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Guidance for Private Property Owners: Steps and Alternatives for Disposal of Material Dredged from River and Harbors of Casco Bay

Normandeau Associates

The Environment Company

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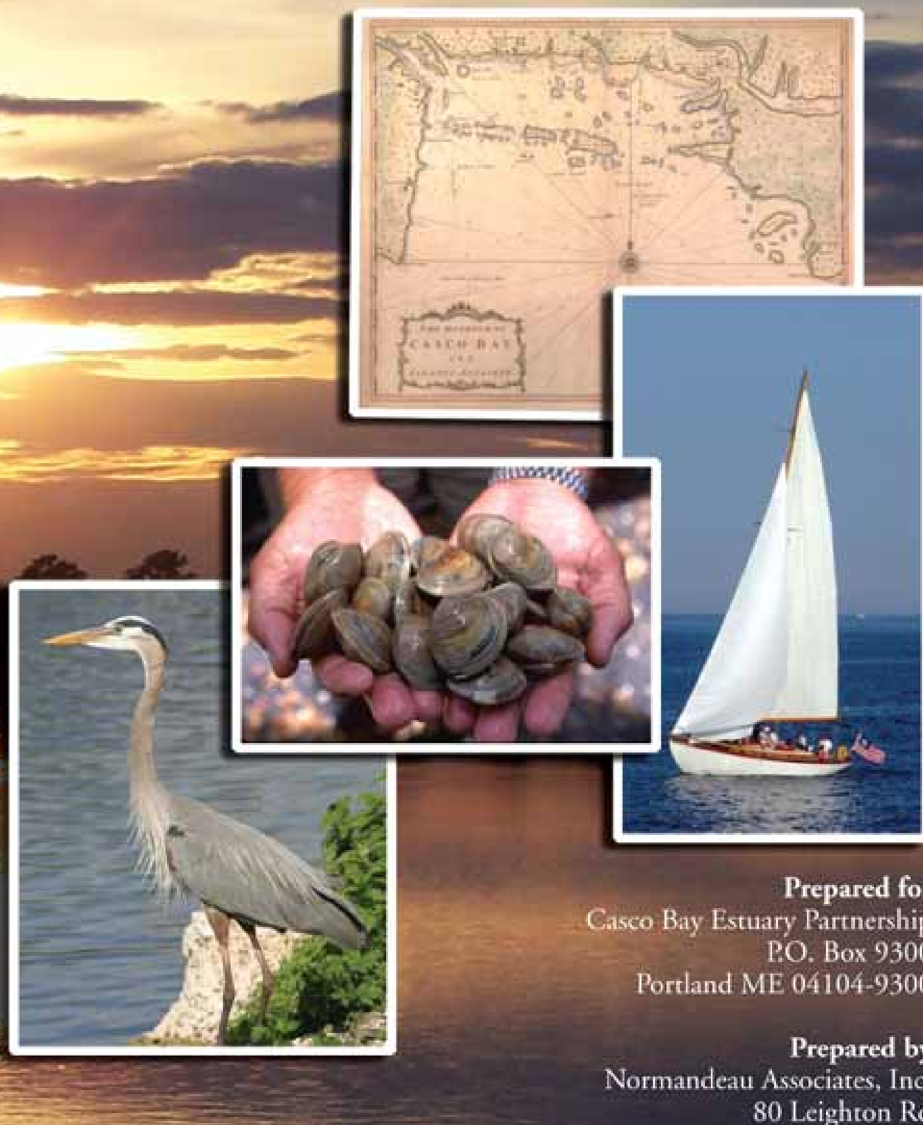

Prepared for
Casco Bay Estuary Partnership
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In Association with
The Environment Company

R-21260
June 2008

TEC inc

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

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Table of Contents

Page

List of Figures

List of Tables

Page

1.0 INTRODUCTION AND METHODS

The overall goal of the project is to help private owners navigate the dredging/disposal process and make informed decisions that are:

- Cost effective (including all steps of the process);
- In compliance with regulations; and
- Geared to specific needs (material volume, sediment type and level of contamination).

As part of this objective, we have attempted to do the following:

1. Describe the regulatory process for disposal alternatives (upland, ocean, and others) in simple but accurate terms.
2. Develop a complete list of disposal alternatives.
3. Develop a comprehensive alternatives analysis for possible disposal alternatives and screening process.
4. Develop a resource compendium in an appendix, including resources (websites, reports, contacts, used to develop information).

Normandeau and TEC used a variety of sources to gather the background information that forms the basis of this evaluation. We contacted federal and state agencies, municipal officials, contractors involved in the various aspects of dredging, private owners, and other stakeholders in the dredging process. Cost estimates were developed by contacting individual contractors for the different elements of dredging and disposal.

2.0 RELEVANT REGULATIONS

2.1 FEDERAL REGULATIONS

Dredging and disposal activities are governed by federal and state regulations (Table 2-1); local ordinances or regulations may also be relevant. The dredging process can be divided into two separate, permitable processes: dredging, and disposal or discharge of dredged materials. The US Army Corps of Engineers regulates the discharge of dredged materials; the regulatory program depends on whether the disposal occurs inside or outside of the shoreward limit of the territorial sea (defined as three miles from shore). Section 404 of the Clean Water Act contains the regulations governing inshore disposal or "waters of the United States", which includes freshwater wetlands, mud flats, salt marshes, and the sea floor. Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) governs ocean disposal, with oversight by the US Environmental Protection Agency. The Corps has no jurisdiction over upland disposal as long as there are no wetlands or linkage to waterway involved. Dredged materials are exempt from the Resource Conservation and Recovery Act (RCRA), which applies to the storage, transport and disposal of hazardous waste materials (Tom Fredette, New England District Corps, personal communication).

The Corps permit application process is an entry point for all federal agencies to review and comment on a project. The federal agencies consider how the project will affect resources under their jurisdiction. Three agencies in particular would be likely to comment on a dredging project in

Table 2-1. List of relevant federal and state regulations, agencies responsible, governing actions, and website references

Law	Agency with Jurisdiction	Governing Actions	Separate Permit or License Required?	Website reference
Federal				
Clean Water Act, Section 404	Corps	Dredged material disposal in "waters of the US", includes wetlands and inshore disposal	Yes	http://www.usace.army.mil/cw/cecwo/reg/sec404.htm; http://www.usace.army.mil/cw/cecwo/reg/40cfr230.pdf
Section 103 Marine Protection, Research and Sanctuaries Act	Corps, US EPA	Dredged material disposal in offshore disposal sites	Yes	http://www.usace.army.mil/cw/cecwo/reg/mprsa103.htm
Endangered Species Act	US Fish & Wildlife; Nat'l Marine Fisheries Service	Protection of federally-listed threatened and endangered species	Could require Section 7 Consultation	http://www.fws.gov/endangered/; http://www.nmfs.noaa.gov/pr/laws/esa/
Marine Mammal Protection Act	Nat'l Marine Fisheries Service	Protection of marine mammals	No	http://www.nmfs.noaa.gov/pr/laws/mmpa/
The Magnuson Fishery Conservation and Management Act	Nat'l Marine Fisheries Service	Protection of habitat designated as important for commercial fish/shellfish	No	http://www.nmfs.noaa.gov/habitat/habitatpro; tection/efh/;http://www.usace.army.mil/cw/cecwo/reg/EFHregs_rev.pdf
Resource Conservation and Recovery Act	US EPA	Governs storage, transport and disposal of hazardous waste materials. DOES NOT APPLY TO DREDGED MATERIALS	Not applicable	
State				
Natural Resources Protection Act	DEP, Bureau of Land and Water Quality	Dredging and dredged material disposal in state waters	Yes	http://www.maine.gov/dep/blwq/docstand/nrpapage.htm
Solid Waste Management Rules: Beneficial Use of Dredged Material	DEP, Bureau of Remediation and Solid Waste Management	Upland Disposal dredged material	Yes	http://www.maine.gov/dep/rwm/solidwaste/forms/beneficialuse.
Submerged Lands Lease	Dept. of Conservation	Governs dredging and disposal below mean low water	Yes	http://maine.gov/doc/parks/programs/sublands/index.html
401 Water Quality Certification	DEP, Bureau of Land and Water Quality	Dredged material disposal must comply with water quality standards	No, part of NRPA	http://www.state.me.us/dep/blwq/docstand/wqc/wqc.htm
Hazardous Waste, Septage and Solid Waste Management Act	DEP, Bureau of Remediation and Solid Waste Management	Management and transport of hazardous wastes	Unclear	http://maine.gov/dep/rwm/hazardouswaste/index.htm#in; http://janus.state.me.us/legis/statutes/38/title38ch13sec0.html

Portland Harbor. Two agencies, US Fish and Wildlife Service and National Marine Fisheries Service, will review the project for potential impacts to federally-listed endangered species. National Marine Fisheries Service will determine if there are adverse impacts to Essential Fish Habitat, which is a classification system for important habitats for commercially-important finfish. The US EPA will review any proposed ocean disposal activities. The Corps has to take into account all factors relevant to the project, including human factors such as economics, energy needs, safety and navigation as well as environmental factors such as fish and wildlife and water quality. The Corps may hold a public hearing for controversial projects.

The Corps' application process involves several key questions:

1. A statement describing the need for the project and whether the project has been dredged before (Maintenance).
2. An evaluation of the potential dredging and disposal alternatives, with a compelling argument that the least environmentally damaging practicable alternative has been selected; in the case of ocean disposal, the application should demonstrate that there are no other "practicable" alternatives. In other words, sites can be ruled out if they are too costly, logistically difficult to use, or can't be used from an engineering perspective.
3. Adverse impacts have been avoided and minimized.

Ocean disposal requires a specific testing regime that is described in Section 3.0. For further information, contact Mr. Jay Clement at the Corps' Maine project office (623-8124)

2.2 STATE REGULATIONS

Four sets of state regulations potentially govern dredging and disposal of marine sediments and require a permit (Table 2-1). The first, the Natural Resources Protection Act (Title 38, Chapter 3, §§ 480-A to 480-Z) governs activities in Maine wetlands and waterways; these include freshwater wetlands as well as coastal wetlands, defined as any areas below mean high water. The NRPA application process applies to dredging as well as any disposal that affects wetlands. This would include ocean disposal in state waters, disposal in intertidal areas, and upland disposal in areas with wetlands and vernal pools. The Corps and DEP processes are generally conducted in tandem. The state NRPA application includes and addresses some of the same issues as the Corps application:

1. A statement describing the need for the project and whether the project has been dredged before (Maintenance).
2. An evaluation of the potential dredging and disposal alternatives, with upland and beneficial use preferred over ocean disposal.
3. For new (i.e. has not been previously dredged) projects, a biological assessment of the dredging and disposal areas.
4. For offshore disposal, publication of the proposed route to the disposal site, for public comment.
5. Assurance that the project will be conducted during the time of year that will minimize impacts to marine fish and shellfish, generally November 1-April 15.

In order to meet NRPA standards of protecting significant fisheries and wildlife habitat, dredging projects in Portland Harbor (and in other areas in Casco Bay that have important lobster habitat) require a lobster survey prior to dredging to determine the need for mitigation.

In the case of ocean disposal, Maine DEP relies upon and reviews sediment testing results prepared for the Corps. For further information, contact Mr. Robert Green, 822-6300.

The second set of regulations govern disposal on land and require a license from Maine DEP, Bureau of Remediation and Solid Waste Management. Some dredged material is clean enough to dispose on land without posing a risk to human health. Chapter 418 "Solid Waste Management Rules: Beneficial use of Solid Waste" outlines the specific protocol that applies to dredged material. The license application documents the following:

1. The dredged material meets the criteria in Chapter 418 (see Table 3-1).

2. Disposal is in a non-residential setting with appropriate cover, and follows Maine Best Management Practices for Erosion Control (refer to http://www.state.me.us/dep/blwq/docstand/escbmps/index.htm.
3. Storage or disposal will not pollute surrounding air, or water, or result in illegal discharges of sediments or contaminants, or pose a health hazard.
4. There are no adverse effects to protected resources.

For further information contact Eric Hamlin, DEP, at 822-6300.

Table 3-1. Chemical constituents and non-hazardous levels for beneficial use.

	Column 1	Column 2
Chemical	**Non-hazardous**	**Two-times non-hazardous levels**
Arsenic	< 29 mg/kg	< 58 mg/kg
Cadmium	< 8.0mg/kg	< 16.0mg/kg
Chromium	< 38 mg/kg[1]	< 76 mg/kg
Lead	< 800 mg/kg[1]	< 1600 mg/kg
Mercury	<60 mg/kg[1]	<120 mg/kg
Benz[a]anthracene	<2.0 mg/kg	<4.0 mg/kg
Benzo[b]fluoranthene	<5.0 mg/kg	<10.0 mg/kg
Benzo[k]fluoranthene	<49.0 mg/kg	<98.0 mg/kg
Benzo[a]pyrene	<8.0 mg/kg	<16.0 mg/kg
Chrysene	<160.0 mg/kg	<320.0 mg/kg
Dibenz[a,h]anthracene	<2.0 mg/kg	<4.0 mg/kg
Indeno[1,2,3-c,d]pyrene	<14.0 mg/kg	<28.0 mg/kg
PCB (unless otherwise approved by DEP)	< 0.74 mg/kg	< 1.48 mg/kg
Dioxin TEQ (unless otherwise approved by DEP)	<16 pg/g	<32 pg/g

[1]Levels of chromium and lead that exceed 100 mg/kg and mercury that exceed 4 mg/kg may require additional TCLP testing to assure material is nonhazardous Source: Maine Solid Waste Management Rules: Chapter 418, Beneficial Use of Solid Wastes.

A special situation exists for the chromium, cadmium and mercury. Additional testing to demonstrate non-hazardous qualities may be required for these constituents if levels exceed certain thresholds as shown in Table 3-1.

While dredged material is exempted from the federal RCRA or hazardous waste regulations, it is unclear whether state Hazardous Waste Management rules govern dredged material. A material is characterized as hazardous waste based on concentrations of specific chemicals, including several metals, PCBs, herbicides and pesticides.

A third area of state regulation is the submerged lands program. Most land below the mean low water mark is owned by the State and is part of the public trust. Any change in use, including dredging, may require a submerged land lease or easement for the project from the Department of Conservation (Title 12 M.R.S.A. Section 1801 and 1862-1867). In order to secure a lease, the applicant must demonstrate that there are no adverse impacts to public trust rights - fishing, waterfowl hunting, navigation, and recreation; and/or services and facilities for commercial marine activities. A dredging lease for a private owner can range from $100 for less than 1,000 cy of dredged materials to $1,000 for more than 10,000 cy.

For further information, contact the Submerged Lands Program at Bureau of Parks and Lands, 287-3061.

Finally, the fourth set of regulations involve the 401 Water Quality Certification program is administered by the Maine DEP as part of the Natural Resources Protection Act. The program, delegated to the State by EPA, governs activities that may result in any discharge into the navigable waters, including all wetlands, watercourses, and natural and man-made ponds. The proposed activity must demonstrate that the discharge is consistent with the federal Clean Water Act and the Maine Water Quality Standards. Any conditions contained in a water quality certification become conditions of the federal permit or license. In making a decision on a request for 401 Water Quality Certification, DEP must consider the effects of proposed discharges on ground and surface water quality and existing and designated uses of waters of the state. Compliance with water quality certification is reviewed during the NRPA permit process (see above).

3.0 TESTING PROCESS

3.1 OCEAN DISPOSAL

The EPA/ New England District Corps' Regional Implementation Manual (RIM; EPA 2004) describes the tiered testing approach to evaluate dredged material's suitability for ocean disposal, shown in Figure 3-1. The RIM summarizes two other documents that govern offshore disposal (EPA/USACE 1991, known as the "Green Book") and inshore disposal ("Inland Testing Manual", EPA/USACE 1998). The goal of the tiered approach is to require the minimum amount of testing that will ensure there are no adverse environmental impacts from ocean disposal. Each tier provides an increasing level of testing and review, with higher associated costs.

3.1.1 Process for Portland and Cape Arundel ("103 sites")

Tier I. Review of Existing Information and Identification of Contaminants of Concern

Tier I can be thought of as a desktop study. As a first step, the owner should contact Mr. Jay Clement at the Corps' Maine project office (623-8124) to discuss the project. The owner should provide the Corps at that time with existing information including, most importantly, previous sediment testing

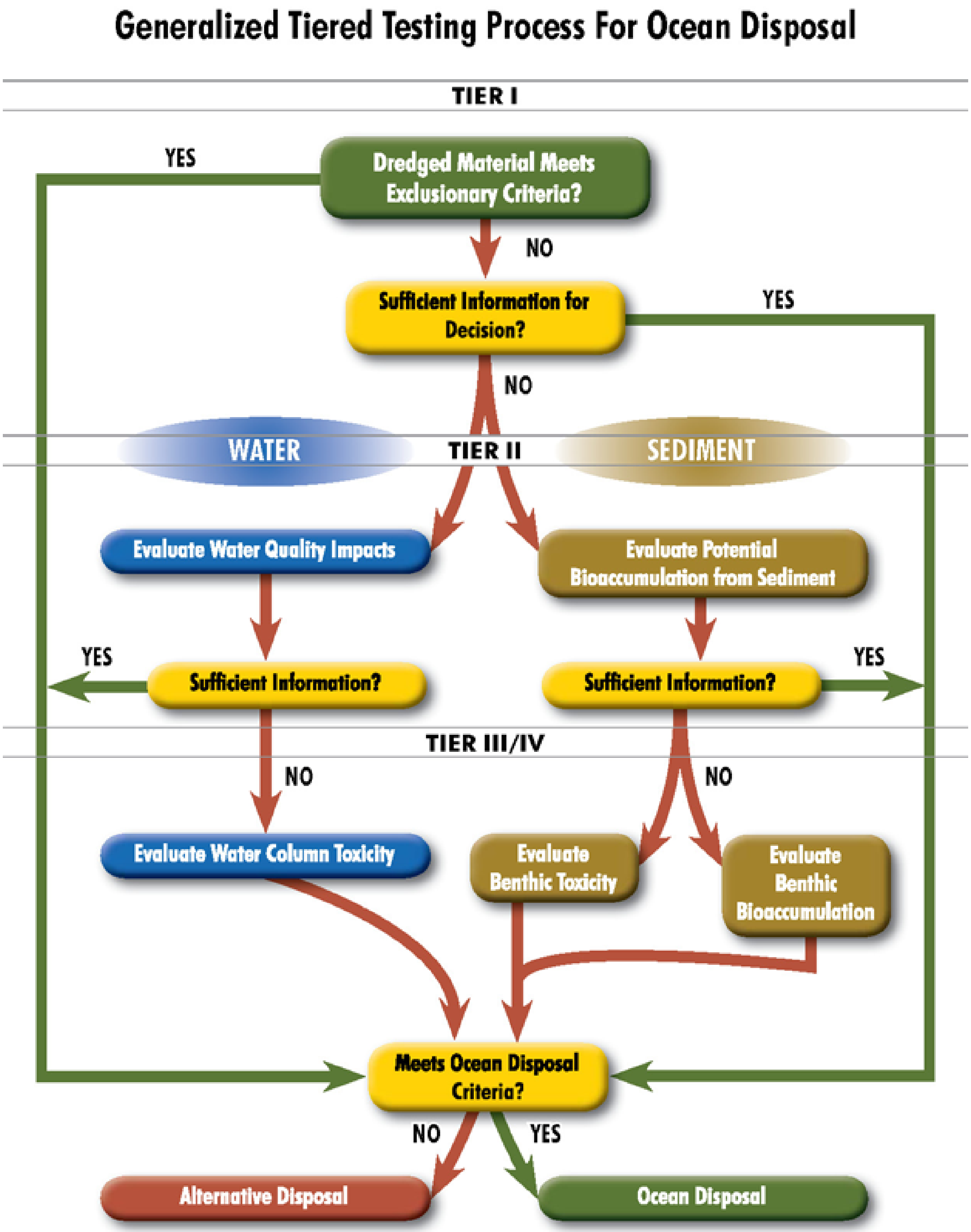

Figure 3-1. Ocean Disposal Testing Process.

results. Additional information on other potential sources of contaminants, such as spills, industrial and municipal discharges, runoff, and results from other dredging projects help the Corps make this initial determination. Landscape factors such as bathymetry, water flow, watershed qualities, and sediment type are also considered. As part of this process, the Corps identifies “contaminants of concern”, those chemicals that could pose an environmental hazard, especially in terms of meeting water quality standards. Typical chemicals include metals, PAHs, PCBs, dioxin and pesticides. This is assessment is always a relative one, based on a comparison to concentrations at the reference site (Portland or Cape Arundel). It should be noted that certain types of sediments (sand, gravel, rock from areas with strong currents or sediments that are distant from sources of contaminants) meet Corps’ “exclusionary criteria” are exempt from further testing and may be disposed at sea. Tier I review has two outcomes:

1. Existing information is sufficient to determine that the material may be disposed at sea or,
2. Additional information is necessary, requiring Tier II testing.

In general, Tier 1 testing can involve inexpensive testing for grain size and bulk chemistry, on the order of $1,000 or less.

Tier II. Water Column and Potential Bioaccumulation Analyses

The Tier II analyses rely on chemical testing to evaluate the potential for disposal impacts on both the water column and bottom-dwelling organisms (benthos). Water and sediments from the project site and the disposal area are collected and analyzed in the test. Tier II and Tier III testing require collection of site-specific water and sediment. This process is costly and protocols must be followed exactly in order for the data to be acceptable to the regulatory agencies. The quality of the information gathered is affected by many factors including: collection of representative samples, proper sample collection and handling techniques, and proper storage methods. A meeting with the Corps regulatory branch is essential to develop a well designed Sampling and Analysis Plan (SAP). The owner may develop the plan and submit it to the Corps or alternatively, the Corps can develop the plan for the owner. In either case, the Corps will need to review the dredge project in terms of the location of the project, the area and depth to be dredged, and proximity to previous projects and known sources of contaminants. This will allow the Corps to determine the location, number and depth of samples that will be representative of the dredged material. The final SAP includes a project description; sampling locations; sample collection and storage procedures; analytical laboratory name and location; analytical laboratory procedures and reporting limits. The Laboratory performing the analyses must provide a Quality Assurance/Quality Control Plan and be able to meet Corps electronic data submittal requirements. The SAP should also be submitted to Maine DEP for review.

Timing is also a critical element of the testing. Chemical and biological analyses have to occur within specific windows after collection (“hold times”). As the evaluation process moves through Tier II and into Tier III, it is important that the owner, the laboratories, and the Corps understand the timeline for review and decision making.

Water column analyses involve a two step process. If contaminants of concern have not been identified in Tier 1, the Corps will do so based on the analytical results. Using a simple model, the Corps uses sediment concentrations to estimate water column concentrations during disposal. The model assumes that 100% of the contaminants are released to the water column. At this point, the

Corps may be able to determine that water quality criteria would be met and, from a water quality perspective, the material is suitable for ocean disposal. Otherwise, a “standard elutriate test” is performed, which mimics the disposal activity by mixing sediment and water. The test measures resulting contaminant concentrations in the water, allowing the Corps to determine whether state water quality criteria would be met.

Sediment contaminant levels are also used to determine benthic impacts. Benthic organisms accumulate contaminants found in the surrounding sediments. Levels are harmful (toxic) to varying degrees, depending on the type of organism and specific chemical. Using sediment chemistry data, mathematical models predict contaminant levels in benthic organisms or “theoretical bioaccumulation potential (TBP)”. The bioaccumulation potential from the dredging site is compared to that at the disposal site. Currently, models exist only for certain chemicals (called nonpolar organics, which includes some PAHs, PCBs, and dioxins).

The outcome of Tier II testing is two fold:

For water quality impacts:

- Water quality standards are met, or would be met even after initial mixing , and further testing is needed (Tier III water column toxicity), or;
- Water quality standards are not met, and the material is not suitable for ocean disposal.

For sediment impacts

- Estimated tissue concentrations from the dredging site are similar to those at disposal site; depending on the specific contaminants of concern, further testing may or may not be needed (Tier III), or:
- Estimated tissue concentrations from the dredging site are higher than those at the disposal site; further testing is needed (Tier III).

Based on the results of sediment and water testing, the Corps, with input from US EPA, will decide whether the information is sufficient to make a decision or further testing is needed. Tier 1I (and associated Tier III) testing costs vary depending on factors such as the type of contaminants of concern the number of tests required, and the disposal site selected. Costs for Tier II can range from $20,000-$50,000 and more, depending on the number of samples.

Tier III. Toxicity and Bioaccumulation Testing

Tier III testing or “biological testing” uses living marine organisms to estimate whether there would be adverse effects from dredged material disposal. Like Tier II, Tier III has both water column and benthic components. Representative marine organisms are exposed to varying concentrations of water from the dredge and disposal sites (or clean sea water, if the disposal site is known to be toxic). The survival rates are statistically compared to determine whether the undiluted dredged material is more toxic than diluted dredged material. The Corps will also use modeling to estimate concentration of the contaminant of concern that requires highest dilution. Concentrations are compared to known levels that are harmful or lethal. The outcome of Tier III water column testing is three fold:

- Based on bioassay results, the dredged material is not toxic to water column organisms, or

- The contaminant concentrations in the water column that result from dredged material disposal are less than those known to be lethal or toxic to marine organisms; however, benthic impacts must be considered, or;
- The contaminant concentrations in the water column that result from dredged material disposal are higher than those known to be lethal or toxic to marine organisms; not suitable for ocean disposal.

Tier III benthic effects are based on two tests: toxicity (whole sediment bioassay) and bioaccumulation, measuring the contaminant levels in tissue. In whole sediment bioassay, two species of marine crustaceans are to exposed dredge and reference area sediments. The mortality rates are statistically compared to determine if the sediment is acutely toxic. In benthic bioaccumulation, two typical benthic organisms (a clam and a worm) are exposed to sediment for 28 days. The tissue concentrations of contaminants of concern are measured and statistically compared to determine if the dredge sediment results in higher bioaccumulation. In addition, tissue concentrations are compared to levels established by the Food and Drug Administration as harmful, when available. Tier III benthic testing can have the following outcomes:

- Tissue concentrations of one or more contaminants exceed FDA standards; dredged material will result in benthic bioaccumulation of contaminants, or;
- Tissue concentrations are less than FDA standards or there are no standards; Statistical comparisons show tissue contaminant concentrations from dredged material are similar to disposal area; no bioaccumulation of contaminants, or;
- Tissue concentrations are less than FDA standards or there are no standards; Statistical comparisons show tissue contaminant concentrations from dredged material exceed those at disposal area; technical evaluation and perhaps Tier IV testing required.

Ocean disposal would be approved only if the dredged material passes both the water column and benthic testing phases. Costs for Tier III can cost an additional $50,000-$100,000+.

Tier IV. Long Term Bioassays and Bioaccumulation Tests, Risk Evaluations and other case-specific testing/evaluations

When a unique resource or resource area is involved in the disposal of dredged material, an evaluation on the long-term effects on sensitive aquatic organisms, and the risks to human health, may be required and, addressed in a risk assessment prepared by the EPA. Specific concerns would be addressed through selective testing of each disposal operation. Methods are described in the "Green Book" (EPA/USCOE 1991) ; all testing is closely coordinated with the EPA and the ACOE.

3.1.1 Process for Rockland ("404 site")

The tiered process for the Rockland disposal site is essentially the same (Figure 3-1). However, the regulations for this inshore or "404" site allow much more flexibility in the evaluation process. Using professional judgement, the Corps may be able to make its determination based on reduced testing procedure (such as bulk chemistry analysis). Furthermore, the Corps may allow capping as tool to isolate contaminants, allowing ocean disposal. Koning (2002) gives an excellent summary of the differences in regulatory process between 404 and 103 disposal sites (Koning 2002, http://www.oceancommission.gov/meetings/jul23_24_02/answers/koning_answers.pdf)

3.2 UPLAND DISPOSAL

Two options for disposal of dredged material on land are:

- Material meeting criteria for beneficial use may be used, with appropriate cover, for fill in commercial, industrial, and urban projects (Figure 3-2).
- Materials that do not meet beneficial use criteria must be disposed of in a licensed landfill.

3.2.1 First steps

A dredging project that is considering upland disposal should begin by contacting Maine Department of Environmental Protection (DEP) Solid Waste Management Division (Mr. Eric Hamlin, 822-6300) for advice on how to proceed.

3.2.2 Qualifying for Beneficial Use

Dredged material is regulated by the DEP as a "special waste," requiring a license for disposal on land. To qualify for a beneficial use license, dredged materials must be:

- tested for grain size.
- tested for contaminants (metals, dioxin, hydrocarbons) as shown in Table 3-1.

Grain size analysis, which measures the size of sediment particles, will determine if the material is coarse enough not to require a DEP special license.

Three exceptions where licenses are not required to dispose of dredged materials are:

1. Dredged materials from Class A waters, which are outside Portland Harbor but include areas of Casco Bay.
2. Coarse grained material such as gravel or sand, defined as having less than 15% fine material (passing through a #200 sieve).
3. Small amounts of material (less than 100 cubic yards) that are placed adjacent to the dredging site and drain into the same body of water.

3.2.3 Testing the Dredged Material

Laboratories listed in the Yellow Pages under "Laboratories-Testing" can provide testing services. The state certifies analytical laboratories, which provides an assurance that the results are reliable. Sample requirements include:

- A minimum of four sediment samples for each surface area acre of dredging should be collected.
- Samples should be collected to the depth that dredging will occur, and each layer mixed well.

3.2.4 Using the Tested Material

Material that meets the criteria in Table 3-1 - Column 1 is defined as "non-hazardous" and can be disposed on non-residential property with a cover of concrete, asphalt, or 6"of compacted soil.

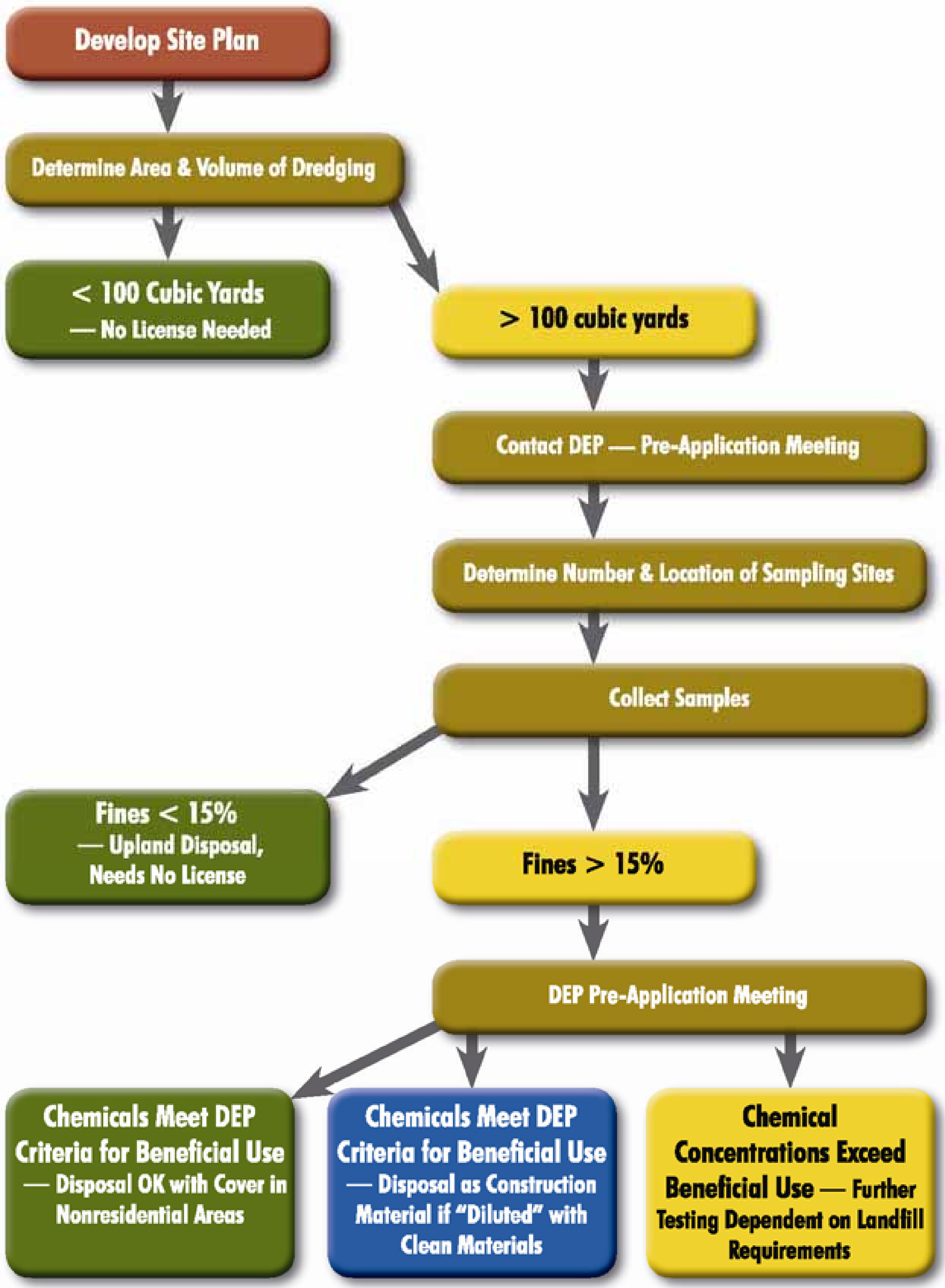

Figure 3-2. Upland disposal process.

DEP regulates this disposal through a process known as "reduced procedure of beneficial use of dewatered dredged material" (Chapter 418 "Solid Waste Management Rules: Beneficial use of Solid Waste"). An application must be submitted to DEP that includes:

1. Description of material, including quantity, testing results and proposed use;
2. A USGS topographic map showing dredging and disposal areas, with GPS coordinates, and;
3. A written plan showing the plan for dewatering, transport, and disposal that demonstrates there are no public health risks from the process.

Dredged material with chemical concentrations less than two times non-hazardous levels (Table 3-1 - Column 2) can be combined with inert material and used as construction fill. Ratio of the two materials should be calculated to ensure the overall contaminant levels meet the nonhazardous criteria in Column1.

Dredged material with chemical concentrations that exceed those in Table 3-1 - Column 2 needs to be taken to a licensed landfill. Each landfill has its own requirements for testing dredged material; contact facilities in advance of sediment sample collection and analysis. Most landfills require some type of TCLP testing (Toxicity Characteristic Leaching Procedure), which tests the level of contaminants that would be leached out of the material. It may make sense to include landfill testing if there is a chance that the material might have to go to a landfill; this avoids the expense of re-collecting the sediment.

A pre-application meeting that includes testing results listed above is mandatory and helps determine disposal options. To avoid the need for additional permits, it is important to confirm that the disposal site has no protected resources, such as wetlands or vernal pools.

If it is determined that Maine's Hazardous Waste regulations apply to dredged material, additional testing will be required, and disposal options may become more limited.

4.0 FEASIBILITY OF DISPOSAL ALTERNATIVES

4.1 OCEAN DISPOSAL SITES

There are three ocean disposal sites within hauling distance to Casco Bay: Portland, Cape Arundel, and Rockland. Two sites, Portland and Cape Arundel, are located outside of the shoreward (3-mile) limit of state waters, and are regulated by Corps of Engineers and USEPA under the Section 103 of the MRSPA and, for Cape Arundel, Maine DEP under Section 401 of the CWA. The Rockland Disposal site is located in State waters and is regulated by the Corps of Engineers under Section 404 of the Clean Water Act and Maine DEP.

The Portland Disposal Site is located 7.1 nautical miles (km) east of Dyer Point, Cape Elizabeth, approximately nine nautical miles from the entrance to Portland Harbor (Figure 4-1). This site is the closest to the Harbor.

The Cape Arundel site is located 2.8 km. southeast of Cape Arundel, approximately 28 nautical miles from Portland Harbor (Figure 4-2). This site is slated for closure in 2010.

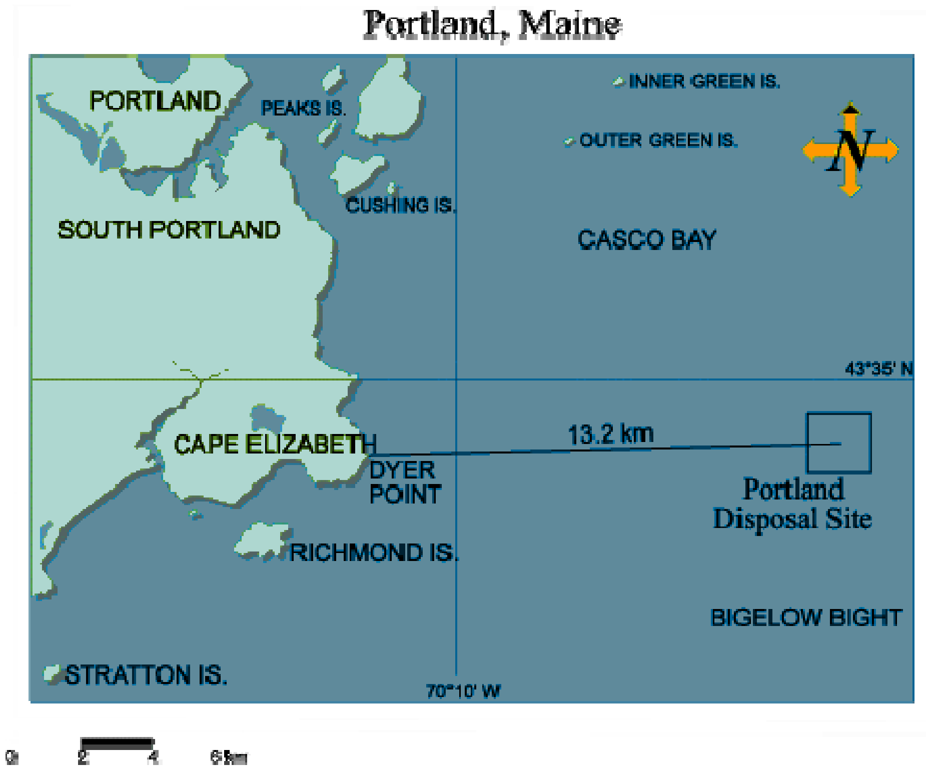

Figure 4-1. Portland Disposal Site

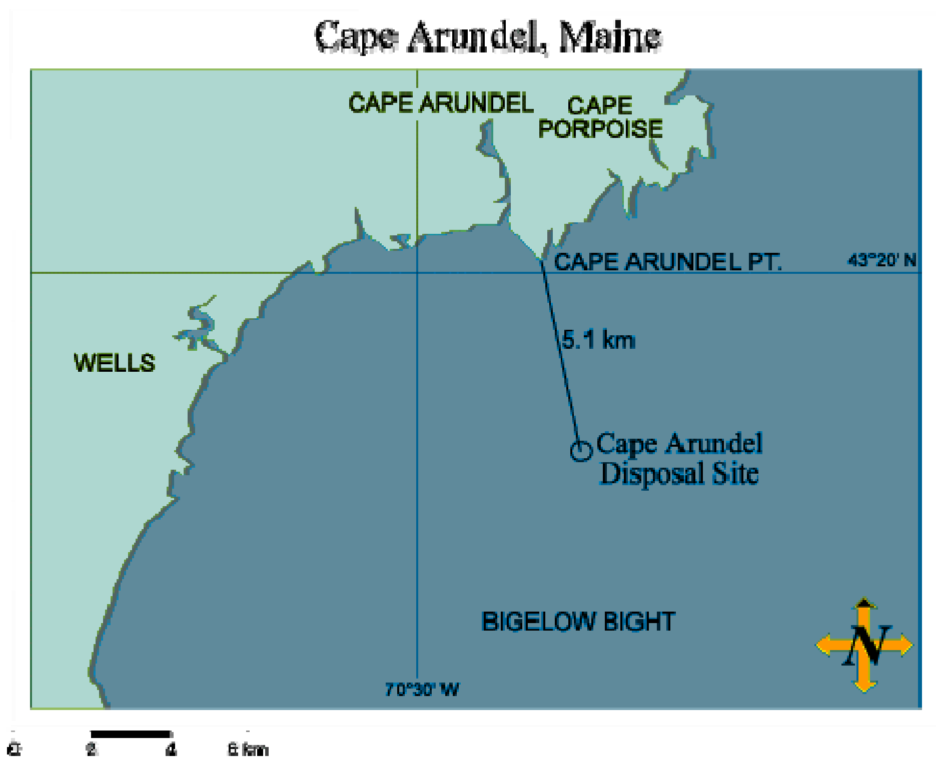

Figure 4-2. Cape Arundel Disposal Site.

The third ocean disposal site, the Rockland site is located 3.1 km. east southeast of Brewster Point, Glen Cove, and approximately 62 km from Portland Harbor (Figure 4-3). This site is the farthest from Portland, and the round trip requires approximately 24 hours. Disposal at Rockland may require simpler and less expensive bulk chemistry testing, since it is in State waters and the need for biological testing is a discretionary agency decision under CWA regulations. Acceptance of material from outside Penobscot Bay has been controversial, as this is a productive lobster fishing area. (Hannah Pingree Online Journal 1/25/05).

The feasibility of ocean disposal is dependent on several factors. The potential for high up-front costs can be offset by lower disposal costs, depending on the volume of material and proximity of the disposal site. The tiered testing regime can cost a minimum of $60,000-$70,000, with no guaranteed outcome. However, testing may not be required for maintenance dredging if sufficient and appropriate information exists from previous (within the past 10 years) tests. Collaboration with other owners can provide economies of scale for both the up-front testing and disposal.

4.2 UPLAND DISPOSAL

The feasibility of upland disposal depends on two factors:

- Sediment contaminant levels.
- Proximity and availability of suitable dewatering and disposal areas.

There are two options for disposal of dredged material on land. Material meeting the criteria outlined for beneficial use of dredged material (Maine Chapter 418) may be disposed on land (See Section 3.2). Material that does not meet the criteria must be disposed of at a licensed landfill. In either case, dredged material must be dewatered prior to disposal.

4.2.1 Dewatering Sites

The appropriateness of a dewatering site depends on several criteria. Of primary importance are capacity and proximity. Site capacity will be determined by the characteristics of the dredged material, most importantly the proportion of coarse sediments and the moisture content. The Corps of Engineers has publically-available modeling program SETTLE to calculate the size needed to retain and store dredged material (Hayes and Schroder 1992; http://el.erdc.usace.army.mil/products.cfm?Topic=model&Type=drgmat). For dredged material that is predominantly silt/clay, dewatered sediment is approximately 60% of the original volume (James Meagher, Mineral Processing Systems LLC, personal communication March 28, 2008). Site proximity is important because it directly affects the cost; the closer the site, the less costly the transport cost. In addition, from a regulatory perspective, the discharge produced from dewatering process needs to return to the same water body as the dredging project. Otherwise, it will require an additional state discharge permit.

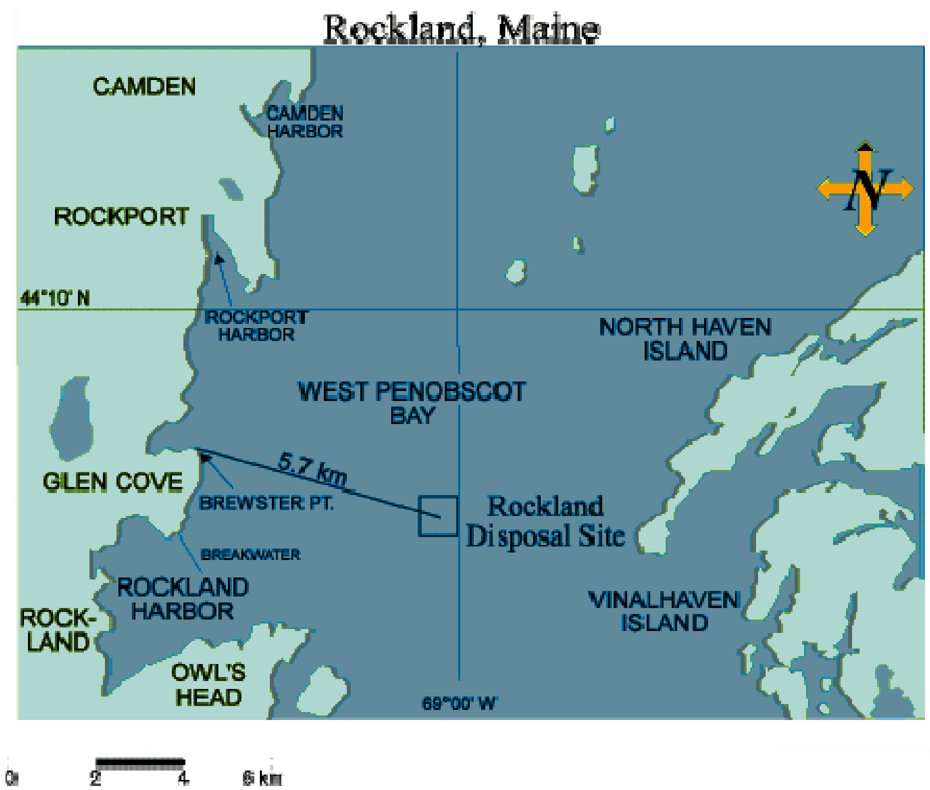

Figure 4-3. Rockland Disposal Site

Secondary criteria include presence of the exclusionary criteria listed below:

- Water Supply watershed
- Wellhead protection zone or State - identified aquifer
- Historic/archeological site or district
- Prime/significant agricultural land in agricultural use
- State-identified hazardous waste site
- Federal/State listed rare or endangered species habitat
- Identified natural resource area(stream, wetland, deeryard)
- Public or nonprofit conservation/open space or recreational land
- Coastal features
- Private conservation/open space
- Wetlands
- Hydric soils
- Shoreland zone/resource protection zone/other zoning restrictions

The most cost-effective dewatering site is on the owner's property. However, in many cases there is insufficient space to allow dewatering. We have identified five potential dewatering sites adjacent to the Fore River and Portland Harbor. One is an historical industrial site with existing conditions that may preclude it from use, another is privately owned with low likelihood of use (Table 4-1, Figures 4-1 to 4-5. Additional dewatering services can be provided on site by companies such as Clean Harbors. Owners have found other creative solutions, such as use of a barge for dewatering prior to disposal. Some of these sites would also be appropriate for disposal as beneficial use.

Site 1, referred to as the Northern Utilities property, a parcel west of the Casco Bay Bridge, off West Commercial Street (Figure 4-4). Abutters include the City of Portland on the east and Guilford Rail/Pan Am (also known as the Clay Docks) on the west. Approximately 2 acres would be available for dewatering on the eastern side of the parcel. A former coal gasification plant, the site is currently a VRAP (Voluntary Remediation Area Program) site to remove remaining coal tar, primarily PAH (polycyclic aromatic hydrocarbons), along the shoreline and in groundwater. Further efforts are ongoing with the installation of absorbent booms in the intertidal (Bob Cleary, Northern Utilities, personal communication, March 2008; Joe Payne, Friends of Casco Bay, personal communication March 28, 2008). DEP has indicated that existing conditions at this site might preclude use of the site until further testing resolves the potential for coal tar leaching.

Site 2 also known as the Clay Docks, is the largest parcel of undeveloped land on the Portland waterfront (Figure 4-4). This site, owned by Guilford/Pan Am, has approximately four acres potentially available for dewatering or beneficial use. There has been some interest in using dredged material to bulkhead and fill the old clay dock area; since fill would occur in regulated coastal wetland, an NRPA permit would be required. The potential capacity of this site is not known and would require an engineering analysis. There is interest in developing this land; discussions are ongoing with potential buyers.

Both Site 1 and Site 2 provide proximity to the Fore River and Portland Harbor for easy access to off-loading material from a dredge scow, and to either roadway or rail transportation

Figure 4-4. Location of potential dewatering sites around Portland Harbor

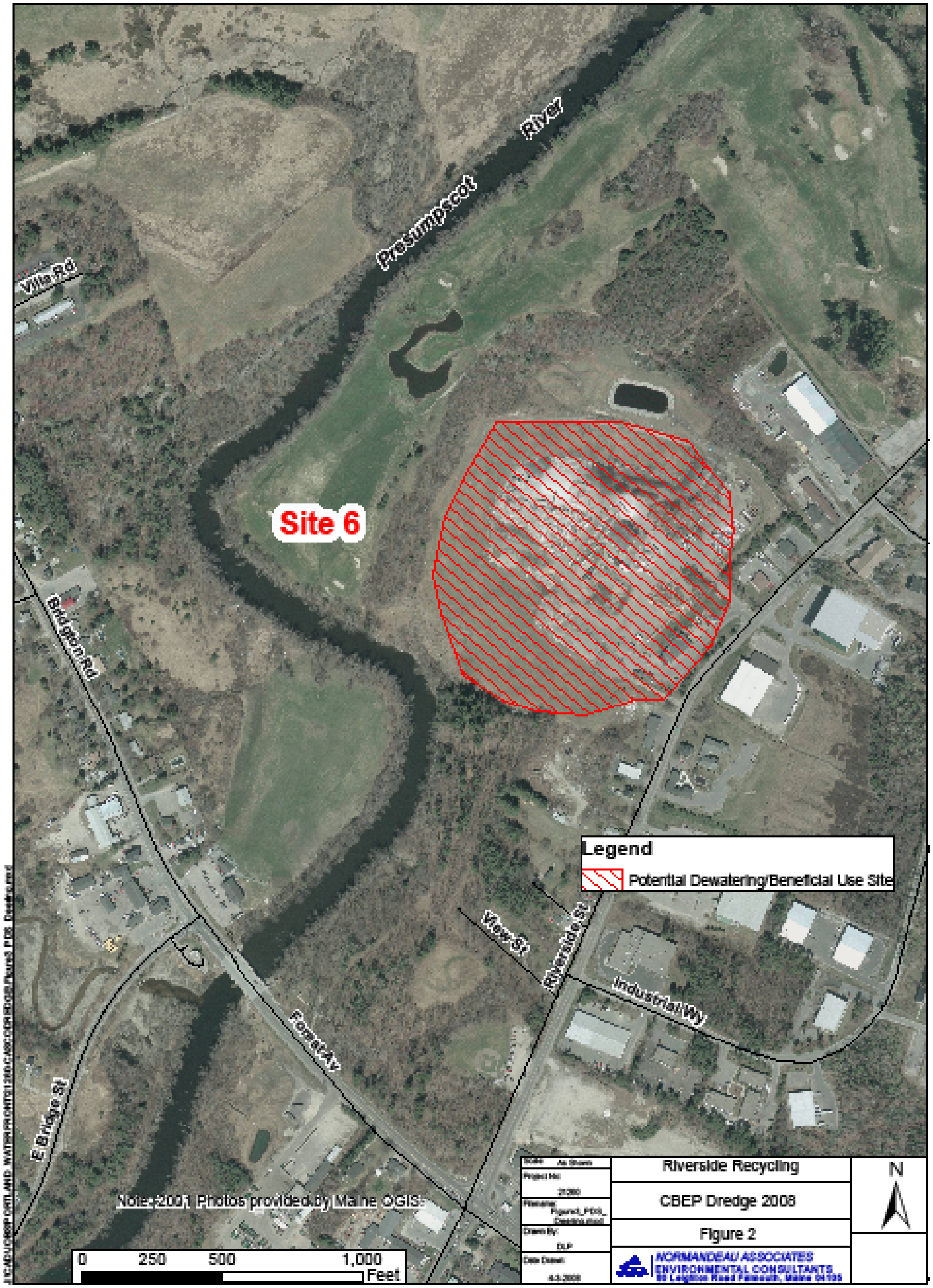

Figure 4-5. Riverside Recycling potential dewatering/beneficial use areas.

Table 4-1. Comparison of potential dewatering sites.

Site Name	No.	Area available (Ac)	Benefits	Limitations
Northern Utilities	1	2	Close to most dredge projects	Contaminant issues will likely preclude use
Clay Docks (Guilford/PanAm)	2	4	Close to most dredge projects	May be privately developed; Use may involve filling in wetland and thus unlikely to be permitted
Turners Island	3	1	Close to most dredge projects; rail access	Privately owned
Bug Light Boat Ramp	4	1+	Close to most dredge projects; publically owned	Available only during winter; potential conflicts with recreational use
Private property nr. Bug Light	5	0.5	Close to most dredge projects	Privately owned

Site 3 is located on Turner's Island in South Portland (Figure 4-4). The site is adjacent to both the Fore River and a privately-owned rail spur, which could facilitate cost-effective transport. Currently this site is not set up to store material, but is licensed to accept material for transport by rail. The owner would consider offering on- site storage if demand for space was warranted. (Roger Hale personal communication March 26, 2008) The property potentially has just over one acre available for dewatering, although much of the area is utilized, so its ultimate capacity is unknown.

Site 4 is at the South Portland Boat Ramp at Bug Light (Figure 4-4). Slightly more than one acre of the parking and overflow parking areas could be used for dewatering during the winter months when recreational use is lowest. The site would be suitable only if the dewatering was complete and material moved to the disposal area by the start of the boating season. More detailed information regarding volumes of material and area required for the dewatering process will be needed by the City if the project were to go forward to fully address the feasibility of using this location (Tom Meyers, City of South Portland, personal communication, March 2008) This site also offers proximity to the Harbor and roadway transportation.

Site 5 is also on the South Portland side of the Harbor, on privately owned property, adjacent to the Bug Light Park (Figure 4-4). This area could potentially offer up to one half acre or more for dewatering. As the site will probably be developed, the owner is unlikely to want to allow its use as a dewatering site.

Commercial entities such as Clean Harbors can provide sediment dewatering tanks or containers that can be used on site or on their property in South Portland near Sprague Energy. Options include dewatering cans with a sediment capacity of 30 cubic yards, fractionation tanks that hold 20,000 gallons of dredged material, and geotextile tubes. All three options can filter effluent so that it is a licensed discharge to the Fore River. They also have carbon vessels that offer more filtering properties. An additional method is provided by Mineral Processing Services distributor of Geotube®, a geotextile containment sediment dewatering device. This device can be deployed either on barges or land-based operations capable of processing sediment from hydraulic or clamshell designed dredges at high rates. Geotubes supported with Smartfeed® process control technology provide treatment of discharged water to permit specifications. This technology has been used on marine harbor sediments in New England and New York City in the past year with great success.

4.2.2 Potential Beneficial Use Disposal Sites

Material that passes DEP's beneficial use of dredged material chemical testing regime can be disposed on land as beneficial use. The geotechnical qualities of the material may dictate its ultimate use. High proportions of silt and clay, typical of the mud around many private owners' docks, decrease the material's stability and limit its utility as construction material unless it is mixed with more granular material or stabilized with geotechnical fabric such as Geotube™.

Riverside Recycling, run jointly by the City of Portland and Commercial Paving, occupies approximately 20 acres of land, with considerably less available for dredged material storage (Table 4-2; Figure 4-5). The site is not currently licensed by DEP to take dredged material. However, dredged material could be acceptable if it qualifies for beneficial use and can be mixed with asphalt or other component to be sufficiently stable for construction use. More information on quantity and quality of material would be needed to determine feasibility of accepting material at this location (Jim Hiltner, Commercial Paving/Riverside Recycling, personal communication, March 2008).

The Portland Jetport (Site 7) is one potential site for disposal of dredged material as beneficial use in fill for runway extensions (Table 4-2; Figure 4-6). Discussions within the City are on-going at this time. The areas under consideration for beneficial use at the Jetport could be over eighty acres.

Table 4-2. Comparison of potential disposal sites.

Site Name	Site No.	Area available (Ac) or Capacity (CY)	Benefits	Limitations
Riverside Recycling	6	20	Potential for mixing and reuse as construction material	
Portland Jetport	7	80+	Close to Portland Harbor	Would require careful timing and assessment of geotechnical properties of dredged materials.
Northern Utilities	1	2	Close to most dredge projects	Contaminant issues will likely preclude use
Narrow Gauge Railway	8	1	Close to most dredge projects	Would require assessment of geotechnical properties
Ocean Gate	9	Unknown; Capacity of 400,000-500,000 cy	In Portland Harbor; Might not need dewatering	Would require careful timing and assessment of geotechnical properties; might involve fill in wetland
EcoMaine Landfill	10	Several	Quasi-municipally owned	Dewatering required
Turners Island	3	1	Close to most dredge projects; rail access	Privately owned

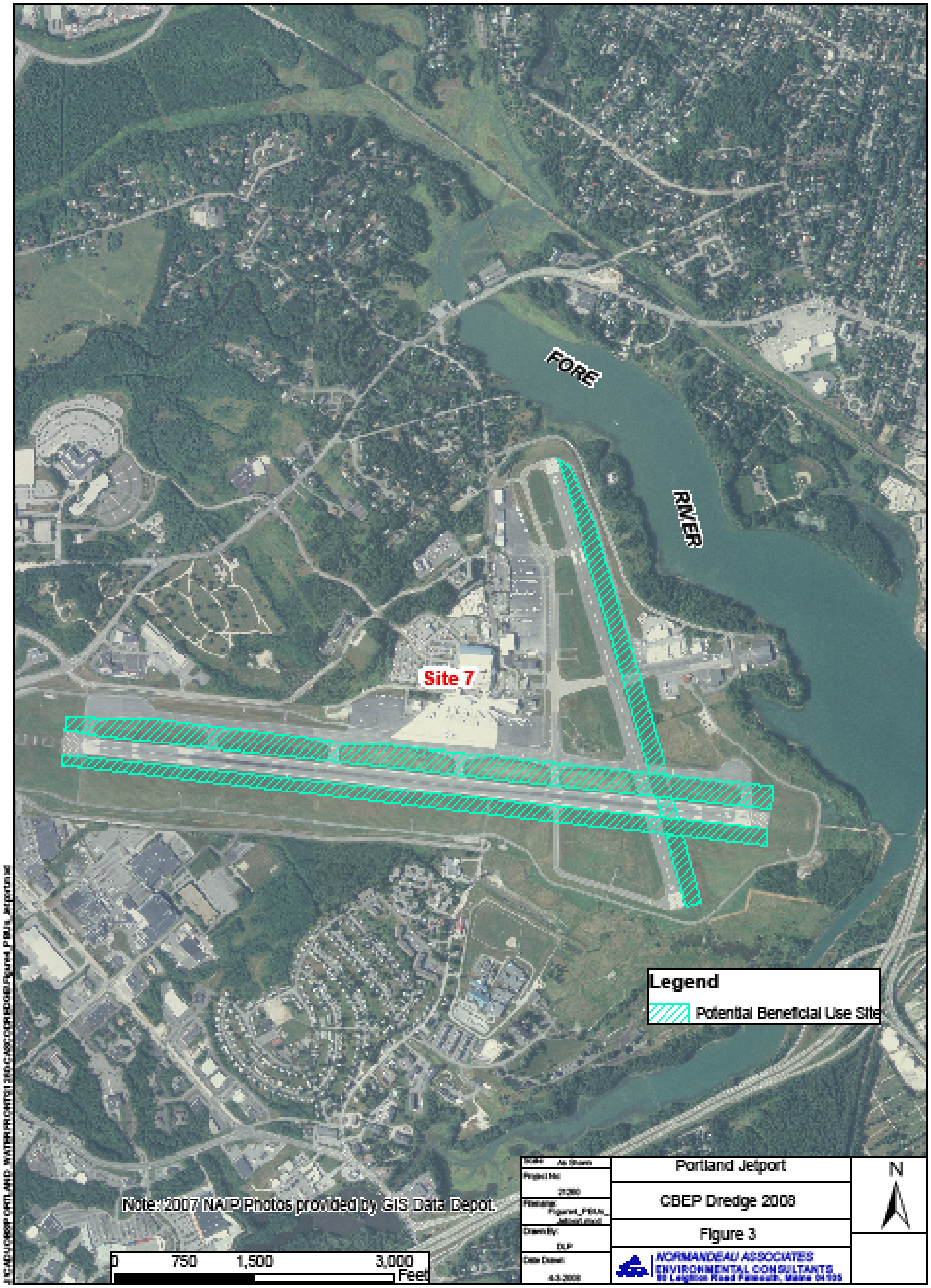

Figure 4-6. Portland Jetport potential beneficial use areas

The Northern Utilities/Guilford Rail area discussed above also has potential for beneficial use as fill and or capping (Table 4-2; Site 1, Figure 4-4). These sites need additional information to formulate an agreement to accept dredged material.

The City of Portland Transportation Director indicated that the Narrow Gauge Railway also expressed interest in using material along the track bed from the Fish Point Bridge towards Tukey's Bridge (Table 4-2; Site 8, Figure 4-4). This fill would be above the tide line in upland zone, and used to stabilize the bank along the track. This area would be approximately less than one acre (Jeff Monroe former City of Portland, personal communication, March 4, 2008)

Another area of interest is to use the material as fill for the Ocean Gate Project (Site 9, Figure4-4). This area would have the capacity to use 400,000 to 500,000 cubic yards (Jeff Monroe, op.cit). The fill would occur in the intertidal zone, a regulated wetland, both federal and state permits would be required.

The EcoMaine Landfill (Site 10), "quasi municipally" owned by several towns, is located off Gannett Road/Cummings Road on the South Portland, Westbrook, Scarborough lines (Table 4-2; Figure 4-7). The Landfill has the potential to store several acres of dredged material. Currently they are not licensed for special wastes and would need to get the Landfill Board and DEP approval to take dredged material that does not meet the beneficial use criteria. All material brought to the site would need to be dewatered to a state of at least 20% solids. More specific information would be needed to proceed with license change request to DEP (Kevin Roche EcoMaine, personal communication February 19, 2008).

Turner's Island could be a potential dewatering /storage site. As a privately owned site, there would need to be an economic benefit for the owners to consider changing the use of this site.

An overview of all potential dewatering, beneficial use, and CAD cell locations is shown on Figure 4-8.

Some Casco Bay municipalities outside of Portland Harbor have made provisions for upland disposal of dredged material. For example, the Town of Yarmouth has allowed private owners to dispose of dredged material at the Town's landfill.

4.2.3 Licensed Landfills

Special waste, defined as material designated for upland disposal that does not meet the criteria for beneficial use, must be disposed of at a licensed landfill. There are four landfills within a 130-mile radius of Portland Harbor that will accept special wastes.

Waste Management of Maine runs the Cross Roads facilities in Norridgewock, Maine, Turnkey in Gonic, NH and the Consumat SANCO facility in Bow, NH. Casella Waste Systems owns the Pine Tree Landfill in Hampden ME and operates the state-owned Juniper Hill Landfill in Old Town (formally Sawyer Environmental Recovery Facility). These facilities are licensed Commercial Solid Waste Facilities that can receive Special Wastes dredged material. Each company has a specific list of chemical analyses that are required prior to disposal. The Turnkey facility is the closest, 75 miles from Portland Harbor.

Norridgewock is second closest, at 90 miles from Portland Harbor. Consumat SANCO is 110 miles from Portland Harbor, and Pine Tree is farthest, at130 miles from the harbor.

Figure 4-7. EcoMaine potential beneficial use areas

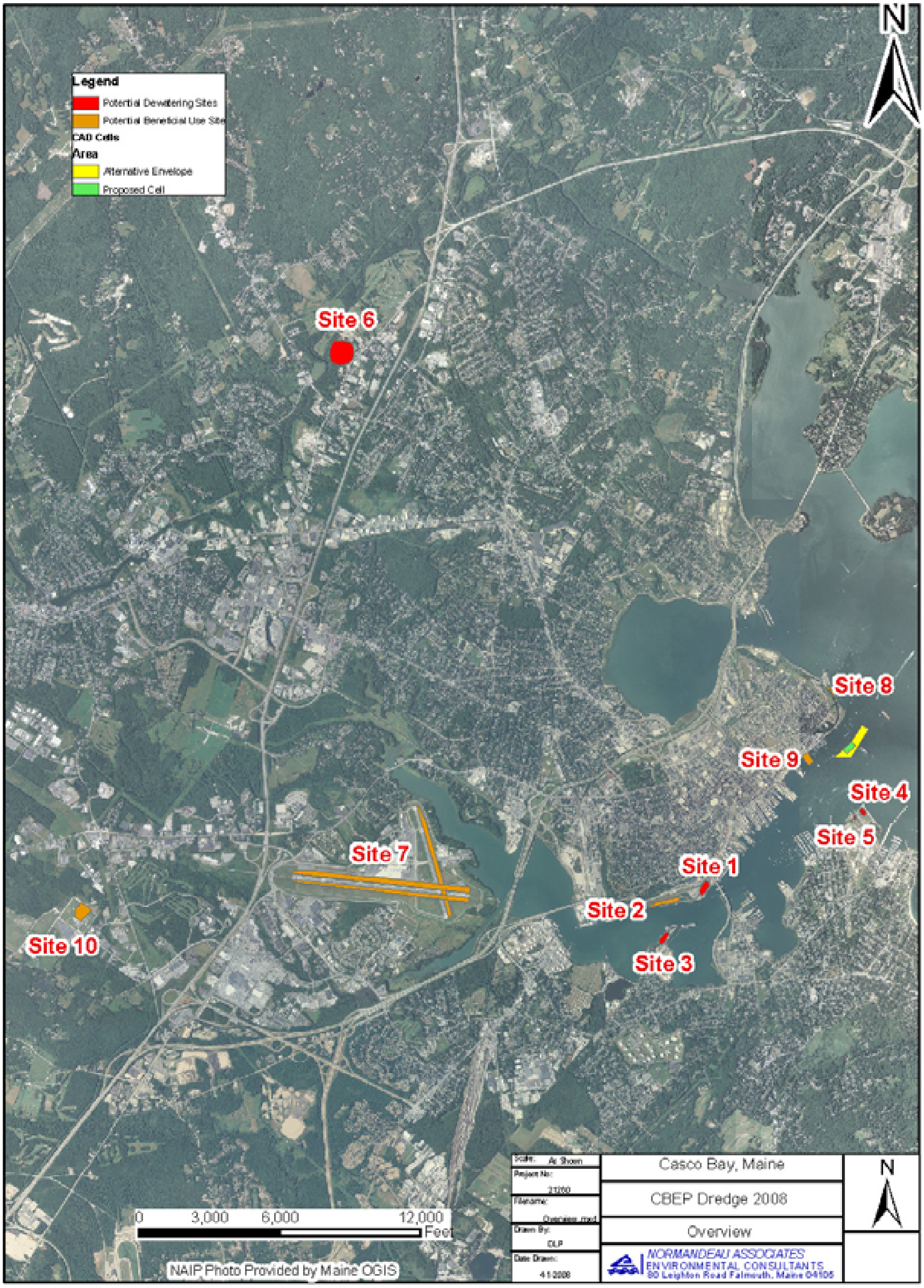

Figure 4-8. Overview All Site Locations

4.3 CAD

Confined Aquatic Disposal (CAD) cells provide a dredged material disposal option that is innovative and may be more cost effective then other options. CAD cells are in-water disposal alternatives that can be located near the place of dredging thereby eliminating the need to transport dredged material to other locations and keep the short term impacts of dredging and dredged material disposal within a relatively limited area of the environment. A common type of CAD cell is created by the excavation of marine sediment from an area in a harbor, typically within the navigation channel. It is important that the sediment within the CAD cell footprint is both stable enough to maintain side slopes during construction and filling and uncontaminated enough to be suitable for unconfined ocean disposal and/or used for beneficial purposes. Cells have been dug anywhere from 45 to 90 feet (ft) below the mudline. Avoiding areas with shallow depths to bedrock below the mudline is basic to CAD cell development. The void of the CAD cell formed by the removal of the marine sediment is filled with dredged material that is not suitable for ocean disposal. This cell physically contains the dredged material and isolates it from the surrounding environment. Figure 4-9 shows a cross section of the CAD cell in the Thames River constructed during the fall of 2006 and its location relative to the dredging activities at the Submarine Base New London, Groton, Connecticut.

CAD cells have become a common tool for dredged material management in many areas of the United States and, particularly, in New England. CAD cells have recently been created and used in New Bedford, Boston Harbor, and Hyannis, Massachusetts, the Thames River and Norwalk in Connecticut and in Providence, Rhode Island. A CAD cell was also created in Newark Bay in New Jersey that has been used for moderately contaminated dredged material from the ports of New York and New Jersey.

4.3.1 Steps in CAD Cell Creation

General Location

CAD cells are typically located in inner harbors near the areas to be dredged. A major reason for locating CAD cells within navigation channels is that the harbor bottom in these areas has been previously disturbed from construction and periodic maintenance dredging and, thus, does not represent an undisturbed habitat. Additionally, water depths in navigation channels are typically of sufficient depth to provide dredging equipment ample access to the CAD cell area. The downside to this location is that future deepening of the channel above a CAD cell would be problematic, if not prohibitive. The CAD cells in Boston, Providence, Groton and Norwalk, Connecticut are located in the federal navigation channel. Areas in navigation channels that are not candidates for future deepening are best. The Boston Harbor CAD cells, for example, are located upriver from roadway tunnels that limit future deepening. Cells in New Bedford and Newark Bay are located outside of the channel. These latter two locations required dredging an entrance driveway to the cell, which created additional dredged material for the CAD cell. One of the additional criteria that needs to be explored if a location for a CAD cell is outside the navigation channel is the quality of habitat that will be altered by the excavation and filling process. More pristine habitats should be avoided and areas of previous disturbance should be preferred.

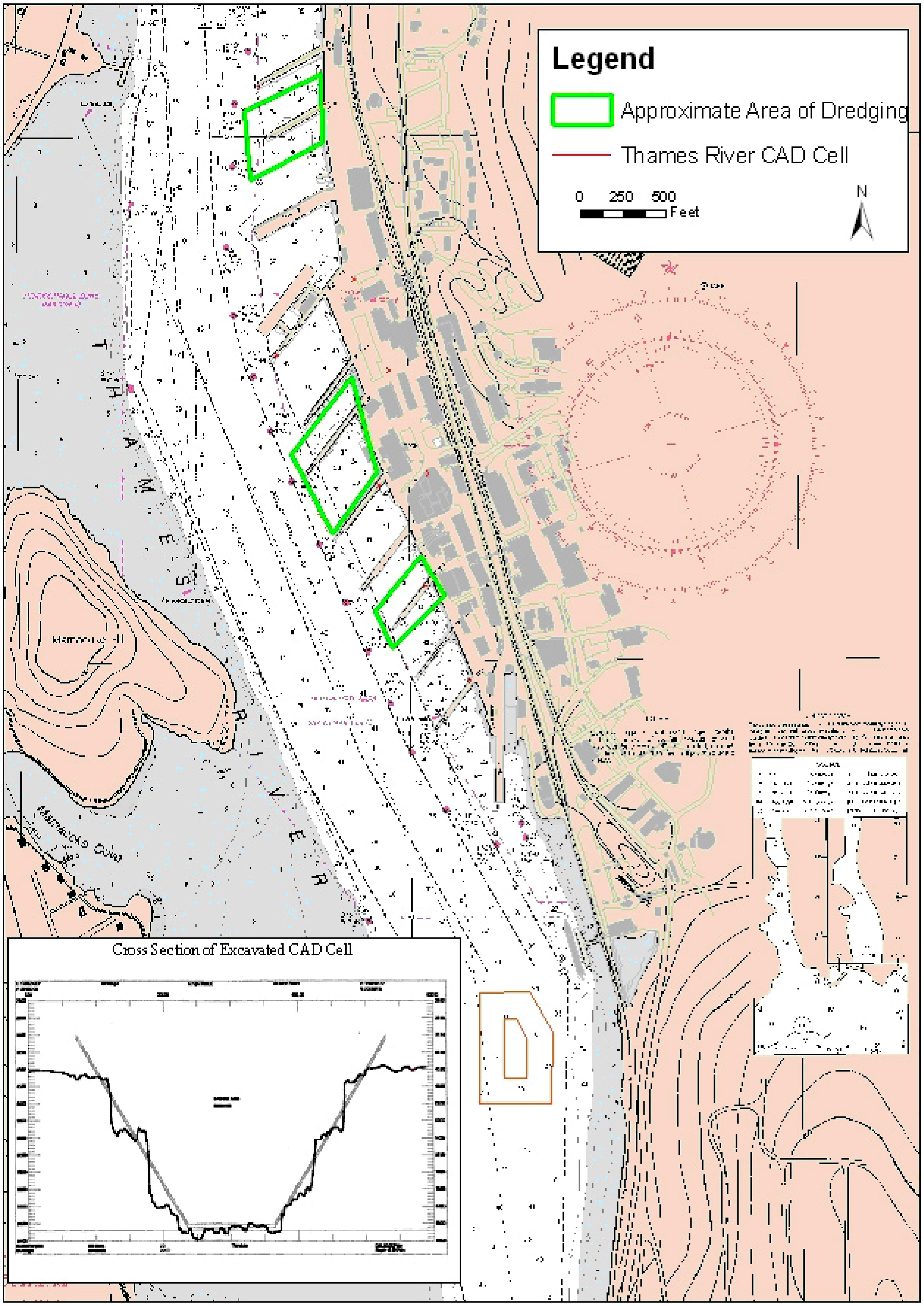

Figure 4-9. Thames River CAD CellArmy Corps of Engineers, New England District (USACE-NED) typically relies on a full geotechnical program in the proposed CAD cell areas.

Site Location Studies

Once the general locations near the proposed dredging actions in the harbor are known, the area below the mudline or sub-bottom needs to be investigated. Obtaining geotechnical boring information from past studies of potential channel deepening or from nearby construction projects can be beneficial, but mostly as supplemental information. For the Massachusetts Dredged Material Management Plan prepared by the Office of Coastal Zone Management, geophysical surveys were done for Gloucester, Salem and New Bedford harbors. Geophysical or sub-bottom profile surveys can provide valuable information on the location and depth to bedrock as well as indicate the type(s) of sediment below the mudline. Sub-bottom profiles were successfully done in Salem and also for the Navy in Groton to assist in siting feasible CAD cell locations. It is also best to drill several geotechnical borings to bedrock in the potential CAD cell location to correlate with the geophysical survey. The sub-bottom profile works by recording sound reflection. By correlating the sound recording data with geotechnical borings the speed of the sound differentials can be matched with the actual depth and sediment type observed in the boring. This spot correlation can then be used as validation of the longer track of the sub-bottom profile throughout the area of investigation. A common and frustrating problem (particularly for those paying the bills) of geophysical surveys in the marine environment is the presence of methane gas frequently produced along the mudline when much of the upper layer of sediment are silts and/or organic matter that can interfere with the survey and no results are provided. This was the case in recent sub-bottom surveys in Gloucester, New Bedford, and parts of channels in Jacksonville, Florida and Sydney, Nova Scotia. In the case of New Bedford, survey crews employed an innovative (and expensive) technique of deploying small explosives placed along a sunken wire that exploded, lifted the methane and allowed the sub-bottom profiler to get a clear scan. The results in New Bedford, along with several geotechnical borings, have provided excellent planning information for CAD cell design and construction (Massachusetts Office of Coastal Zone Management 2003). CAD cells are not feasible if bedrock will be encountered that will eliminate any cost advantages of this dredged material disposal method, so understanding the nature of the sub-bottom within a potential CAD cell location is critical to the success of the effort.

Costs for sub-bottom profiling, including a bathymetric survey to know the surface depth of the mudline, can range from $10,000 to $50,000 depending upon the time in the field and area to be surveyed. An associated geotechnical boring program should be integrated with a bathymetric survey and sub-bottom profile with a minimum of three holes to bedrock. A traditional drill rig from a fixed platform is required to go to bedrock or to a set depth below any planned CAD cell depth. The Thames River CAD cell boring never found bedrock but went to 60 ft below the mudline; bedrock was found 90 ft below the mudline in New Bedford Harbor. A geotechnical program of this size including mobilization and demobilization costs would range from $20,000 to $50,000. The US The results should provide a graphic that clearly illustrates the harbor bottom and sub-bottom geology. In the case of the Thames River CAD site, the surveys revealed silty clay sediment with limited stratigraphy throughout the proposed footprint. In New Bedford Harbor, the presence of irregularly shaped bedrock aided in the formation strategies for the future CAD cells that could go as deep as 90 ft below the mudline.

4.3.2 CAD Cell Concepts

With the knowledge of depths to bedrock, planning for CAD cells can involve laying out one cell or a series of cells. In Boston, New Bedford and Groton, CAD cell locations were identified for a multitude of dredging events. The configuration of a CAD cell depends upon a number of variables, including:

- Size and shape for construction efficiency (rectangular or square)
- Cell excavation depth
- Side slopes
- Planned volume of dredged material going in (with bulking factor)
- Thickness of upper layer of sediment that may need to be accommodated in the cell
- Thickness of desired cap material
- Cell volume contingency factor

The rectangular shape for a CAD cell seems to be the preferred from a constructability perspective. The Groton initial CAD cell, for example, was 400 ft by 600 ft. This cell was excavated to 45 ft below the mudline of the federal navigation channel (-40 ft mean lower low water). A floor of the cell was created and the side slopes were 1 vertical (V) to 3 horizontal (H). The cell accommodated approximately 153,000 cubic yards (cy) of dredged material from the SUBASE pier area. Approximately 220,000 cy of material was excavated to create the cell and of that 17,000 cy was placed back in the cell as the cap. About 203,000 cy of sediment was taken to the New London Disposal Site in Long Island Sound approximately 7 miles from the SUBASE.

The cell dimensions can vary depending upon the goals of the project, depth to bedrock and sediment type. Where silts and glacial till have been encountered, slopes of 1V to 3H have been typical with slopes also at 1V to 4H where concerns for nearby shoreside structures are involved. In Boston Harbor, the presence of “Boston blue clay” in the sub-bottom stratigraphy has allowed much steeper side slopes and provided more capacity within the cells.

Figure 4-10 illustrates the conceptual design of a CAD cell. This illustration is from the New Bedford Harbor plan where the cell was planned with a 1V to 3H side slope and a floor that is located just above bedrock. This cell is one of several depicted with a total capacity exceeding 1 million cy. The Pope’s Island North area is located well outside the navigation channel area and was selected by the local sponsors in New Bedford and Fairhaven.

4.3.3 CAD Cell Placement Requirements for Portland

The criteria presented above can be applied to finding an appropriate location for a CAD cell in Portland Harbor. Below is a list of criteria that could be used for locating a CAD cell in Portland Harbor:

- The area should be in the maintained portion of the harbor but in a low traffic area and an area not requiring future deepening.
- Distance from dredging projects should be minimized to keep costs down.
- The benthic community should not have high value for shellfish or lobster.
- Depth to bedrock should be adequately deep.

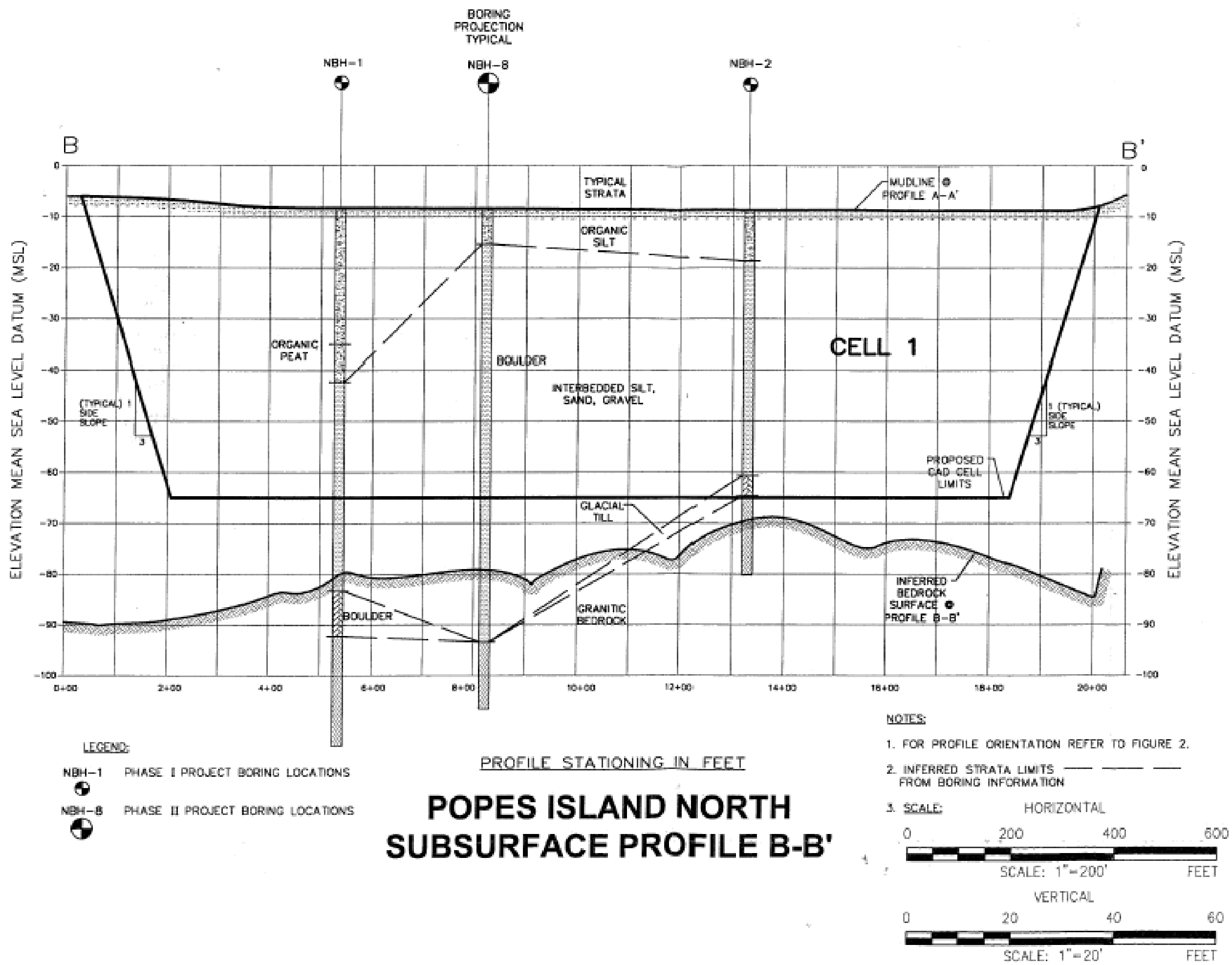

Figure 4-10. Example of a CAD Cell Concept for New Bedford Harbor, MA

- Sub-bottom material should be clean enough for ocean disposal.
- Sub-bottom material should have the proper geotechnical properties to maintain side slopes during construction.

Figure 4-11 shows Portland Harbor and its various channels and anchorages. The five dredged areas shown on the map are Federal Navigation Projects (FNP) that are maintained by USACE and are areas where the harbor bottom has been previously disturbed. The blue and red areas represent the portions of the FNP that area most used by commercial ships. Additionally, they are both channels that may require deepening in the future. The green area is a shallower and less frequently used channel. In addition, the area of this channel located southeast of Fish Point is used primarily as an anchorage. Ships tend not to anchor on its northwestern side due to the proximity to shallower water. This area is a good area to investigate further as it is likely to meet all the criteria listed above. Figures 4-4 and 4-8 show the location that is of interest for CAD cell development. Other areas should not be ruled out, but may not be able to meet all the criteria above. Areas north in the Back Cove approach and perhaps farther south beyond the 45 foot channel (red) depicted on Figure 4-11 may also be feasible locations. Areas outside the federal navigational project areas may be of higher

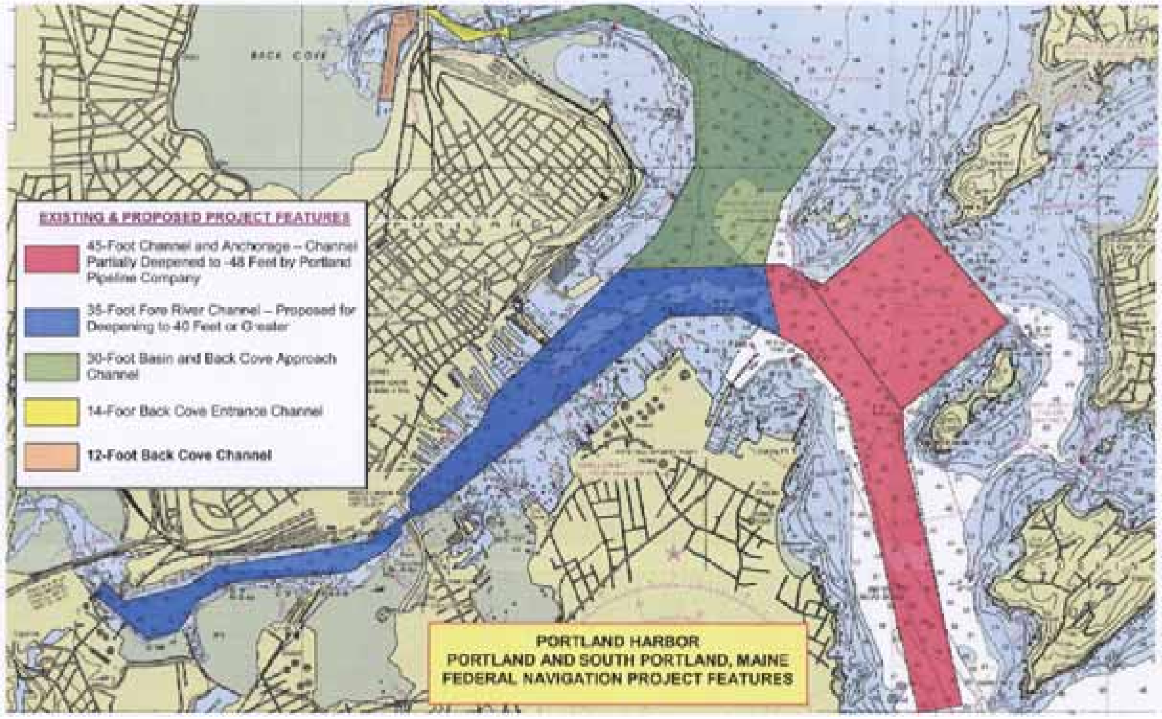

Figure 4-11. Portland Harbor Channels and Anchorages

habitat value and may require additional dredging for access. In addition, depth to bedrock could be an issue in several areas.

As discussed in section 4.1, three ocean disposal sites exist for disposal of the suitable material. These are: Portland Disposal Site located approximately 9 nm from Portland Harbor, Cape Arundel Disposal Site located approximately 28 nm from Portland Harbor and Rockland Disposal Site located approximately 33 nm from Portland Harbor. A nearby ocean site is required for the clean material excavated from the CAD cell to maintain cost effectiveness of this disposal option. The use of the Portland Disposal Site would seem to fit that purpose well.

4.3.4 CAD Cell Construction and Costs

Most CAD cells are created at the same time as new and/or maintenance dredging activities are occurring. As a consequence, the costs are typically “mixed” with dredging. However, according the USACE-NED, the CAD cell created in Norwalk Harbor cost approximately $20 per cy (Jack Karalius, USACE-NED, personal communication). This estimate has been confirmed by other USACE-NED information that uses a $20 to $30 per cy range based upon a number of projects that have been undertaken. CAD cells have been funded mostly by the USACE although reimbursement from local sponsors has included charging fees for use by non-federal projects. The CAD cells in New Bedford have been funded by the Commonwealth of Massachusetts through its Seaport Bond program. The Thames River CAD cell has been funded by the US Navy and has been used exclusively by them.

CAD cell excavation is typically done with a clamshell bucket dredge. The initial layer of sediment is typically held in a few barges for placement back into the cell as sediment testing probably would reveal detectable levels of contaminants that would preclude ocean disposal. Depending upon the sediment type, side slopes are dug in a stair-step fashion to the bottom. After the initial layer is placed in the storage barge, the subsequently excavated dredged sediment is placed in bottom-dumping barges that transport the material to an ocean disposal site and/or beneficial use site (Material from the New Bedford CAD cell excavation was taken to cap "Polychlorinated biphenyl (PCB) hot spots" on the outside of the hurricane barrier in the harbor). Once the cell has been excavated, dredged material from the project areas can be brought to the cell, positioned and dumped into the open water with use of a bottom-dumping scow or barge being the most efficient. The disposal of dredged material could be planned to place the sediment with the highest elevated level of contaminants first with less contaminated sediment sequenced to the top. Maintenance dredged material in many urban harbors is typically silty. During dredging, silty dredged material will mix with water and "bulk" to a larger volume. Bulking factors range from an additional 20 to 50 percent (and higher) and need to be calculated in the size of the CAD cell.

Capping of CAD cells has been done in most cases. The concept is that cleaner cap material (typically 3 ft in thickness) will cover the moderately contaminated material and prohibit its dispersion and allow biota to return to the area more readily. Cap material is routinely used to cover dredged material in aquatic disposal mounds in open water sites managed by the USACE-NED that have been monitored for many years. Cap material is also routinely used in upland situations as part of remediation action plans. Capping of CAD cells has been less clear-cut and because of the location and construction of these excavated sub-aqueous pits may not be needed. Dredged material placed in a CAD cell will consolidate and cause a concave shape in the cell footprint. It would be best to let the dredged material have an extended amount of time to consolidate before cap material is placed. However, because of permit requirements and dredge contractor agreements, cap material has been added to several CAD cells soon after the final project dredged material was deposited. In other areas, most notably in the Providence River and recent cells in Boston Harbor, CAD cells have not been immediately capped and subsequent projects have been allowed to use available capacity.

Agreement on what material is suitable for cap material is important. During the initial CAD cells in Boston Harbor, sand from Cape Cod Canal was used as cap. Monitoring revealed that much of the sand sunk through the softer dredged material in the cell. In the Groton CAD cell, sediment excavated from the upper cell footprint was used as cap. Recent monitoring revealed that the while the cap appears to have mixed with the pier area sediment, the upper layer is predominantly from the material used as cap. A more important finding of this recent monitoring was that the material in the CAD cell had consolidated over the course of one year to the extent that the concave shape had drawn down approximately 10 ft (TEC 2008). This consolidation process will occur in all CAD cells and should be understood for capping purposes and possible additional disposal capacity at a later date.

4.3.5 CAD Cell Regulatory Process

Several of the CAD cell projects have been part of larger dredging or pier construction projects that have been subjected to the National Environmental Policy Act (NEPA) and/or a similar state process (Massachusetts Environmental Policy Act). In the case of NEPA, this is because the proponent of the proposed action (United States Army Corps of Engineers [USACE] or United States Navy) is a federal agency so either a Categorical Exclusion, Environmental Assessment or Environmental Impact Statement is required. CAD cell creation by a non-federal agency would probably not need a

NEPA document other than the documentation done by the USACE in association with their permit application decision.

The permits typically required for CAD cell construction and use are similar to those required for dredging projects and include:

- Section 10 River and Harbor Act 1899 (Structures in Navigable Waters), USACE.
- Section 404 Clean Water Act (CWA), 1972 (Dredge and Fill), USACE.
- Section 401 CWA (Water Quality Certificate), State Department of Environmental Protection (DEP).
- Section 103 Marine Protection, Research and Sanctuaries Act (MPRSA), 1972; USACE (Excavated material from the CAD cell footprint).

There could also be state Coastal Zone Management Act consistency requirements and local ordinances or regulations that would apply, depending on the location of the CAD cell.

Mitigation measures applied to dredging projects include observance of seasonal dredging windows, type of dredge equipment and monitoring of suspended sediment would likely apply to CAD cell construction and use. Other monitoring has included compensation for shellfish resource losses (such as lobster relocation), monitoring of turbidity and post disposal bathymetric and sediment testing for presence of cap material.

Sediment sampling and testing of the future CAD cell site would be required. Initially, it is important to define the sediment quality of the upper layers to determine the level of contamination and point at which there are no longer non-background levels of contamination. A sub-sampling program using vibra-coring would provide samples for testing and evaluation. In the case where potential contaminated sediment is probable, it should be sufficient to take 5 ft length cores with sub-samples every one ft. Sediment could be tested for some, but not all, chemical parameters typically required by the USACE regulations to determine the depth at which there is low or no levels of contamination. The depth and subsequent volume of sediment that would need to go into the CAD cell can be determined. Also, if the selected area is not in the navigation channel, surveys of macro-benthos to establish the overall quality of the habitat have been done.

The sediment to be dredged and taken to the CAD cell is typically tested for the traditional bulk chemistry screen recommended by the USACE. State DEP and USEPA as well as National Oceanic and Atmospheric Administration (NOAA) Fisheries could participate in the process to determine which tests are needed. For the CAD cell itself when the point of the native material is found, other projects, including the Groton CAD cell, have tested only for three metals and physical parameters including grain size. The regulatory decision has used these limited tests to determine that the native material in the sub-bottom below the mudline is non-anthropogenic or not subjected to exposure to industrial processes and, therefore, is excluded from biological tests required in Section 103 of MPRSA and can be taken to open water sites for disposal. This decision has been critical in holding down the testing costs for determining the suitability of CAD cell native sediment for unconfined ocean disposal. With these assumptions and approach, costs for sediment sampling and tests within the CAD cell would be in the range $50,000 to $100,000 depending on the size of the CAD cell footprint and number of samples.

5.0 ALTERNATIVES ANALYSIS

5.1 SCREENING PROCESS

Choosing an appropriate disposal site depends on a variety of factors. We reviewed a number of documents and studies to gain insight into how others have selected an appropriate disposal site. These included the Providence River EIS, Boston Harbor Navigational Improvement EIS, the Pearl Harbor HI dredged material management plan (Schroeder and Palermo 2000). Ultimately, disposal site selection relies upon volume and type of material, which narrows the range of available alternatives. Then the choice becomes a cost/benefit analysis, where factors such as upfront costs (testing, permitting, engineering) and disposal costs balance against benefits such as schedule and certainty.

Disposal options are highly dependent on the type of dredged material. Table 5-1 shows the disposal options for the four basic classes of material: sand, parent material, "clean" mud, and contaminated mud. While an oversimplification, it helps refine the choices for the owner.

Table 5-1. Types of dredged materials and disposal options

	Ocean (Portland/ Cape Arundel)	Nearshore (404) Rockland	CAD	Upland Beneficial Use	Upland contained (geotube™ or other)	Upland Landfill
Sand (<4% fines)	✓	✓	✓	✓	✓	✓
Parent material (e.g. blue clay, till)	✓	✓	✓	✓	✓	✓
Clean "mud"	✓	✓	✓	✓	✓	✓
Contaminated "mud"			✓		✓	✓

For example, disposal options for sandy sediment include ocean, upland beneficial use, upland contained, upland landfill, CAD cells. However, an owner would likely choose the least expensive option. As dredged material becomes more contaminated, options become more limited. For material that is considered contaminated (i.e. does not meet the ocean disposal or beneficial use standards), landfill or CAD cell are the only options If Maine Hazardous Waste regulations are applicable to dredged material, disposal options may be further reduced..

The other major factor in disposal site selection is the amount of dredged material. There is approximately 200,000 cy of dredging planned for Portland Harbor (Figure 5-1). The average dredge project volume is approximately 11,000 cy, and includes the estimated 100,000 cy for the Oceangate project; if the Oceangate project is excluded, average dredge project is slightly more than 6,000 cy. Therefore, in our assessment, we include costs for this "typical" dredge project.

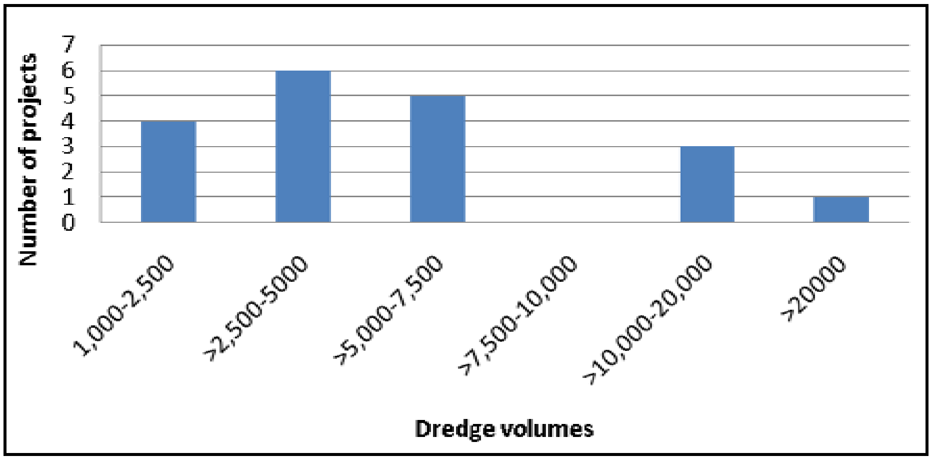

Figure 5-1. Estimated number of projects and dredge volumes in Portland Harbor.

Table 5-2 shows estimated costs for the various disposal alternatives. These costs were obtained by interviewing various contractors and owners in Portland Harbor. Upfront costs were those that were associated with the initial evaluation and planning, and were not strictly dependent on the size of the project. Engineering and permitting costs include engineering design and plan preparation, bathymetric and biological surveys, sediment sample collection, permit application preparation and fees, and advertisement. These costs vary depending on the complexity of the project and the amount of work that the owner can do “in house”. Disposal costs were calculated on a cubic yard basis and included dredging, transport and disposal. The range in costs was expressed as the estimated low and high costs, as there was considerable variability in the costs we received through the interview process. In addition, costs vary depending on the complexity of the permitting process. For example, a project could secure a permit for ocean disposal using existing information, resulting in a considerable reduction in testing fees, or might have to complete the full tiered testing, which could cost more than $100,000. We assume that the costs for sand and parent material are largely similar. Upland contained options such as Geotube™ are highly dependent on site-specific conditions, so were also not included.

The costs for CAD cell are based on several assumptions. The cost of the actual CAD cell creation includes both the geotechnical work ($30,000 to $100,000) plus the cost of digging the cell ($15-$17 per cubic yard), with an overall cost of approximately $20-$30 per cubic yard (Tom Fredette, US Army Corps of Engineers, personal communication). We did not include the CAD cell creation in the up-front costs, assuming that the CAD cell would need to secure upfront funding that would not involve the private owner. However, we did include a user fee, based on the approximate cost of the CAD cell creation. Of course, this fee depends on the actual number of users. Another important factor is sediment testing; while the US Army Corps and USEPA have indicated that testing may not be needed prior to disposal, other CAD projects in New England have required bulk chemistry. This dramatically affects the up-front costs of CAD cell disposal.

The highest upfront costs of ocean disposal are approximately double those of the upland beneficial use and landfill, mainly because of the high cost of testing. If an owner can use results from other projects or their own previous results (which according to Olga Guza, USEPA, personal communication) have a “shelf life” of 10 years), the upfront costs are reduced by the $60,000-

Table 5-2. Estimated upfront and cubic yard costs for various dredge alternatives.

		Ocean		Upland Beneficial Use		Upland Landfill		CAD[1]	
		Low[2]	High	Low	High	Low	High	Low	High
UP-Front Costs	Engineering design/permit	$10,000	$50,000	$10,000	$50,000	$10,000	$50,000	$10,000	$50,000
	Chemical/physical testing	$1,000	$100,000	$1,600	$5,200	$1,200	$1,200		$100,000
	Dredge mobe/demobe	$15,000	$20,000	$15,000	$20,000	$15,000	$20,000	$15,000	$20,000
Total Up-Front Cost		**$26,000**	**$170,000**	**$26,600**	**$75,200**	**$26,200**	**$71,200**	**$35,000**	**$170,000**
Dredge/Disposal Cubic Yard Costs	Dewater			$50	$80	$50	$80		
	Transport				$7.08	$4.00	$12.55		
	Tipping ($55/ton; 1 cy=0.84 ton) [3]					$46.20	$46.20		
	CAD cell user fee [4]							$20.00	$30.00
	Dredge	$15.00	$250.00	$23.00	$75.00	$23.00	$75.00	$15.00	$18.00
Total Cubic Yard Cost		**$15.00**	**$250.00**	**$73.00**	**$162.08**	**$123.20**	**$183.75**	**$35.00**	**$48.00**
Estimated cost for a 6000 cy disposal (4200 dewatered volume)		**$116,000**	**$1,670,000**	**$464,600**	**$1,047,680**	**$825,200**	**$1,173,700**	**$265,000**	**$558,000**

[1] Does not include one-time costs associated with CAD cell creation, $30,000-$100,000 in geotechnical plus estimated upfront construction costs of $4-$6 million, which could be offset by user fees. [2] Low cost of testing assumes existing information is sufficient for permitting.
[3] Assumes that 1 cy dredged material weighs 0.84 tons; dewatering reduces volume by 30%
[4] CAD cell user fee based on approximate cubic yard cost of creation.

$100,000 for tiered testing. Disposal at Rockland could also avoid the expense of Tier II and III testing, partially offset by the increased costs of transport. The up-front costs of for the private owner using a CAD cell range from the lowest to second-highest, depending on the need for sediment testing. The high estimate for ocean disposal includes one contractor who quoted $250/cy for contaminated sediments. The ocean and CAD cell disposal costs are lower than other alternatives that require transfer and multiple types of transportation. Upfront costs of upland beneficial use and landfill are one-third to one-half the costs of ocean disposal because of the decreased costs of testing. Per yard disposal costs for upland beneficial use and landfill are higher because costs increase each time a material is handled. The per yard costs of landfill disposal are approximately double that of beneficial use, because of the increased transport distance and tipping fees. The estimated costs of CAD cell disposal are probably overestimated because the CAD cell would be closer than any ocean disposal site, reducing transport costs. The per yard disposal costs will depend on the CAD cell user fee. CAD cell disposal costs were lower than all but ocean disposal without testing and the lower estimate of upland beneficial use.

Costs for various sized projects are shown in Table 5-3. If the project does not need additional testing, ocean disposal is the least costly option for all sizes of projects. The next most costly, if it became available, would be use of a CAD cell, if no testing is needed. Upland beneficial use is third least costly for small projects up to 6,000 cy; for larger projects, CAD cell with testing becomes less costly.

Evaluation of the disposal alternatives was conducted for each of the four sediment types. Factors included overall benefits and limitations, regulatory complexity, and costs (upfront and disposal). The alternatives analysis for clean sand is shown in Table 5-4. Ocean disposal is the least expensive option because of the low upfront costs would be at the low end ($35,000; no testing other than grain size is needed) and low disposal costs. Upland beneficial use could be a cost effective option if the material is marketable, offsetting the costs of dewatering and transport. However, depending on the amount of material, finding a dewatering site could be problematic.

The alternatives analysis for clean mud is shown in Table 5-5. If existing information is sufficient to allow ocean disposal, this is the most cost effective option. The level of testing needed for ocean disposal could increase the overall costs so that upland beneficial use becomes more cost effective. However, testing could reveal that the sediment is unsuitable for ocean disposal. Upland disposal requires a dewatering and disposal site, which may not be available. A CAD cell, if available, would have a comparable cost to upland beneficial use disposal without the challenge of finding a dewatering and disposal site.

The alternatives analysis for contaminated mud is shown in Table 5-6. Ocean disposal would require extensive, expensive testing, and might ultimately not be suitable for ocean disposal. Upland disposal would likely require dewatering and transport to a licensed landfill, which has significant transport expense but simple and inexpensive permitting and testing. A dewatering site would need to be available, or use of a commercial facility, with increased costs. A CAD cell, if available, would be the most cost-effective option.

Table 5-3. Costs for various sized dredge projects

	Ocean		Upland Beneficial Use		Upland Landfill		CAD	
Project Size (CY)	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
1,000	**$41,000**	**$420,000**	**$99,600**	**$237,280**	$149,400	$254,950	**$90,000**	**$318,000**
2,000	**$56,000**	**$670,000**	**$172,600**	**$399,360**	$272,600	$438,700	**$125,000**	**$366,000**
6,000	**$116,000**	**$1,670,000**	**$464,600**	**$1,047,680**	**$765,400**	**$1,173,700**	**$265,000**	**$558,000**
10,000	**$176,000**	**$2,670,000**	**$756,600**	**$1,696,000**	**$1,258,200**	**$1,908,700**	**$405,000**	**$750,000**
100,000	**$1,526,000**	**$25,170,000**	**$7,326,600**	**$16,283,200**	$12,346,200	$18,446,200	**$3,555,000**	**$5,070,000**

[1]Yellow highlight indicates the least costly option for each project size; blue highlight indicates the second least-costly option.

Table 5-4. Alternatives analysis for disposal of clean sand.

CLEAN SAND	Benefits	Limitations	Regulatory Complexity	Cost: Upfront	Cost: Disposal
Ocean	Inexpensive up-front and disposal costs.		Straightforward No need for testing other than grain size; NRPA/Corps permit needed	Inexpensive; negligible testing needed	$15-$18/cy
Upland (beneficial use)	Desirable material, easily permitted	Need dewatering and disposal locations; May be timing constraints.	Straightforward; NRPA for dredging; Exempted from solid waste licensing	Inexpensive, negligible testing needed	$73-$162/cy
Upland (landfill)	Desirable as construction material or landfill cover	Need dewatering location; may be timing constraints	Straightforward NRPA for dredging; Exempted from solid waste licensing	Inexpensive, negligible testing needed	$124/cy; unless sold as cover
CAD Cell	Could be used as capping material	Funding needed for feasibility study, permitting, creation	NRPA for dredging; No testing needed for disposal	Lengthy expensive process to permit new site	$35-$48/cy

Table 5-5. Alternatives analysis for disposal of clean mud.

CLEAN MUD	Benefits	Limitations	Regulatory Complexity	Cost: Upfront	Cost: Disposal
Ocean	Inexpensive disposal	Expensive testing regime unless there is existing info.	Complex, requires biological testing federal/state permits	High unless there is existing info.	$15-$18
Upland (beneficial use)	Moderate expense, testing	Need dewatering and disposal locations; May be timing constraints	Moderate, 2 state permits needed	Moderate, depending on dewatering/disposal site	$73-$162
Upland (landfill)	Low expense, testing	Need dewatering location, May be timing constraints	Corps/NRPA for dredging; landfill testing	Low	$123-184
CAD Cell	Testing expense, none to moderate; no dewatering	Funding needed for feasibility study, permitting, creation	NRPA for dredging, Corps for disposal	Lengthy expensive process to permit new site; testing may be necessary	$35-$48/cy

Table 5-6. Alternatives Analysis for disposal of contaminated mud

CONTAMINATED MUD	Benefits	Limitations	Regulatory Complexity	Cost: Upfront	Cost: Disposal
Ocean	Disposal costs cheapest, if suitable	Expensive testing with uncertain outcome	Complex, requires biological testing, federal/state permits	High	$15-250/cy
Upland (beneficial use)	May not be feasible depending on degree of contamination	Requires dewatering and disposal sites; may require mixing to meet standards	Moderate, 2 state permits needed	Moderate	$73-$162/cy
Upland (landfill)	Certain outcome	Requires dewatering and disposal sites	Corps/NRPA for dredging; none for disposal landfill testing;	Low	$123-184/cy
CAD Cell	Testing expense, none to moderate; no dewatering	Funding needed for feasibility study, permitting, creation	Corps/NRPA for dredging, Corps for disposal	Lengthy expensive process to permit new site	$35-$48/cy

6.0 SUMMARY

The assessment of disposal options for private dredging projects in Portland Harbor had the following conclusions:

1. The number of dewatering and upland disposal sites around Portland Harbor has decreased since the 1998 evaluation. There are a few sites that could be available, but all have constraints.
2. Ocean disposal remains the most cost-effective disposal option if there is existing information that allows the project to go forward without the expense of bioassay/bioaccumulation testing. Disposal at a CAD cell could be a less-costly option if available. Upland disposal using beneficial use can be a cost effective option if there are both disposal and dewatering areas available to the owner.
3. Entrepreneurs around the Harbor are investigating creative approaches to disposal, including rail transport, barge and container dewatering, and use of geotextile fabric containers for dewatering and disposal. These may ultimately provide cost-effective options for disposal.

7.0 REFERENCES CITED

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USACE_NED 2008. Personal communication with Tom Fredette

USACE_NED 2008. Personal communication with Phillip Nimeskern.

USACE-NED 2001. USACE-NED 2008. Personal communication with Jack Karalius, Project manager for CAD cell disposal project, Norwalk, CT.

USACOE 2005. Department of the Army Programmatic General Permit, State of Maine.

APPENDIX A

Resources Used to Develop this Document

Websites of Interest

US Army Corps of Engineers:

http://www.nae.usace.army.mil/reg/index.htm New England District Corps website
http://el.erdc.usace.army.mil/dots/pdfs/eedp06-4.pdf Environmental Effects of Dredging Technical notes
http://www.nae.usace.army.mil/damos/mapsinfo.asp?myName=Portland location of Portland disposal site

Dredged material disposal fate study at the Portland Disposal Site 1998-2000. DAMOS study 153. 2004
http://www.nae.usace.army.mil/damos/pdf/153.pdf http://www.nae.usace.army.mil/reg/rim.htm
Regional Implementation Manual http://www.nae.usace.army.mil/reg/rim.htm
Ocean disposal locations http://www.nae.usace.army.mil/damos/maps.asp
Regulatory program http://www.usace.army.mil/cw/cecwo/reg/sadmin3.htm
http://www.google.com/search?hl=en&q=EPA%2FUSACE+%22Green+book%22&btnG=Search
EPA/Corps Green book
http://stinet.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA269382
Inland Testing Manual http://www.epa.gov/waterscience/itm/ITM/
ACOE dredge management plan http://www.nae.usace.army.mil/damos/pdf/dmmp.pdf
Corps Damos program http://www.nae.usace.army.mil/damos/application checklist
http://www.helcom.fi/stc/files/Guidelines/ReportingFormDredgedMaterial.pdf
Konig letter on comparison between 404 and 103 sites
http://www.oceancommission.gov/meetings/jul23_24_02/answers/koning_answers.pdf

Dredging software including the SETTLE program

http://el.erdc.usace.army.mil/products.cfm?Topic=model&Type=drgmat

Essential Fish Habitat
http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/
Endangered species act
http://www.nmfs.noaa.gov/pr/laws/esa/
Site with all relevant federal regulations
http://www.usace.army.mil/cw/cecwo/reg/sadmin3.htm

EPA:

Managing Contaminated Sediments EPA http://www.epa.gov/waterscience/cs/library/managingcs.pdf
Decision making process, Long Island Sound EIS
http://www.epa.gov/region01/eco/lisdreg/assets/pdfs/eis2003/lismain01.pdf
Info on special waste shipping http://www.epa.gov/epaoswer/hazwaste/ldr/wap330.pdf

Maine DEP:

MaineDEP Bureau of Land and Water Quality:
http://www.maine.gov/dep/rwm/data/landfillactive.htm active land fills in state
http://www.maine.gov/dep/rwm/solidwaste/forms/beneficialuse.htm Maine DEP beneficial use

http://www.maine.gov/dep/blwq/docstand/fsdredg.htm Maine - Application to Dispose of Dredge Material in Coastal Waters

http://www.maine.gov/dep/blwq/docstand/fsdredg.htm

Issue Profile: Applications to Dredge or to Dispose of Dredged Material in Coastal Waters

http://www.maine.gov/dep/blwq/docstand/nrpapage.htm

Natural Resources Protection Act (NRPA)

http://mainegov-images.informe.org/dep/blwq/docstand/nrpa/nrpabook.pdf

Class SA waters http://maine.gov/dep/blwq/topic/vessel/SA/mapoverview.htm

Maine DEP Submerged Lands Program:

http://maine.gov/doc/parks/programs/sublands/index.html

http://mainegov-images.informe.org/doc/parks/programs/sublands/PDF/059c053.pdf

APPENDIX B

Useful Contacts

Agency Contacts

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APPENDIX C

CAD Case Studies

BOSTON HARBOR

The CAD cells in Boston Harbor may be the best known example of this disposal option. They have been rigorously studied since their creation. The Boston Harbor CAD cell project has been done in phases that allowed for changes to be made between the phases as more was understood about the sub-bottom and the capping processes. There are 9 cells in the project all located in the Mystic River in the federal navigation channel and near working piers and terminals. The original cell layout had more cells than the current nine. The cells were designed with various sizes and original depths were planned to be 20 ft below the channel. However, it was learned that the “Boston Blue” clay that made up the substrate was very stable when dredged and could tolerate much steeper slopes and deeper depths. Slopes of these cells are nearly vertical and depths in several cells went to 40 and 45 ft. One cell is 70 ft below the river bottom. These depths allowed for fewer cells to be created for the required capacity. Capping was originally done as the cells were at capacity. During the second phase more time elapsed between filling and capping to allow the dredged material to settle in the cell. Delay times from last deposition to first capping ranged from 30 to 52 days. The cells were capped with sand from the Cape Cod Canal. In total, roughly 785,000 cy of material were placed in the cells. These cells were created by and used by the USACE for material from the federal navigation channel and by marine terminal owners including MASSPORT and other operators (USACE 2001)

PROVIDENCE RIVER

Providence River is an interesting example of CAD cell creation and use. This project was started in 2003. The original plan was for the USACE to construct these cells solely for the use of navigational dredged material. However, they had calculated the cells’ required volume based on a bulking factor of 2. Bulking factors account for additional volume created by water during the dredging process. Because bulking did occur at the levels anticipated at the end of the maintenance dredging, there was enough extra capacity left to interest the state. The Rhode Island Coastal Resources Management Council (RICRMC) took over the permits from USACE, reimbursed them for the CAD cell capacity and now manages the use of the cells. There are six cells all located in the navigational channel near active terminals and piers. The substrate consisted mostly of glacial till consisting of gravel and sand with some pockets organic peat. They were constructed with side slopes of 1V to 1.5H and had depths of between 80 and 100 ft below the bottom of the channel. The state has used to cells for commercial, marina and residential dredging projects. RICRMC has a tiered fee system for use of the cells. Currently, marinas pay $11.65 per cy, commercial projects are charged $15 per cy and residential projects are charged $25 per cubic yard. These fees are expected to go up in 2008-2009 and are expected to be $15, $18 and $50 per cy for marinas, commercial and residential respectively. For the life of these cells, 5 years, none of them have been capped but when they reach capacity, it is the intention and as required in permits to cap them (RICRMC 2008).

NORWALK CONNECTICUT

These CAD cells were created and used by the USACE for maintenance dredging in Norwalk in 2006. The project consisted of two cells both in the northern terminus of a 10 ft deep navigation channel. The cells were dug to 50 and 35 ft below the channel with 1V to 1.5H side slopes. A total of 52,000 cy were removed to form the cells and 35,000 cy of dredged material were placed in the cells.

Both cells had 3 ft caps placed on them. The cost for dredging just the CAD cell was $20 a cy. Towards the end of the project, the Corps was approached by the city to see if additional material from three marinas could be placed in the cell. Because the cells had extra capacity and the material met disposal criteria they were allowed to deposit the material at a cost of $22 per cy. This cost included the cost of creating the cell and a $2 administration fee (USACE-NED 2008).

THAMES RIVER, CONNECTICUT

This CAD cell was created in 2006 by the US Navy for disposal of material from pier work being done at the Submarine Base in Groton. Currently there is a single cell but a second is in the planning stage for some additional maintenance dredging. The cell is located in the navigational channel; however, it is north of the Gold Star Bridge (I-95) where most vessel traffic occurs in the region. The channel is maintained at a depth of 40 ft and the cell was dug nearly 45 ft below the channel. The cell received roughly 154,000 cubic yards of dredged material. The cell was capped with material that was saved during excavation of the cell. Capping took place directly after filling activities had ended. Testing of the cap has shown that the capping was successful, but better results may have been realized if time had been allowed to pass before the cap was placed (TEC 2008).