agencies in the treatment of **inner-harbor** sediment. The permits would ask for increased yearly volumes of silts and clays, i.e., 10,000 cubic yards of material that is <63 microns, with a daily limit of 550 cubic yards of such material, which is the volume averaged in the two dredge demonstration projects in 2001 and 2005.

- A discussion took place concerning the advisability of modifying existing permits versus issuance of new permits in regard to **inner-harbor** volumes. The ACOE permit runs until December 2011. This remains an open question.

- A request for disposal of fine-grained material and extension of disposal area needs to be submitted to the MBNMS. Their new Management Plan goes into effect early February and existing dredging is what is indicated in the ACOE permit.

- In regard to federal permits (U.S. Army Corps of Engineers "ACOE" and Monterey Bay National Marine Sanctuary "MBNMS"), an Environmental Assessment "EA" would have to be produced in conjunction with the permit applications. It was left open as to who would write the EA. The ACOE has done them in the past for Section 404 permits.

- Subsequent to the meeting, the Port District received a memo from EPA Region IX, stating that based on dredge demonstration projects, the agency would not object to permits requesting nearshore disposal of 550 cy/day of sediment that contains 37% sand. (See email below.)

1/27/09 E-mail from Melissa Scianni, U.S.E.P.A. to Santa Cruz Port District, Army Corps of Engineers, MBNMS, RWQCB, Coastal Commission, and MBUAPCD.

Brian:

I would like to reiterate EPA's position on the DMP, specifically Section 7-2: Proposed Dredge Disposal Changes for Inner-Harbor Dredging. As we stated at the 12/19/2008 meeting, the Santa Cruz Harbor Nearshore Disposal Area falls only under the jurisdiction of the CWA and is not regulated under MPRSA. When under only the CWA you are not necessarily limited to greater than 50% sand for nearshore placement. Rather you have to show no significant avoidable adverse impact to aquatic resources, and your alternative has to be the LEDPA. EPA believes that your existing demonstration projects have shown no significant adverse effect down to the grain size you actually discharged (58% fines in 2001, and 69% fines in 2005) at the rate you discharged it (590 cy/day of fines in 2001, and 506 cy/day of fines in 2005).

In the DMP, Santa Cruz Harbor proposes to use a maximum daily disposal rate of 550 cy/day (i.e. the average of 590 and 506) for silts and clays dredged from the Inner Harbor. However, there is no proposed limit on the grain size of material to be disposed of in the nearshore. Based on the results of the demo projects, EPA would not object to permitting disposal of up to 550 cy/day of material down to 63% fines (i.e. 37% sand; taken from the average of 58% and 69% from the demonstration projects).

If there are any questions about EPA's comments, please contact me using the information below.
Melissa

Melissa Scianni
Wetlands Office (WTR-8)
EPA Region 9
75 Hawthorne St
San Francisco, CA 94105
(415) 972-3821

ADD GRIGGS LETTER

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