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Multiuser Confined Disposal Sites Program Study

For

Washington Department of Ecology
Sediment Management Unit
Olympia, Washington

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DRAFT REPORT

MULTIUSER CONFINED DISPOSAL SITES PROGRAM STUDY

by

PTI Environmental Services

In association with

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For

Washington Department of Ecology
Sediment Management Unit
Olympia, Washington

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INTRODUCTION

The 1989 Puget Sound Water Quality Management Plan contains several requirements for the Contaminated Sediments and Dredging Program implemented by the Washington Department of Ecology (Ecology). One of these requirements, the Multiuser Confined Disposal Sites Program, is a study to evaluate the utility and viability of establishing a system of multiuser confined disposal sites for contaminated sediments dredged from Puget Sound. Results of the study will be used by Ecology as the basis for a recommendation to the Puget Sound Water Quality Authority (PSWQA) for the establishment of a multiuser site program.

Over the past several years regulatory agencies have established various criteria for determining the degree of contamination in sediments allowable for disposal at designated open-water unconfined disposal sites. These interim criteria have now been replaced by disposal guidelines developed by the Puget Sound Dredged Disposal Analysis (PSDDA) study (PSDDA 1988b). Disposal requirements for contaminated sediments not allowed for open-water unconfined disposal are currently being addressed.

Confined disposal involves the containment of dredged material so that migration of contaminants and effects on the environment and human health are minimized. Confined disposal standards are now under development to address the level of contamination above which the standards will apply; the required testing for determining application; and the design, operation, and closure/post-closure requirements of confined disposal sites.

Confined disposal will occur either in the upland environment similar to municipal sanitary landfills, in the nearshore environment, which generally involves the filling of intertidal or subtidal areas for the creation of usable land or intertidal habitat, or in the aquatic environment where confinement will occur in deeper waters.

Upland, nearshore, and confined aquatic disposal of dredged material generally occurs at sites established specifically for the project, especially for larger dredging projects. Although some existing sites in the Puget Sound basin receive dredged material for disposal from more than one dredging project, these sites are limited to municipal and demolition landfills and a small number of other upland sites.

The concept of multiuser sites involves the establishment of one or more sites that would be available for use by all dredgers on a long-term basis for the disposal of dredged material requiring confinement.

The objectives of the Multiuser Confined Disposal Sites Program Study being conducted by Ecology are to identify the issues; to make recommendations regarding the utility and viability of multiuser sites for the confined disposal of contaminated sediments in upland, nearshore, and aquatic areas; and to develop an action plan for implementing the recommendations. Initial efforts involved developing issue papers on the environmental, economic, and institutional aspects that need to be considered in adopting and implementing a multiuser confined disposal sites program and producing this draft report. Six issue papers were developed to support the conclusions and recommendations contained in this draft report. The issue papers, which can be obtained from Ecology, are:

- *Assessment of Needs*
- *Environmental and Public Health Issues*
- *Institutional Analysis and Options*
- *Cost Analysis*
- *Funding Analysis*
- *Issues Assessment and Public Involvement/Education Plan.*

This report presents the main findings of the issue papers and conclusions and recommendations on the utility and viability of establishing a multiuser site program. The report is organized into nine sections. In general, the sections correspond to the issue papers prepared as part of this study. Section 2 presents a brief history of contaminated sediments disposal and events that have led to the multiuser confined disposal sites program. Historical disposal practices, including volumes of dredged and contaminated material and disposal sites, are discussed. A projection of volumes by user group and potential sites over a 20-year planning period are presented to indicate the future requirements for multiuser sites. Section 3 presents the key environmental and public health issues associated with constructing and operating a multiuser site in an aquatic, nearshore, and upland environment. A discussion of costs and comparison of costs among alternative sites are presented in Section 4, and the funding alternatives are addressed in Section 5. The institutional options for siting, owning, operating, and regulating multiuser sites are presented in Section 6. Public involvement and education aspects of establishing a multiuser site program are presented in Section 7. The conclusions that can be drawn from this study regarding the utility and viability of a multiuser site program are presented in Section 8. Recommendations for proceeding with the program and issues requiring resolution by decisionmakers are discussed in the last section.

The information obtained while conducting this study will be used by Ecology in developing a recommendation to the PSWQA. A consensus building process is recommended in the next phase to provide an opportunity for affected groups and the general public to comment on the conclusions drawn in this study. The consensus building process recommended uses a group such as the Agency Forum for Sediment Issues with expanded representation from those entities or groups having a major involvement or potential involvement in dredging, transport, and disposal integrated with a broader-based consensus building involving government decisionmakers, user groups, special interest groups, and the general public.

ASSESSMENT OF NEEDS

This section includes a brief description of dredging needs in Puget Sound and a history of contaminated sediments issues; the results of a review of dredging and disposal of contaminated sediments for the 1985-1988 period; projected volumes of contaminated dredged material for the 20-year planning period 1989-2008, and a description of the three types of confined disposal sites that may be used for multiuser sites. The 1985-1988 review and the 20-year projection information is a summary from the *Assessment of Needs Issue Paper* (PTI 1989).

BRIEF HISTORY OF CONTAMINATED SEDIMENT DISPOSAL

The Puget Sound waterway provides a major transportation corridor for shipping goods and commodities. A system of navigable waterways is a critical part of the infrastructure for the development of this region and the state's economic base. Port activities and the region's active small boat activities require navigation channels to be of sufficient depth to allow free and safe movement. Particulates from soil erosion, storm water and other effluents enter Puget Sound and accumulate on the bottom as sediments, requiring dredging in order to maintain necessary depths for shipping.

Areas that need dredging include over 50 miles of navigation channels. In addition, the 34 port districts in the region with approximately 50 miles of port terminal ship berths and over 200 small boat harbors require regular maintenance dredging. In the next 20 years it is estimated that 35 million cubic yards of material will be dredged from the Puget Sound waterways. Of this amount, approximately 8 million cubic yards may require confined disposal.

The maintenance of navigation channels has been conducted without the benefit of an overall management plan. Dredging has been conducted by private developers, marina owners, industries, ports, and public agencies of the federal, state and local governments. The majority of dredging has been conducted by public agencies and the ports. In general, dredging has been conducted on a project-by-project basis with little coordination among dredgers with regard to the timing of dredging or the mutual need for disposal sites.

Individual property owners, such as ports and marina owners, have typically disposed of dredged material not suitable for open-water unconfined disposal on their own property if they had available space and used local sanitary landfills or nearshore or aquatic sites as space was available.

The pattern of case-by-case disposal has evolved in response to individual dredging needs. However, with growing environmental awareness, particularly of the impacts on water quality in the region, the Puget Sound Water Quality Management Plan has included a requirement for the study of a more comprehensive and coordinated confined disposal system for contaminated dredged material.

Safe disposal of dredged sediments in Puget Sound became an issue in the early 1980s with the convergence of several events regarding Puget Sound water quality. In 1984, two major disposal sites (one in Elliott Bay and one in Port Gardner) were closed due to public concern about contaminants and possible effects on marine organisms. At about the same time, research revealed contaminants in marine sediments and biological abnormalities such as liver tumors in bottomfish. Chemical contaminants entering the sound were not flushed out as previously believed but remained in bottom sediments.

Extensive media and political coverage led to several corrective measures, including giving broad water quality management power to PSWQA. The U.S. Environmental Protection Agency (EPA) established the Puget Sound Estuary Program to identify water and sediment quality problems and promote cleanup actions.

A related action was the PSDDA study, a multi-agency effort headed by the U.S. Army Corps of Engineers (Corps). The organization's objectives were to identify acceptable locations for open-water unconfined disposal of uncontaminated sediments, to develop adequate site management plans, and to define consistent and objective evaluation procedures for dredged material proposed for open-water unconfined disposal. Phase I of the study has been completed and resulted in the successful designation of open-water unconfined disposal sites in central Puget Sound. Phase II is in process and is addressing sites in northern and southern Puget Sound. Disposal requirements for dredged material found unsuitable for open-water unconfined disposal are now being addressed by Ecology. The multiuser sites program is part of this effort.

HISTORICAL CONFINED DISPOSAL

Information on existing sites, representative users, and volumes of dredged material during the 1985-1988 period is presented in this section. This time period was selected because of the availability of records and because the disposal of dredged material was being regulated by restrictions on open-water unconfined disposal. Detailed information on the approach and methods used to identify sites, users, and volumes is presented in the *Assessment of Needs Issue Paper* (PTI 1989).

Disposal Site Users and Volumes of Dredged Material

Disposal site users, can be categorized as follows:

- Corps
- Ports

- Marinas
- Boat repair facilities
- Local governments
- Industrial and commercial transportation
- U.S. Navy
- Log storage facilities
- Private citizens and developers.

The volume of dredged material disposed of in upland, nearshore, or confined aquatic sites; the volume of contaminated material; and the location of the projects is presented in Table 1 for each user category. Contaminated dredged material is defined as that material found unsuitable for open-water unconfined disposal.

Approximately 1.2 million cubic yards of dredged material was placed in confined disposal sites from 1985 to 1988. Forty percent (488,640 cubic yards) of that material was contaminated. The Corps is a significant generator of dredged material in the sound and placed in upland or nearshore sites 548,809 cubic yards of material, 53,904 cubic yards (11 percent) of which was designated as contaminated. Dredgers other than the Corps applied to dredge 664,856 cubic yards of material and dispose of it in upland, nearshore, or confined aquatic sites. Sixty-six percent (438,636 cubic yards) of this material failed open-water unconfined disposal guidelines in use at the time and was designated as contaminated.

The amount of contaminated material dredged for each user category expressed as a percent of the total amount of contaminated material dredged during the 1985-1988 time period is presented below.

Ports	46%
U.S. Navy	25%
Corps	11%
Commercial/Industrial Transportation	9%
Marinas	6%
Boat Repair Facilities	3%
Local Government	<1%
Log Storage Facilities	0%
Private Citizens and Developers	0%

Geographic Areas and Sites

Table 2 presents the type, status, and location of disposal sites used for material designated as contaminated and the amount of contaminated material for each user category for the 1985-1988 period. The information is presented for the north, central, and south geographic areas of the sound illustrated in Figure 1. The future capacity for disposal sites used during the review

TABLE 1. SUMMARY OF ALL MATERIAL DISPOSED OF IN UPLAND, NEARSHORE, AND CONFINED AQUATIC DISPOSAL SITES BY DREDGING LOCATION AND USER CATEGORY, 1985-1988 (cubic yards)

	Corps		Ports		Marinas		Boat Repair Facilities		Local Governments		Commercial and Industrial Transporation		Log Storage		U.S. Navy		Private Citizens and Developers		Total	
	T[a]	C[b,c]	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C
Swinomish					32,000		8,000												40,000	0
Bellingham																			0	0
Blaine																			0	0
Fidalgo/Anacortes	40,711	40,711	38,400	24,000	600		15,300	11,700			10,000								105,011	76,411
Lummi Bay																			0	0
San Juans																			0	0
Pt. Angeles			36,494	1,944							20,000								56,494	1,944
Pt. Townsend					4,600														4,600	0
Admiralty Inlet	30,466	0																	30,466	0
Whidbey Island															54,000	54,000			54,000	54,000
Hood Canal													25,000						25,000	0
Sinclair/Dyes Inlet			4,000												70,200	70,200			74,200	70,200
Pt. Gardner	464,439	0	32,000	32,000	11,100								400						507,939	32,000
Elliott Bay			125,300	125,300	19,765	4,920	1,120	1,120	3,452	3,452	32,075	28,300					8,000		189,712	163,092
Lake Washington	13,193	13,193																	13,193	13,193
Commencement Bay			42,000	42,000					100	100	15,600	15,600							57,700	57,700
Olympia/Budd Inlet					3,900	3,900											750		4,650	3,900
Tacoma Narrows					20,700	16,200													20,700	16,200
Shelton/Oakland Bay																			0	0
Pickering Pass																			0	0
Steilacoom										30,000									30,000	0
Total confined disposal	548,809	53,904	278,194	225,244	92,665	25,020	24,420	12,820	3,552	3,552	107,675	43,900	25,400	0	124,200	124,200	8,750	0	1,213,665	488,640
% user contaminated material[d]		10%		81%		27%		53%		100%		41%		0		100%		0		NA[e]
% of contaminated total[f]		11%		46%		6%		3%		<1%		9%		0		25%		0		40%

[a] T - Total.
[b] C - Contaminated.
[c] Contaminated material exceeded any one of the following: Puget Sound interim criteria, Four Mile Rock criteria, Port Gardner criteria, or PSDDA guidance.
[d] Percent of user category material contaminated.
[e] NA - Not applicable.
[f] User category material contaminated as percent of total contaminated for all user categories.

TABLE 2. DISPOSAL OF CONTAMINATED MATERIAL TO UPLAND, NEARSHORE, AND CONFINED AQUATIC DISPOSAL BY GEOGRAPHIC AREA AND USER CATEGORY, 1985-1988[a] (cubic yards)

Area	Status	Type	Location	Corps	Ports	Marinas	Boat Repair Facilities	Local Governments	Commercial and Industrial Transportation	Log Storage	U.S. Navy	Private Citizens and Developers	Total
Northern Puget Sound	Open	Landfill	Whidbey NAS[b]								54,000		54,000
	Open	Upland	Port of Anacortes[c]	40,711	24,000		11,700						76,411
			Port of Port Angeles[d]		1,944								1,944
Central Puget Sound	Closed	Landfill	Kent-Highlands			3,000							3,000
	Closed	Nearshore	Terminal 90-91		115,500								115,500
			Pier 2 - Tacoma		40,000								40,000
	Closed	Upland	Port of Tacoma		2,000								2,000
			Private fill						3,000				3,000
	Open	Landfill	Coal Creek[e]		33,000	720	1,120	3,452	16,800				55,092
			Cedar Hills[f]		2,200								2,200
			Olympic View[g]								70,200		70,200
			Hidden Valley[h]			15,000		100					15,100
	Open	Upland	Adjacent property		6,600				24,100				30,700
			Private fill			1,200							1,200
			King County farmland	13,193									13,193
Southern Puget Sound	Closed	Upland	Private fill			1,200							1,200
	Closed	Aquatic	Budd Inlet			3,900							3,900
TOTAL				53,964	225,244	25,020	12,820	3,552	43,900	0	124,200	0	488,640

[a] Contaminated material exceeded any one of the following: Puget Sound interim criteria, Four Mile Rock criteria, Port Gardner criteria, or PSDDA guidance.

[b] The Whidbey Island Naval Air Station (NAS) landfill capacity is dependent on its inclusion in the NAS Superfund site.

[c] The Port of Anacortes has an estimated 20,000-30,000 cubic yard capacity.

[d] The Port of Port Angeles has a log pond with a 110,000 cubic yard capacity and an airport fill area with limited capacity.

[e] The Coal Creek landfill has the capacity to remain open until 1992.

[f] The Cedar Hills landfill has the capacity to remain open until 2009.

[g] The Olympic View landfill currently is permitted until 1996, with possible future capacity until 2008.

[h] The Hidden Valley landfill has the capacity to remain open until 1991 or 1995.

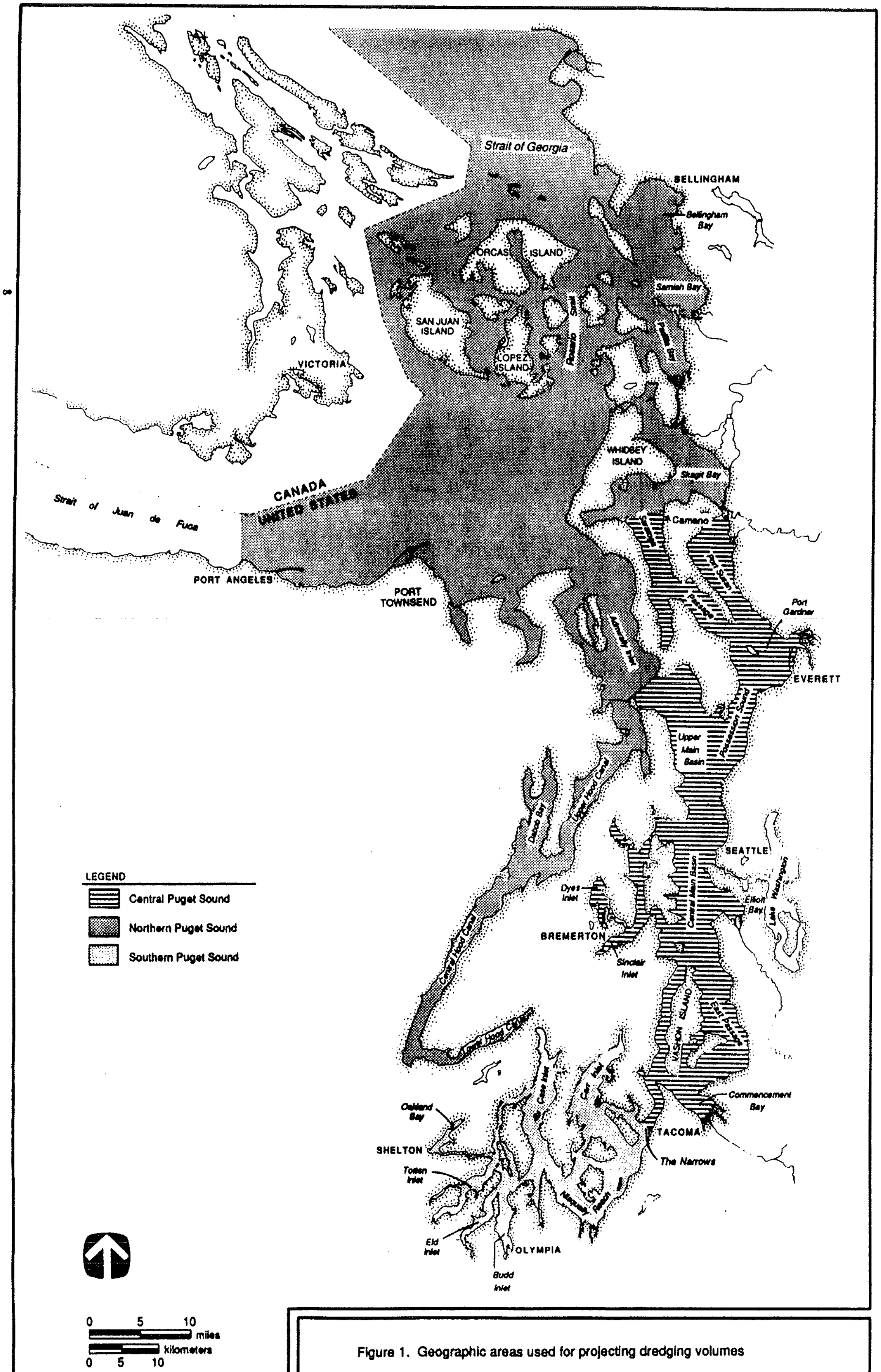


Figure 1. Geographic areas used for projecting dredging volumes

period, other than municipal landfills, is also presented in Table 2. Municipal landfills are currently used for disposal of contaminated sediments and represent a viable continuing disposal option. Forty percent of the dredged material exceeding open-water unconfined disposal criteria was placed in landfills during the 1985-1988 period. For landfills that have additional capacity, the capacity that would be available for contaminated sediments is not known, and only the anticipated life expectancy of the landfills is presented.

Following is a discussion of the disposal locations for contaminated material for each of the three major geographic areas in Puget Sound.

Northern Puget Sound—Contaminated dredged material placed in upland, nearshore, or confined aquatic disposal amounted to 132,415 cubic yards. Of this quantity, 24,000 cubic yards were designated as contaminated based on Port Gardner criteria, 54,415 cubic yards were designated as contaminated based on Puget Sound interim criteria, and 54,000 cubic yards were designated as contaminated based on PSDDA guidance. Only three sites in the northern Puget Sound accepted dredged material that exceeded interim criteria. The Port of Port Angeles, and the Naval Air Station on Whidbey Island placed contaminated dredged material on their respective properties. The Port of Anacortes used a site in the port area (the Scott Paper site).

Central Puget Sound—The central Puget Sound region had the most contaminated dredged material placed in upland, nearshore, or confined aquatic disposal (351,185 cubic yards). Of this quantity, 192,093 cubic yards of material exceeded interim criteria, 138,100 cubic yards exceeded Fourmile Rock criteria, and for 20,992 cubic yards the criteria exceeded was not determined. Numerous sites accepted contaminated material for disposal. Historical or one-time use sites include 1) Kent-Highlands landfill (King County), 2) Blair Waterway Slip 2 (Tacoma), 3) Terminal 90/91 short fill (Seattle), 4) Mud Lake (Tacoma), and 5) two unidentified sites.

Sites with future capacity include 1) Coal Creek (or Newcastle) landfill (King County), 2) Cedar Hills landfill (King County), 3) Olympic View landfill (Kitsap County), 4) Hidden Valley (or Thun Field) landfill (Pierce County), 5) Cathcart landfill (Snohomish County), and 6) several unidentified sites.

Southern Puget Sound—The southern Puget Sound region had two projects with a total of 5,100 cubic yards of contaminated dredged material placed in upland, nearshore, or confined aquatic disposal. All of this material was designated as contaminated based on interim criteria. The One Tree Island marina project dredged an aquatic pit, partially filled the pit with 3,900 cubic yards of contaminated dredged material from the project, and then covered the contaminated material with clean material. This site was for one-time, private use only. The Dorotich marina used 1,200 cubic yards of material as fill and subsequently covered it with an asphalt parking lot.

FUTURE REQUIREMENTS

This section presents the projected volumes of dredged material requiring confined disposal by user group, locations of potential sites, and a brief discussion of the effects of contaminant concentrations on confined disposal for the 20 year planning period 1989-2008. The volume projections are based on the assumption that all material not suitable for open-water unconfined disposal will require confined disposal.

Projected Future Volumes by User Group

The volumes of dredged material requiring confined disposal were projected for each user group by geographic area for the planning period 1989-2008. Two sets of projections, presented in Table 3, are based on calculations from URS (1989) and PSDDA (1988b, 1989) of the percentage of material estimated to fail criteria for open-water unconfined disposal. The two projections are treated as a range in the following discussions unless otherwise specified.

The total projected volume of material for Puget Sound is 7.2-10 million cubic yards. The volumes represent an average yearly disposal rate of 0.36-0.5 million cubic yards. Approximately 68 percent of the material would be generated from the Elliott Bay and vicinity dredging area in central Puget Sound. The remaining material is projected to be evenly distributed among the other two dredging areas of central Puget Sound (i.e., Commencement Bay and Port Gardner), northern Puget Sound, and southern Puget Sound.

For all of Puget Sound, the Corps, port, marina, and commercial/industrial transportation user categories represent the major users, with each user group projected to generate approximately 20-28 percent of the total volume. Results for each geographic dredging area are:

- **Northern Puget Sound**—Of the total volume of material for Puget Sound that may require confined disposal, 378,000-637,000 cubic yards (5-6 percent) are generated in this area. The U.S. Navy is the primary generator (24-58 percent of the contaminated material). The ports and the Corps generate 37 and 21 percent, respectively, of the material requiring confined disposal. The industrial/commercial transportation user category generates 8-21 percent of the contaminated material; marinas, 6-13 percent; boat repair facilities, 3-6 percent; and local governments, <1-2 percent.

- **Central Puget Sound, Port Gardner and vicinity**—Of the total volume of material for Puget Sound that may require confined disposal, 401,000-703,000 cubic yards (4-10 percent) are generated in this area. Commercial transportation (14-38 percent), marinas (9-25 percent), ports (7-22 percent) and perhaps the Corps (0-65 percent) are major generators. Boat repair facilities (4-11 percent) and local governments (1-3 percent) are other generators.

TABLE 3. PROJECTED VOLUMES FOR UPLAND, NEARSHORE, AND CONFINED AQUATIC DISPOSAL BY DREDGING AREA AND USER GROUP, 1989-2008 (1,000 cubic yards)

	Corps		Ports		Marinas		Boat Repair Facilities		Local Governmentss		Commercial and Industrial Transportation		U.S. Navy		Total	
	URS[a]	PSDDA[b]	URS	PSDDA	URS	PSDDA	URS	PSDDA	URS	PSDDA	URS	PSDDA	URS	PSDDA	URS	PSDDA
Northern Puget Sound																
1989-2000 (12 years)[c]	0	80	0	142												
2001-2008 (8 years)	0	53	0	94												
Subtotal	0	133	0	236	51	36	23	16	6	4	78	54	220	152	378	637
Central Puget Sound																
Port Gardner and vicinity[d]																
1989-2000 (12 years)	0	156	94	16												
2001-2008 (8 years)	0	104	62	11												
Subtotal	0	260	156	27	177	37	79	16	22	5	269	56	0	0	703	401
Elliott Bay and vicinity																
1989-2000 (12 years)	612	832	555	821												
2001-2008 (8 years)	408	555	370	547												
Subtotal	1,020	1,387	925	1,368	953	1,296	424	576	118	160	1,447	1,969	e	e	4,887	6,756
Commencement Bay and vicinity																
1989-2000 (12 years)	161	527	60	202												
2001-2008 (8 years)	108	352	40	135												
Subtotal	269	879	100	337	0	46	0	20	0	6	0	69	0	0	369	1,357
Southern Puget Sound																
1989-2000 (12 years)	250	205	113	92												
2001-2008 (8 years)	167	137	75	62												
Subtotal	417	342	188	154	82	108	36	48	10	13	124	165	0	0	857	830
TOTAL	1,706	3,001	1,369	2,122	1,263	1,523	562	676	156	188	1,918	2,313	220	152	7,194	9,987

[a] URS - Calculated from *Standards Development for Confined Disposal of Contaminated Sediment Review of Information.* Draft Final Report. February 1989.
[b] PSDDA - Calculated from:

Final Environmental Impact Statement - Unconfined Open-Water Disposal Sites for Dredged Material - Phase I. June 1988.
Evaluation Procedures Technical Appendix - Phase I. June 1988.
Draft Environmental Impact Statement - Unconfined Open-Water Disposal for Dredged Materials - Phase II. March 1989.

[c] Lummi Bay marina not included.
[d] U.S. Navy homeport not included.
[e] U.S. Navy dredging estimates for Sinclair Inlet not included.

- **Central Puget Sound, Elliott Bay and vicinity**—Of the total volume of material for Puget Sound that may require confined disposal, 4,887,000-6,756,000 cubic yards (67-68 percent) are generated in this area. Based on the PSDDA projections, distribution of contribution by user category is the Corps (21 percent), ports (21 percent), marinas (19 percent), boat repair facilities (9 percent), commercial/industrial transportation (29 percent), and local governments (2 percent). Dredging activity in Sinclair Inlet performed by the U.S. Navy is not included in the projections. The U.S. Navy conducts dredging for construction projects only and does not conduct routine maintenance dredging. One project (160,000 cubic yards) that may involve contaminated sediments is in the planning stages.

- **Central Puget Sound, Commencement Bay and vicinity**—Of the total volume of material for Puget Sound that may require confined disposal, 369,000-1,357,000 cubic yards (5-14 percent) are generated in this area. The primary user categories are the Corps (65-73 percent) and the ports (25-27 percent). Marinas (0-3 percent), boat repair facilities (0-1 percent), local governments (0-<1 percent), and commercial/industrial transportation (0-5 percent) are other smaller generators.

- **Southern Puget Sound**—Of the total volume of material that may require confined disposal, 830,000-857,000 cubic yards (8-12 percent) are generated in this area. Based on the PSDDA projections, the major generators are the Corps (41 percent), industrial/commercial transportation (20 percent), ports (19 percent), and marinas (13 percent). Small generators are boat repair facilities (6 percent), and local governments (2 percent).

Potential Disposal Site Locations

Seven potential disposal sites have been identified with a total estimated capacity of 910,000-1,060,000 cubic yards. This estimate does not include planned municipal or demolition landfills or the capacity of three nearshore sites—the Port of Seattle Terminal 90/91 short fill and two additional Port of Seattle sites in the Elliott Bay area. The individual capacity of each of the four individual sites, which are all nearshore sites, ranges from approximately 110,000 to 350,000 cubic yards.

The ports that identified potential sites were Seattle, Port Angeles, Everett, and Bellingham. The ports of Olympia, Anacortes, Shelton, Port Townsend, and Tacoma have not identified any potential disposal sites. Although several sites located in Commencement Bay were identified in the literature, these sites are no longer under consideration for use as disposal sites by the Port of Tacoma. The upland sites are being considered for prime development, and the nearshore sites have been designated for alternative uses. Several sites in Commencement Bay could be used for disposal of Superfund site materials in the event of remedial actions.

Range of Contaminants

Dredged material to be placed in upland, nearshore, or confined aquatic sites may range in contamination from clean material to be placed in nearshore and upland sites for a beneficial use or for economic considerations, to material that fails open-water unconfined disposal criteria, and finally to material classified as dangerous waste. The confined disposal standards now under development may set a contaminant level above which the standards apply. If this level is above the PSDDA guidance for open-water unconfined disposal, the volume projections for material requiring confined disposal will be reduced.

Ranges of contaminant concentrations are relevant to the continued use of existing sites for contaminated dredged material. For example, King County allows material in its demolition landfills only up to 10 percent of the contamination level of dangerous waste. King County is applying this requirement as an interim measure until confined disposal standards are developed by Ecology.

Ranges and types of contaminants may also be relevant to the design of disposal sites. For example, if an area had sediments contaminated with only metals or polycyclic aromatic hydrocarbons, site design might be specific to these contaminants. The standards for confined disposal now under development by Ecology will determine the relevance of range and type of contamination on disposal site design.

GENERIC SITE DESCRIPTIONS

Aquatic, nearshore, and upland multiuser sites were evaluated in this study based on environmental and economic considerations. A description of these three types of sites is provided below and the sites are illustrated schematically in Figure 2.

Confined Aquatic Disposal

Confined aquatic sites are disposal facilities located in the subaqueous environment. In this alternative, contaminated sediments would be dredged from multiple locations and transported by barge for confined disposal at a different aquatic location. The disposal site would be of sufficient size to accommodate the material dredged from many projects. The disposal site would remain active for approximately 20 years. The contaminated dredged material would be discharged using a bottom drop barge in an excavated disposal facility, naturally occurring depression, or in a mound. The discharge of sediments would occur during slack tides. Other methods could be used to reduce dispersion, such as use of a diffuser or silt curtain.

Upon completion of an individual project or group of projects occurring within a limited timeframe (e.g., 1-2 months), the dredged sediments would be capped with clean material. The cap material would be obtained through dredging nearby clean sediments or through importing clean

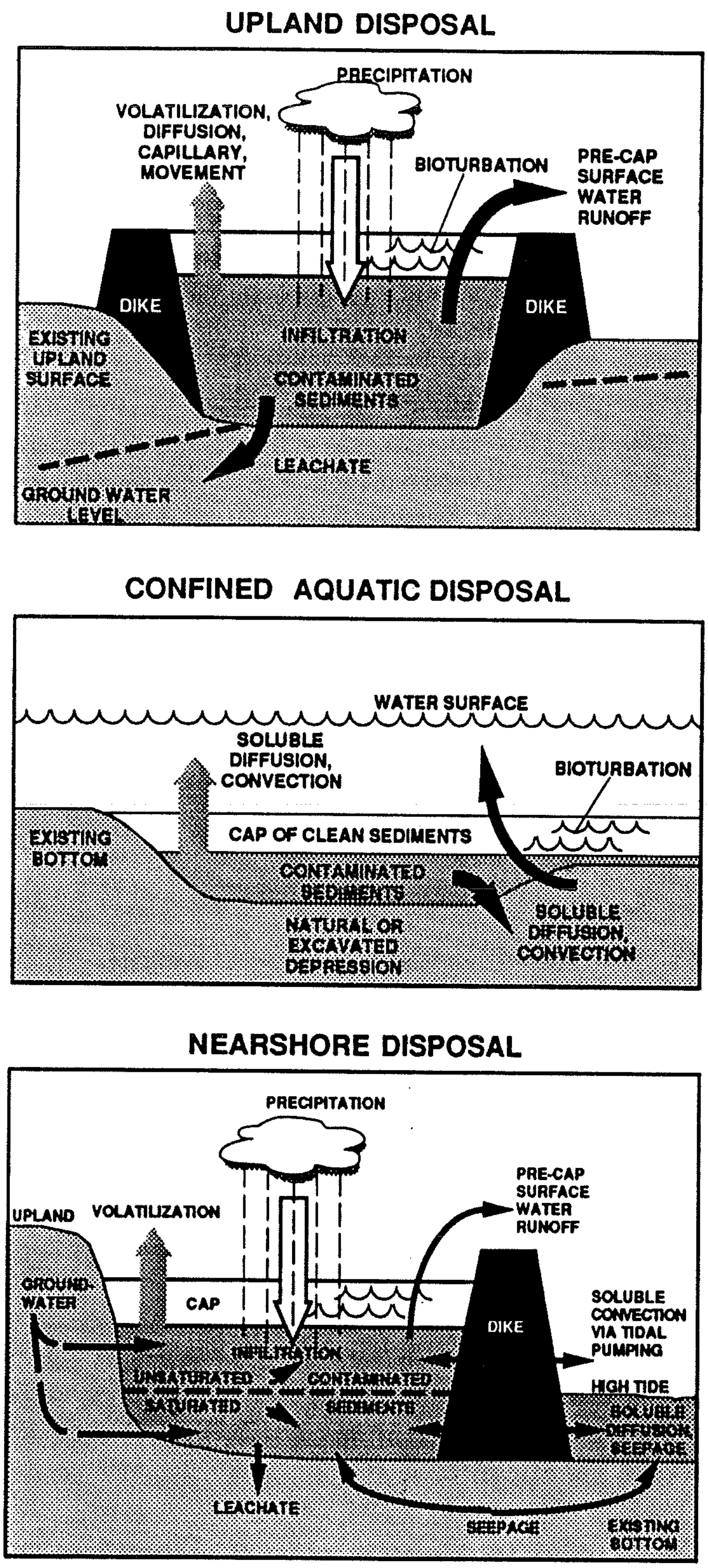


Figure 2. Upland, confined aquatic, and nearshore disposal sites

material from upland sources. For the cap material that is dredged, it is assumed that both hydraulic and clamshell technologies would be used on a project by project basis. Placement of a cap would minimize exposure of the surrounding biota to the contaminated sediments and the potential for contaminant migration.

Nearshore Disposal

Nearshore disposal sites are confined disposal facilities located adjacent to land and within the area influenced by normal tidal fluctuations. A site may contain a cluster of cells, each surrounded by dikes. Typically, dredged material is added to the cells using a drop barge and a silt curtain until the final elevation is above the high tide elevation. When the material is initially placed in the site, it is saturated. After the site is filled, the dredged material above high tide will dewater and dry, the material below high tide will remain saturated, and the intermediate layer will be alternately unsaturated and saturated as the tide ebbs and floods. Nearshore sites are typically finished to grade to allow a beneficial use of the site after completion. Dredged material can be placed in the saturated area only or in both the saturated and unsaturated areas.

Upland Disposal

Upland disposal sites are located in an environment that is not influenced by tidal waters. Fresh surface waters could be an issue, however, at an upland site. An upland disposal site would be diked to confine the dredged material and capped at the completion of the fill. The site would likely be developed in stages or cells, and would be filled and closed serially over the 20-year life of the facility. The design standards would probably be comparable to the minimum functional standards for sanitary landfills (Chapter 173-304 WAC), and would include liners, monitoring for the detection of liquids (leachate) seeping into underlying soils, groundwater monitoring, and collection and treatment of leachate. No separate dewatering facility would be required; the excess water would be handled by the leachate collection system and would be either fully treated prior to direct discharge or pretreated prior to disposal in a secondary treatment plant system.

ENVIRONMENTAL AND PUBLIC HEALTH ISSUES

The environmental and public health issues associated with constructing and operating multiuser confined disposal sites are identified for each of the three alternative site environments (aquatic, nearshore, upland). The issues associated with dredging and transport which affect all of the alternative sites are addressed. The purpose of this assessment is to identify the environmental and public health issues for each site environment, compare the environmental and public health effects among sites, and to identify potential mitigation measures that could effectively reduce or prevent impacts. This section summarizes the information presented in the *Environmental and Public Health Issues Paper* (GBB 1989b).

The environmental and public health issues associated with the disposal of contaminated sediments at multiuser sites are, in general, similar to the issues for sites established on a project by project basis. The key difference for a multiuser site program is that operating larger sites over a long period (e.g., 20 years) minimizes the number of areas disrupted by site construction and operation. On the other hand, the potential impacts on areas where multiuser sites are located could be greater in magnitude than at single project sites. The three types of multiuser sites are treated as generic sites in this report.

GENERAL CONSIDERATIONS THAT INFLUENCE THE RELEASE OF CONTAMINANTS

Five factors and their interaction influence the mobility or immobility of contaminants in the dredging and disposal of material. These factors are 1) physical and chemical properties of the dredged material, 2) level and type of contaminants, 3) conditions at the proposed disposal site, 4) dredging, transport, and disposal activities, and 5) the mitigation methods used to control the contaminant losses.

Characteristics of Dredged Material

Much of the material removed during harbor and channel maintenance dredging in Puget Sound is fine-grained with relatively high clay and organic content. Dredged material may contain significant concentrations of chemicals of concern if located in areas of historical or current discharge of contaminants. Often material to be dredged is devoid of oxygen (i.e. anoxic) and near neutral in pH (a measure of the degree to which the sediment is acidic or basic). Anoxic conditions favor immobilization of many metals. The degree to which contaminants are bound to sediments also depends on the organic matter in and texture of the sediments. Coarse-grained sediments low in organic matter will not bind contaminants as tightly as fine-grained high clay and organic content sediments.

Contaminants

The type of contaminants and their concentration in the dredged sediments affect the potential for release. Chemicals of concern in Puget Sound sediments can be classified as metals or organic compounds, and generally have the following characteristics when present at significant levels.

- A demonstrated or suspected effect on ecology or human health (i.e., the focus of chemical concerns is ultimately unacceptable adverse biological effects)
- A potential for remaining toxic for a long time in the environment (persistence)
- A potential to enter the food web (bioaccumulate).

All other factors being equal, higher concentrations of chemicals in the sediments represent a greater potential for release and a greater potential impact if release occurs.

Metals will often go into solution and become mobile when oxygen is present. When sediments containing metals are removed from the typical no oxygen (anoxic) environment on the sound bottom to an upland site, and become dry and exposed to oxygen, metals will be released when the sediments are exposed to water, i.e., rainfall. Organic compounds have a greater mobility potential where a greater exchange of water occurs within the sediment. It has been suggested (PSDDA 1986) that due to these characteristics, sediments contaminated with metals be disposed of in water or in a site that remains saturated and that sediments contaminated with organic compounds be disposed of above water. However, in general, contaminated sediments in Puget Sound contain both metals and organic compounds.

Disposal Site Conditions

The behavior of contaminants in sediments is influenced by the conditions at the disposal site. Release or loss of contaminants from the sediments is more unlikely when the sediments remain saturated and in a low oxygen (anoxic) condition and neutral in pH. At a confined aquatic site, the contaminants in the sediments would remain close to the *in situ* saturated anoxic, neutral pH conditions. In contrast, sediments that are moved from a saturated anoxic, to an unsaturated, toxic environment, as in the cases of upland and possibly nearshore sites, the contaminants, particularly metals, could be released to the environment. In addition, pH may drop when the sediments dry, favoring the release of some contaminants. In general, leaving, or disposing of, contaminated sediments in a chemical environment as close as possible to their *in situ* state favors contaminant retention (especially metals).

Dredging, Transport, and Disposal Activities

Release and loss of contaminants can occur during dredging, transport, and disposal of contaminated sediments. Potential for release depends on the type of equipment used, e.g., hydraulic or clam shell dredge. Losses can occur in the short-term (i.e., during dredging and disposal) and in the long-term (i.e., after disposal). Net contaminant loss from each phase must be evaluated with respect to their potential impacts and necessary mitigation. Losses of contaminants bound to particulates (solids), contaminants in water (soluble contaminants), and contaminants that escape into the air (volatile contaminants) can occur. The potential impacts of the contaminant losses will be very site-specific and depend on the type and level of contaminants lost, the form in which they are lost (i.e., solid, liquid, gas), the magnitude of the loss, and the surrounding environment and receptors.

Mitigation Measures

Mitigation measures can be implemented to prevent or minimize impacts, although some release of contaminants may be technically unavoidable. Siting is a key mitigation measure because sites should be located in areas where critical habitat is not destroyed by site construction and disposal operations, where the potential for contaminant release is minimized, and where the impact of possible contaminant release on environmental resources and human health is minimized. Additional mitigation measures include selection of dredging, transport and disposal methods and equipment; application of technology to contain the dredged material, such as the use of liners and leachate collection and treatment at upland sites; operations procedures, such as controlling the timing of dredging and disposal; and regulatory requirements such as monitoring. Mitigation measures can be applied during dredging, transport, and disposal operations, and during the site closure and post-closure periods.

AFFECTED RECEPTORS AND RESOURCES

Natural resources and human populations that could be affected by the dredging, transport, and disposal of contaminated sediments are listed by site environment in Table 4. Each receptor or resource is described briefly below.

- **Marine biota** are the plants and animals that live in and depend on the marine environment. Marine biota include benthic biota (e.g., invertebrates, shellfish, and bottomfish that live in or on the bottom sediments), water column biota (e.g., plankton and fishes), attached marine plants (e.g., eelgrass and kelp), and marine birds and mammals.

- **Upland biota** are the plants and animals that live in and depend on the upland environment. Upland biota include a wide range of plants from grasses, shrubs, and trees, and a wide range of animals from insects to large animals such as deer. Upland biota also include those plants and animals that live in freshwater lakes, rivers, and streams.

- **Nearshore biota** generally are a mixture of marine biota and upland biota.

TABLE 4. POTENTIALLY AFFECTED RECEPTORS AND RESOURCES

Receptor/Resource	Dredging	Transport	Confined Aquatic Disposal	Nearshore Disposal	Upland Disposal
Marine biota	X	X	X		
Upland biota		X			X
Nearshore biota	X	X		X	
Human populations	X	X	X	X	X
Habitat	X		X	X	X
Surface water	X	X	X	X	X
Groundwater					X

- **Human populations** that could be affected include workers on the dredge, tug, or barge; people who consume contaminated fish and shellfish; workers at the disposal site; and nearby residents.
- **Habitat** is the physical environment in which marine and upland biota live.
- **Surface water** includes marine and fresh waters. Surface waters serve as a habitat for plants and animals and also as a resource for recreation, water supply, and other uses.
- **Groundwater** is a major source of drinking water and also serves as a possible pathway of contaminants to surface waters.

SPECIFIC IMPACTS AND MITIGATION

The potential impacts and available mitigation measures for dredging and transport and for disposal at each of the three types of sites are discussed below. Figures 2 and 3 illustrate schematically the potential impacts associated with dredging and aquatic disposal operations and the three types of sites respectively.

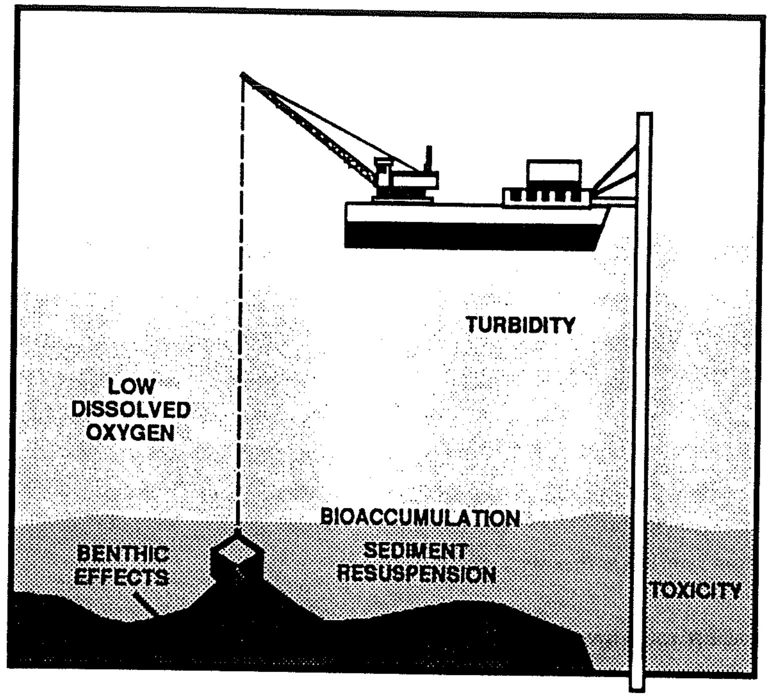
Dredging and Transport

Contaminants within the sediments can be released to the environment during dredging and transport activities. With the exception of the additional mode of truck transport associated with upland sites, the potential environmental and public health impacts that occur during dredging and transport would be similar regardless of the type of disposal site selected.

The principal impact of dredging is the loss or disruption of benthos and habitat in the dredge area. Other potential impacts of dredging are the exposure of benthic biota to contaminated sediments that may escape and settle on the floor of Puget Sound, short-term exposure of water column biota to released contaminants, and an increase in toxic contamination in the sea surface microlayer due to released contaminants. The dredging method (hydraulic or mechanical dredge) can influence contaminant losses at both the dredging and disposal sites.

The transport of dredged material could result in leakage and loss of contaminated sediments. The environmental issues associated with transport are similar to those of dredging. Potential additional impacts are volatilization, or escape of contaminants to the air, which can occur during barge or truck transport. Barge workers and nearby animals could inhale the toxic contaminants. In transporting dredged material from a shoreline transfer point to an upland disposal facility, soluble and particulate contaminants could leak from trucks onto roadways and result in the exposure of upland biota to toxic contaminants or could affect surface waters.

DREDGING IMPACTS



AQUATIC DISCHARGE IMPACTS

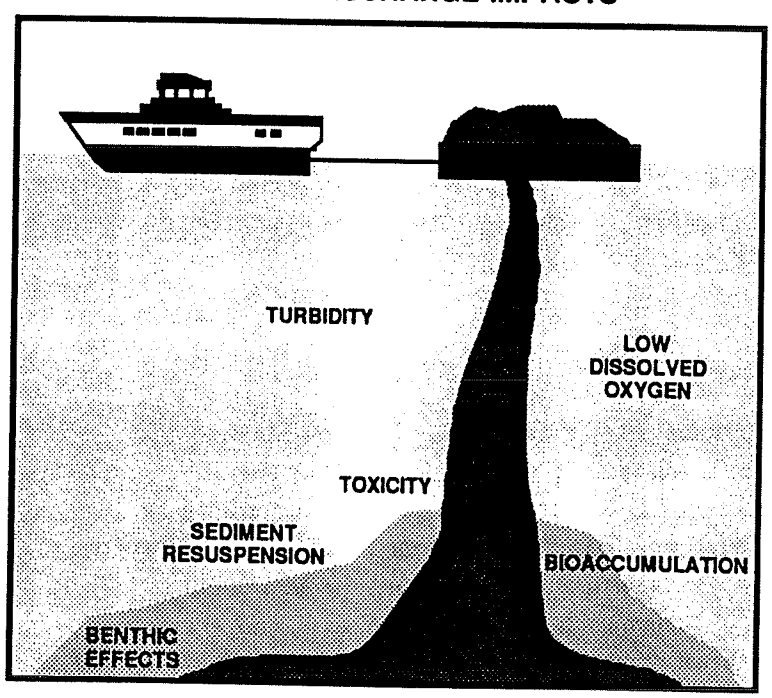


Figure 3. Dredging and aquatic discharge

The mitigation measures available include selection of the dredging method to be used in consideration of the type of material to be dredged, the nature of the contamination, and the disposal location; use of silt curtains to contain released particulates; monitoring to determine effects; and leakage containment (e.g., sealed trucks).

Confined Aquatic Disposal

At a confined aquatic disposal site, contaminated sediments are dredged from multiple locations within Puget Sound and transported by barge for disposal at a different aquatic location. The key impact associated with the construction and operations of an aquatic site is the burial and smothering of benthic biota during discharge of the dredged material and any needed site excavation and dike construction. Additional potential impacts are 1) effects on water column biota and esthetics from turbidity, 2) exposure of benthic and water column biota to toxic contaminants and bioaccumulation of toxics in the food chain, and 3) exposure of humans to contaminated fish and shellfish through consumption.

Two key mitigation measures that could be implemented to minimize impacts at aquatic sites are capping the site and application siting criteria. The placement of a cap of clean material over the dredged material upon completion of an individual project or group of projects (i.e., serial capping) isolates the contaminants from the environment and slows the migration of contaminants. Disposal site selection is critical. Although other impacts can be mitigated through technology or operations, the impact of burying benthic biota can be mitigated only by locating sites in non-critical habitat areas. However, benthic biota are expected to repopulate the site after placement of the cap. Siting is also important in minimizing construction requirements, the loss of contaminants during disposal and prior to and after capping, and in maintaining cap integrity. The impacts of contaminants that may be released and move offsite even after mitigation measures are implemented can be monitored. Changes to the disposal requirements can be made if monitoring results indicate a problem.

Nearshore Disposal

At a nearshore disposal site, contaminated sediments are dredged from multiple locations and transported by barge for disposal at a facility located on the shoreline. Nearshore disposal sites are confined disposal facilities located adjacent to land and within the area influenced by normal tidal fluctuations. The most significant impact of developing a nearshore site would be the destruction of marine and intertidal habitat. Other impacts could include 1) exposure of marine and intertidal species to contaminants that may be released, and 2) exposure of humans to chemicals of concern through direct contact, inhalation of organic vapors or windblown dust, and human consumption of contaminated fish and shellfish.

Environmental and public health impacts can be mitigated through various methods. The siting process can be instrumental in preventing the removal of habitat by selecting a site with no critical habitat. Habitat loss can also be mitigated by creating replacement habitat in another shoreline area. Detention ponds, infiltration basins, and runon and runoff controls can minimize soil erosion and turbidity in marine waters from suspended solids. Interim cover of the diked cells can be used to control the escape of contaminants to the air and release of contaminants to surface water runoff. Placing a final cap onsite minimizes toxicity to land-based biota through biological uptake and creates the potential for beneficial use of the site. Monitoring for contaminant losses through operations and post-closure can be required to determine impacts and a contingency plan can be implemented in the event a problem is detected.

Upland Disposal

At an upland disposal site, contaminated sediments are dredged from multiple locations and transported by barge to an off-loading facility, where the material is transferred to trucks and hauled to an upland facility. Upland disposal involves the placement of dredged material in an environmental that is not affected by tidal waters, although a site could be influenced by surface waters. The major consideration in developing an upland disposal site would be the protection of groundwater resources and potable water supplies. Other impacts of developing an upland site could include 1) effects of soil erosion and runoff on water quality, water column biota, and fisheries resources in any nearby surface waters, 2) exposure of plants to contaminated sediments and bioaccumulation in the food chain, 3) removal of vegetation and habitat, and 4) human exposure to chemicals of concern through direct contact, inhalation of organic vapors or windblown dust, and drinking contaminated groundwater.

Similar to confined aquatic and nearshore disposal, site selection is a critical mitigation measure. The impact of removing habitat can only be mitigated by locating sites in areas that contain no critical or sensitive habitats. The siting process is also important in protecting groundwater and surface water resources. Design requirements of the disposal facility are also important in preventing impacts. Design requirements can incorporate a double liner system, a leachate collection and treatment system, and stormwater runon and runoff controls. Interim cover consisting of clean material can be placed upon completion of each dredging project to minimize the time the contaminated sediments are exposed to the actions of wind and precipitation. A final cover could be placed once a cell reaches capacity. A monitoring program could be designed to track the effects of any contaminant losses both during operations and the post-closure period. Changes to the disposal operations can be made if the monitoring indicates any negative results. A contingency plan could be developed and implemented to correct any adverse effects that are detected through monitoring in the event of design or structural failure during the post-closure period.

COMPARISON OF ENVIRONMENTAL AND PUBLIC HEALTH ISSUES AMONG ALTERNATIVE SITES

The environmental and public health issues associated with disposal of contaminated sediments differ among the three types of disposal sites. The major differences pertain to receptors in the vicinity of the site, the number of pathways, mitigation measures, and the degree of potential of contaminant release. Aquatic sites have the fewest number of pathways and receptors to affect and the lowest potential for release of contaminants. However, aquatic sites are more difficult to monitor and have limited mitigation options and remedial alternatives in the event of failure. Upland sites have the highest number of pathways for release, but have the most mitigation options and remedial alternatives in the event of failure. The siting process for upland disposal can be very effective in avoiding habitats of concern, and surface water and groundwater. Nearshore sites have the most active water exchange due to tidal activity and fall between aquatic and upland sites with respected to pathways, receptors, and mitigation. Sensitive habitat areas are more difficult to avoid and, therefore the impact of habitat loss can be more significant than for either aquatic or upland sites.

COST ANALYSIS

Life cycle system costs were estimated for four types of disposal sites: aquatic, nearshore saturated, nearshore unsaturated, and upland. Nearshore saturated refers to contaminated sediments placed in the saturated (wet) zone only. Nearshore unsaturated involves placement in both the saturated and unsaturated zones. Since confined disposal standards have not been fully developed, the cost estimates are based on the best judgment of Ecology and the contractor developing the standards as to what the standards might require, and on existing data on the design, construction, and operating costs. The results of this analysis provide planning level costs and allow for comparison of the economics of disposal alternatives. The assumptions, cost framework, results, and sensitivity to key variables are presented in this report. The *Cost Analysis Issue Paper* (GBB 1989a) provides a discussion of the methodology used in the analysis, more detail on the assumptions, and the supporting documentation of the results.

COST ANALYSIS FRAMEWORK

Costs were organized by the key activities associated with disposal of contaminated sediments. These activities are:

- **Siting and construction** (costs associated with establishment of the disposal site):
  - Site surveys and selection
  - Permitting
  - Site preparation
  - Construction
  - Installation of monitoring wells
  - Collection of baseline monitoring data
  - Initial design, administration, and engineering
- **Operation** (costs relating to disposal of the contaminated sediments and operation of the disposal site):
  - Testing sediments to be dredged
  - Dredging and transport of sediments
  - Disposal at the multiuser site
  - Monitoring of disposal sites during the active life of the facility

- Operation and maintenance, and administration
- Providing daily or intermediate cover after dumping operations

■ **Closure** (costs associated with closure of the entire site or individual cells within the site):

- Capping of the entire site or individual cells
- Revegetation and drainage for upland and nearshore sites as appropriate

■ **Post-closure:**

- Monitoring after facility closure
- Site maintenance (excludes costs of post-closure failure and remediation actions).

ASSUMPTIONS

Key assumptions relating to the definition of typical sites, pre-dredging sampling, dredging, transport and disposal, indirect costs and financial parameters are presented in this section. The design and operating procedures assumed for each type of facility are also addressed.

Financial Parameters

All results are presented in 1989 constant dollars (i.e., inflation not taken into account). Annual costs were estimated for the 30-year study period, assuming a 20-year operating life and 10-year post-closure period. The costs were discounted to present values assuming a discount (interest) rate of 7 percent.

Design Parameters

The design parameters of the disposal facility affect the facility size and requirements for structural improvements. Each of the four types of disposal facility was sized to accommodate 1.25 million cubic yards of contaminated sediments. This assumption allows for an economic comparison of alternative sites. Assumptions about the design of each type of disposal facility are described in the following scenarios.

Confined Aquatic Disposal—The typical aquatic site is assumed to be a natural depression at a depth of no more than 200 feet in Puget Sound located, on average, 10 miles from the dredging site. To hold 1.25 million cubic yards, the site would cover approximately 45 acres. No initial construction is anticipated such as a dike or underwater excavation. Leasing costs of the site are not included.

The operation of the disposal site is straightforward, with sediments deposited in mounds using a bottom-drop barge. Deposited sediments are capped after each project or group of projects occurring within the same time frame (1-2 months). Dumping will occur only during slack tides, but no other special procedures to reduce dispersion, such as the use of a silt curtain or diffuser, are assumed. The average depth of the sediment mound before capping is assumed to be 20 feet.

Cap material, with a minimum depth of 3 feet placed over the sediments, is to be obtained through dredging nearby clean sediments and through importing clean material from upland sources. For the cap material that is dredged, it is assumed that both hydraulic and clamshell technologies will be employed on a project by project basis over the 20-year period. It is assumed that for each cubic yard of contaminated sediments disposed of, 3.5 cubic yards of cap material is needed.

Chemical, physical, and biological monitoring of the disposal site will occur throughout the active life of the project and for 10 years after final closure. The testing regime will be focused on the most recent sediment deposits with every new mound tested in Years 1, 2, 3, 5, 7, and 10 after capping.

Nearshore Saturated Disposal—A typical nearshore saturated site is located in an intertidal zone nearby high volume dredging areas. The site consists of a series of diked cells, filled to the high water level with contaminated sediments and then filled to the desired grade with clean material covering the contaminants to provide for future use of the site.

Cells are constructed every 2 years with the capacity to contain 125,000 cubic yards of sediments at a depth of 30 feet in a saturated condition. Over the life of the site, 10 cells are constructed in a 2 × 5 matrix of dikes. It is assumed that 15 feet of clean material is required for capping and bringing the site to grade. No liner is to be installed. Total acreage of the site is approximately 56 acres. It is assumed that shoreline and upland acreage (approximately 30 percent of the total site) is purchased at $435,000 per acre (PSDDA 1988a) and that subtidal acreage is available at no cost.

Sediments will be deposited in the cells using a drop barge and a silt curtain to reduce loss of contaminants. Once in the cell, a drag line with a bucket is assumed for material movement within the site.

No chemical or other treatment of the sediments or water is assumed. Chemical and biological monitoring of each cell will be conducted. Capping materials are assumed to be obtained through dredging using both hydraulic and clamshell methods and by importing clean fill from upland sources.

Habitat mitigation, replacing all destroyed habitat and shoreline, is assumed to be required. Costs for this activity can be significant and are highly site specific. The cost factor used in this analysis, $1,000 linear foot of shoreline, represents the approximate market value of shoreline and is a proxy for this requirement (PSDDA 1988a).

Nearshore Unsaturated Disposal—The design and operation of a nearshore unsaturated site is similar to that of the saturated facility with several major differences. Most important, the contaminated sediments are placed in both the saturated and unsaturated zones of the diked cell. This modification means that, because more contaminated sediments are placed in each cell, fewer cells need to be constructed, reducing overall cost. In addition less clean fill capping material is required to prepare the site for future use. However, operating expenses will rise as intermediate cover is required after each project once the contaminated sediments are placed above the mean high high water level.

Upland Disposal—The typical upland site is assumed to be approximately 50 acres located with an estimated average transportation distance of 50 miles. The site is to be constructed to meet the state's minimum functional standards for sanitary landfills with leachate collection and treatment, bottom liner, capping, and groundwater monitoring. Land costs are assumed to be $25,000 per acre (Tetra Tech 1988).

The operation of this facility is less complicated than a standard landfill. Dredged material is placed into cells 20 feet deep that are closed with a 2-foot cap after 2 years of operation, or the disposal of 125,000 cubic yards of dredged material. Six inches of intermediate cover will be required at the end of each project or group of projects occurring in a given year. Half the cap material is assumed to be available from site excavation with the remainder imported at $4.00 per cubic yard (U.S. COE 1986).

Full onsite treatment of the leachate is assumed with all facilities for discharge to a receiving water installed during site construction. The leachate treatment system is sized to process a maximum of 20,000 gallons per day. Final cover activities are expected to be minor, with most of this work completed as cells are closed and capped during normal operations. Gas management and monitoring systems are not needed.

A monitoring program using four wells located on the site perimeter with testing every year is assumed during the active life of the facility. During the post-closure period, tests are to be conducted in Years 1, 2, 3, 5, 7, and 10.

COMPARISON OF COSTS AMONG ALTERNATIVE SITES

Planning level cost estimates are presented in Table 5. The ranking of sites is similar for both variables, life cycle costs and disposal costs. The analysis indicates that disposal at a nearshore saturated site would be the most expensive option with life cycle costs of $45.7 million and disposal costs of $37/cubic yard. At the other end of the cost spectrum is confined aquatic disposal, with life cycle costs of $17.2 million and disposal costs of $14/cubic yard. An upland site is estimated to have the second highest cost with a $38.7 million life cycle cost and $31/cubic yard for disposal.

TABLE 5. DISPOSAL SITE COST ESTIMATES (1989 DOLLARS)

Site	Life Cycle Costs ($ million)	Disposal Costs ($/cubic yard)
Confined aquatic	17.2	14
Nearshore unsaturated	34.0	27
Nearshore saturated	45.7	37
Upland	38.7	31

A nearshore unsaturated site is estimated to cost $34.0 million over the life of the project and $27/cubic yard for disposal.

The results of this analysis suggest that disposal will be significantly more expensive than that projected by the recent studies conducted by PSDDA and Tetra Tech, Inc. However, the cost estimates are in line with the experience of the Port of Seattle at Terminal 90/91 and the added expense of meeting the state's minimum functional standards that would apply to upland disposal sites.

These results, however, must be understood in the context of the key variables that affect disposal system economics and the uncertainty associated with many of the cost components.

The key factors affecting the costs of the alternative sites are:

- All sites
  - Pre-dredging testing requirements
- Confined aquatic sites
  - Volume of material required for capping
  - Source of cap material
  - Distance between disposal site and dredging area
  - Site leasing costs
- Nearshore saturated sites
  - Land acquisition
  - Habitat mitigation
  - Berm construction and the number of cells
  - Depth of site
  - Source of cap material
- Nearshore unsaturated sites
  - Cost efficiencies gained by filling cells to maximum capacity
- Upland sites
  - Design standards
  - Transportation and handling
  - Sediment water content issues.

The cost estimates developed in this report are subject to considerable uncertainty and must be interpreted accordingly. They provide the basis for discussing alternative options and key issues but are not intended for use in budgeting or detailed program development. Several factors account for the uncertainty associated with the results:

- Cost estimates from existing studies are inconsistent
- Costs of certain activities (e.g., dewatering, design of nearshore sites, remediation) are not well documented
- Many costs will be determined by the state's confined disposal standards, which are currently being developed
- Characteristics of specific sites and locations will affect costs.

A breakdown of costs by operation phase is presented in Table 6. In all categories, with the exception of closure, post-closure and monitoring, the costs for the nearshore saturated site are the highest. The costs are particularly high for site development due to land acquisition costs and for ongoing site activities because of the habitat mitigation costs. In comparison to the nearshore unsaturated site, the cell capping for the nearshore saturated site are higher by a factor of nearly seven. Confined aquatic disposal, which is the least costly option, has the lowest site development costs but the highest closure and monitoring costs. The overall costs of an upland site are influenced by the high transportation costs, which are due to the additional costs of hauling the dredged material over land by truck.

TABLE 6. COST COMPARISON OF DISPOSAL ALTERNATIVES (1989 CONSTANT DOLLARS)

Operation Phase	Confined Aquatic	Nearshore Unsaturated	Nearshore Saturated	Upland
Site development	583,000	10,490,521	13,917,501	12,400,885
Survey/acquisition/preparation/ initial construction				
Sediment testing[a]	579,360	1,020,777	1,020,777	629,020
Dredging and transport[a]	4,000,344	2,979,567	2,979,567	10,428,483
Ongoing site activities	593,526	12,733,500	17,396,415	9,232,263
Disposal/construction Treatment/operation and maintenance/dewatering Mitigation/dewatering				
Closure	7,386,842	514,034	3,460,077	575,131
Cell capping/other				
Monitoring	2,505,261	575,839	753,884	264,872
Post-closure	332,383	244,717	239,848	149,885
Contingency	2,243,991	4,436,960	5,965,210	5,052,081
TOTAL	17,203,930	34,016,692	45,733,278	38,732,618

[a] Costs borne directly by dredger.

FUNDING ANALYSIS

A funding analysis was conducted to examine the alternatives for funding multiuser sites and make a broad assessment of the feasibility of the funding alternatives. The analysis is based on the planning level costs described in the previous section and incorporates alternative financing assumptions and assumptions as to investment and borrowing rates. The *Funding Analysis Issue Paper* (CCA 1989) provides more detail on the assumptions and methods used.

In general, the major factors affecting the feasibility of funding multiuser sites are:

- Costs
- Ownership and operation options
- Financing techniques
- Funding sources.

These factors and their influence on the ability to finance a multiuser disposal site are discussed below.

COSTS

Cost estimates for the four types of confined disposal sites: aquatic, nearshore unsaturated, nearshore saturated, and upland developed in the previous section form the basis of the funding analysis. Each of these site types have a different profile of costs. Some sites such as upland have relatively large development costs, requiring large borrowings and higher long-term debt than less capital-intensive sites such as aquatic sites. The ongoing operating costs for the four disposal sites also differ. Each type of disposal site will then show a different sensitivity to financing assumptions and costs.

The quantitative analysis of funding alternatives uses only those costs that are measurable and would be the direct responsibility of the owner or operator of a generic multiuser confined disposal facility. Regulatory costs, liability costs, and other project costs such as sediment testing, dredging, and transport borne by the site user are not included. The funding analysis also does not address total system costs, i.e., the cost for all the multiuser sites that may be needed to handle contaminated dredged material throughout Puget Sound.

Costs that are included are:

- Siting and initial construction costs which are treated as capital costs that require debt financing
- Operation and period cell construction and closure costs for a 20-year period which are treated as operating costs
- Post-closure monitoring, site maintenance, and administration for a 10-year period after closure which are assumed to be funded through a financial assurance account, which is accumulated during the operating lifetime of the facility.

OWNERSHIP AND OPERATION OPTIONS

Institutional options for siting, construction, and operation have a potential impact on funding. It is assumed that for whatever institutional option is used, there is:

- Sufficient debt capacity to incur long-term debt for facility siting and construction costs
- Authority to guarantee a flow of revenue over the life of the facility through flow control, contracts with users, or imposition of taxes and fees
- A bond rating equivalent to Moody's B or better.

Several options for ownership and operation are available, ranging from public ownership and public operation to private ownership and private operation. Eight options are summarized below:

Option 1 is the *total public* option where the public jurisdiction is directly responsible for financing, contracting for independent design and competitive bids for construction of a facility, and operating the facility.

Option 2 is the *turnkey service* option. Under this option, the private sector provides a turnkey service (design-build), turning the facility over to the public entity for operation.

Options 3 and 4 are variations on the turnkey service where the private sector designs and builds the facility, and also operates it under either a short term contract (Option 3) or long-term service contract (Option 4) with the public entity.

Options 5 and 6 are private management contract options where the public entity constructs the facility, then contracts with a private entity to manage and operate the facility, either under a short-term contract (Option 5) or a long-term contract (Option 6).

Option 7 is a private, full service option where the private entity designs, builds, owns, operates and finances the facility. This option is applicable to upland and nearshore sites.

Option 8 is a variation on the private full service option that applies particularly to aquatic sites, because these sites are all under state ownership. In this situation, the private entity leases the site from the state, then finances any construction costs and operates the facility.

Advantages and Disadvantages of Private Ownership

The financial incentives for private industry to build and operate public facilities in cooperation with public agencies were eliminated with passage of the 1986 federal tax reform act. In absence of these incentives to make large equity contributions for funding the capital costs, private industry will invest in a public project based primarily on the income producing potential of the project.

The major advantage of private participation in a project is the potential for more efficient and cost-effective operation compared to public operation. Another advantage of private participation is that it can relieve the public agency of some or all of the burden of directly managing the development and operation of a facility.

The main disadvantages of private ownership or operation are loss of control by the public agency and potentially higher borrowing costs. These disadvantages can be mitigated to some extent by negotiating contractual relations that allow tax exempt financing. Restrictions on tax exempt financing, however, limit the flexibility of these arrangements.

Areas of Risk

The feasibility of the various public/private options depends on the extent to which the public shares in the risks and liabilities involved in developing multiuser confined disposal sites. Four areas of significant risk are:

1. **Unpredictability of siting costs**—Delays and difficulties in siting this type of facility can significantly increase the costs of development.
2. **Unpredictability of customer use**—A multiuser site that is dependent on income from user fees may experience cash flow problems and difficulty in meeting debt payments if use is erratic over a period of years. The unpredictability of customer use affects 1) how much materials are disposed of at a site, 2) when it is disposed of, and 3) whether a multiuser site or an alternative site would be used.
3. **Potential liability for facility failure during and after closure**—Where the responsibility for liability is undefined or unlimited, the owner, developer, operator, and users of the site are vulnerable to a significant economic risk.
4. **Regulatory risk**—New environmental regulations could be imposed on the facility retroactively, resulting in unanticipated costs or cleanup.

The first three areas of risk can be addressed by developing new institutional arrangements (e.g., minimize siting difficulties by instituting a central agency with multi-jurisdictional authority to grant all applicable permits). Specifying a ceiling on liability for the owner/operator with the state to assume liability for additional costs, or setting up a pooled insurance fund are two examples of mechanisms for addressing the risk of unpredictable liability costs. In contrast to the first three areas of risk, regulatory risk is difficult to control because new regulations are often imposed at the federal level or created in response to new knowledge about environmental impacts.

FINANCING TECHNIQUES

Available Alternatives

Alternative financing techniques for capital projects range from high to low costs and include private financing, taxable bonds, tax exempt bonds (general purpose or private activity tax exempt bonds), subsidized low interest loans (e.g., through a revolving loan fund or government loan guarantees), grants, and pay-as-you-go. The subsidized loan, grants, and pay-as-you-go options require the use of funding sources other than user fees. For example, under the subsidized loan or grant options, some form of general tax revenue would be used to support facility development and construction costs. Under the pay-as-you-go option an agency would use available cash balances that had been accumulated from other funding sources and could legally be used for this purpose.

Effects of Financing on Project Costs

Each of the four disposal site options has a different cost profile. The nearshore (saturated and unsaturated) and upland sites have relatively large development costs that require large borrowings and higher long-term debt. In contrast, aquatic disposal sites are less capital-intensive. Sites with relatively high operation costs will be more affected by inflation. The relationships among the capital and operation cost requirements of each type of site and sensitivity to financing costs and inflation are presented in Table 7.

Financing Assumptions

The scenarios examined in the funding analysis are based on a range of financing costs. The low end financing costs (tax exempt revenue bonds) represent the type of funding available to public agencies for public projects. Both public and private purpose bonds can be used depending on the level and type of private participation. Bonds designated as private purpose fall under a statewide cap that limits the total amount of tax exempt private purpose bonds issued each year. The high-end financing costs (private financing), which include a profit margin, represent the type of borrowing available under private ownership of a facility.

TABLE 7. EFFECT OF FINANCING COSTS AND INFLATION ON CAPITAL AND OPERATING COSTS BY TYPE OF SITE

Site	Capital Cost Sensitivity to Financing Costs	Operating Cost Sensitivity to Inflation
Confined aquatic	Low	High
Nearshore saturated	High	Medium
Nearshore unsaturated	High	Medium
Upland	High - medium	High

FUNDING SOURCES

Funding sources may include user fees and a wide range of taxes or assessments and federal assistance. There are a variety of policy issues related to the question of whether the cost of a multiuser sediment disposal site should be funded solely from user fees or not. These issues, which fall under two categories, cost allocation and risk/liability, are discussed below.

Cost Allocation Issues

The issue of fairness or equity in recovering and allocating costs is important in developing funding alternatives. This issue can be clarified by examining who contributes to the problem and who benefits from the solution. Contributors to the contamination of sediments include all sources of discharges into Puget Sound waters. Because it is not feasible to make direct claims of liability on individual prior contributors, other alternatives for recovering costs need to be developed and include:

- Use existing or new general fund resources, based on the argument that the public bears a general responsibility for contamination of sediments
- Use taxes or charges generally related to sources of contamination in the Puget Sound region [sewer discharges (e.g., a tax on sewer utilities), surface water runoff (e.g., a tax on developed properties), commercial/industrial (e.g., business and occupation tax)]
- Use a region tax (e.g., sales tax, gas tax, property tax), based on the argument that the regional public bears a general responsibility for contamination of sediments.

Because both project proponents and the general public benefit from dredging and safe disposal of contaminated sediments, the regional public benefits could be considered in allocating costs by having different fees for "public purpose" users and "private purpose" users (e.g., marinas, boat repair facilities). Some alternatives for allocating cost among those who benefit include:

- Recover a portion of the costs through a general tax, in recognition that there is a general benefit to environmentally safe disposal, and recover the remaining costs through user fees
- Recover costs through a sliding scale of user fees, with lower fees for users that serve a regional public purpose
- Recover a portion of the costs through benefit assessments related to the purposes served by dredging. For example, assess ships based on hull depth (for navigation benefits), assess waterfront or flood zone properties (for flooding and erosion control benefits).

Risk/Liability Issues

The risks (i.e., siting, customer user, liability, regulatory) can, to a large extent, be mitigated by identifying secure sources for funding unanticipated costs associated with the risks. Some key possibilities are 1) establishing an agreement for sharing liability costs among jurisdictions, owners, and users, and 2) securing user fee revenues through requirements that dredgers use the site (flow control) or long-term contracts with users.

RESULTS OF FUNDING ANALYSIS

The feasibility of funding multiuser confined disposal sites depends on the economic impacts on users and public and private institutions, as determined by whether users would be willing to dispose of dredged materials at the price required to support all facility costs and whether institutions responsible for facility construction and operation can bear the debt and risk burden without undue financial hardship. The funding analysis provides an estimate of the range of costs to users and public and private institutions. However, the feasibility is affected by several factors that cannot be defined or estimated at this stage in the study. This includes 1) factors affecting public and private institutions, 2) factors affecting users, and 3) risk and liability issues.

Factors affecting public and private institutions include:

- Overall debt capacity and financial condition
- Authority to control or regulate users
- Availability of and authority over suitable sites
- Capital planning capabilities
- Ability to assume liability for risks
- Ability to facilitate the siting process.

Factors affecting users include:

- Source of funding for public users, return on investment for private users
- Other project costs such as dredging, transport, and sediment testing
- Available disposal alternatives.

Risk and liability issues include:

- Unpredictability of siting and associated costs
- Unpredictability of facility use

- Potential liability for system failure
- Risk of regulatory uncertainty.

Projections of total life cycle costs, including financing costs, were developed for eight combinations of disposal site types and financing techniques. Total life cycle costs are the total costs of developing and operating a site from inception through the life of the site, including closure and post-closure costs. User fees, the cost per cubic yard to a dredger for disposing dredged material at the site, are also developed. These scenarios represent the upper (private financing) and lower (tax exempt revenue bonds) bounds for each of the four types of disposal sites. The baseline assumption is that facility costs are supported 100 percent by user fees and that user fees on a dollars-per-cubic-yard basis are the same for all users. This provides a baseline for comparing alternative site costs and financing costs.

The results for user fees and the present value of life cycle costs are presented in Table 8. The present value life cycle costs takes the cost stream over 20 years of the life of the project and discounts the annual costs to 1989 based on a cost of borrowing money at 7.5 percent.

User fees are shown for Year 1 and Year 15. For some facilities, cost in Years 16-20 are lower due to reduced costs for cell construction and closure, as the last cells are built two to four years before closure. Comparison of user fees for Years 1-15 (1989 dollars) shows the differing impacts of projects with high capital and lower operating costs vs. low capital and higher operating costs. For example, the aquatic disposal option, with low capital costs and high operating costs, show an increase in user fees, whereas the other options all show a decrease.

Ranking of Options

The funding analysis shows that in all cases private financing is more expensive than tax exempt revenue bonds. A major assumption used in the analysis that affected the outcome was that no increased efficiencies would be realized under private ownership. Based on the present value, the ranking of options from lowest to highest cost (note that aquatic disposal costs do not include any lease costs) are as follows:

- Aquatic disposal, tax exempt
- Aquatic disposal, private
- Nearshore unsaturated disposal, tax exempt
- Upland disposal, tax exempt
- Nearshore saturated, tax exempt
- Upland disposal, private

TABLE 8. COMPARISONS OF USER FEES AND PRESENT VALUE OF LIFE CYCLE COSTS AND ANNUAL COSTS

	Inflated Dollars		1989 Dollars	
	Year 1	Year 15	Year 1	Year 15
Comparison of User Fees				
Upland disposal/tax-exempt	$40.47	$51.21	$38.54	$24.63
Upland disposal/private	55.51	75.11	52.87	36.13
Aquatic disposal/tax-exempt	17.47	49.30	16.64	23.71
Aquatic disposal/private	19.53	54.53	18.60	26.23
Nearshore saturated/tax-exempt	62.61	63.83	59.63	30.70
Nearshore saturated/private	81.80	125.46	77.90	60.35
Nearshore unsaturated/tax-exempt	39.12	58.02	37.26	27.91
Nearshore unsaturated/private	60.14	89.65	57.28	43.13

	1989 Present Value[a]	Year 1 Inflated Cost	Year 2 Inflated Cost		Year 20 Inflated Cost
Comparison of Present Value of Life Cycle Costs and Annual Costs					
Upland disposal/tax-exempt	28,370,778	2,529,173	2,586,515	...	2,837,706
Upland disposal/private	38,083,219	3,469,158	3,531,684	...	3,915,262
Aquatic disposal/tax-exempt	18,779,273	1,092,115	1,190,618	...	3,769,338
Aquatic disposal/private	20,838,805	1,220,347	1,328,699	...	4,165,291
Nearshore saturated/tax-exempt	36,853,703	3,913,397	3,939,728	...	1,856,125
Nearshore saturated/private	58,973,254	5,112,237	5,274,517	...	3,897,135
Nearshore unsaturated/tax-exempt	26,686,726	2,444,836	2,493,656	...	1,904,599
Nearshore unsaturated/private	40,784,222	3,758,716	3,840,221	...	2,608,392

[a] Discount rate = 7.50%.

- Nearshore unsaturated, private
- Nearshore saturated, private.

The feasibility of funding any of these options depends on the debt capacity and overall financial condition of an individual jurisdiction or institution, and the total number of disposal sites that need to be built.

Comparison to Costs of Disposing Solid and Hazardous Wastes

User fees for all options are in a reasonable range when compared to current disposal rates for solid waste and hazardous waste in the Puget Sound region. The user fee estimates for Year 1 range from $17-$82 per cubic yard. Dredged sediment weighs an average of 1.2 tons per cubic yard; based on this, user fees range from $17-$68 per ton. Disposal fees for solid waste disposal at landfills in the Puget Sound region are in the $20-$40 per ton range. Hazardous waste disposal fees are often over $100 per ton. However, fees for disposal of dredged material at construction and demolition debris landfills are much less, ranging from $30-$40 for 5 cubic yards of material [e.g., $6.50 per cubic yard at the Coal Creek (Newcastle) demolition landfill in King County]. These facilities, however, typically only accept dredged material in small quantities (e.g., 100 cubic yards).

INSTITUTIONAL OPTIONS ANALYSIS

A range of institutional options for implementing a multiuser confined disposal sites program are developed and analyzed. The approach used in defining institutional options for analysis is to conduct an overview of the existing system for disposing of dredged material and identify the major problems and the major stakeholders. The functions to be implemented in a multiuser site program are then developed and various combinations of responsibilities for the major stakeholders in implementing these functions are created. The institutional options are analyzed based on advantages and disadvantages in meeting evaluation criteria related to the identified problems and the implementability of the option. This section summarizes the options information presented in the *Institutional Options Analysis Issue Paper* (Fernandes Associates and PTI 1989).

PROBLEMS WITH THE EXISTING SYSTEM

The major problems identified with the existing dredged material management and disposal system are:

- Lack of capacity and increasing difficulty in **siting** facilities for solid waste and contaminated dredged material
- Uncertainty and inefficiency due to lack of a **coordinated management plan** for dealing with contaminated dredged material
- Lack of assurance regarding the **consistency** and standards for disposing of dredged material in an **environmentally sound** manner (until standards are adopted)
- Lack of assurance that the current method of disposal results in the most **cost-effective** means of disposal
- Inadequate **involvement** by some stakeholders in disposal planning and decision-making.

Siting

The most significant of these problems is siting. Despite the need for waste disposal sites and the availability of land, communities oppose the location of sites in their "backyards". The major concerns are environmental and public health impacts even if assurances are provided that the best available safeguards will be provided.

The concerns include a lack of trust in the public or private entities responsible for siting and managing sites. Communities are concerned that cost-cutting considerations may override promises made to communities regarding environmental controls. Historically established credibility of the institutions can therefore make a difference in community acceptance.

Communities are also concerned that state-of-the-art knowledge regarding environmental impacts may not accurately reflect long-term damage and may not yet be sophisticated enough to detect all potential hazards. There is also an acknowledgement of the lack of solid waste expertise and concerns about inability to carry out actions stipulated by the permitting agencies.

In the past, siting a waste disposal facility would entail an identification of possible sites based on technical criteria and the determination of sites based on availability. Today, this is merely a starting point, with a major site determination being dealt with through the community negotiation process.

Another problem related to the ability to site facilities is the availability of land. Some institutions have land they can make available for waste disposal facilities which could put them in a more favorable position while others do not.

Some institutions may have access to funding sources for sites that others do not have.

Finally, liability management is a major concern in siting facilities because of the uncertainty of the amount and the share of that liability. Those entities considering owning and operating facilities must now consider what the long-term risks might be and how they might equitably distribute the responsibilities.

Lack of a Coordinated Management Plan

The existing system of disposing of dredged material is handled on a project-by-project basis. There is little coordination among entities in need of dredging, dredgers, transporters, permitting agencies and disposal site owners/operators. Consequently, the system does not lend itself to efficiencies in operation that might be realized through coordinated timing of dredging, sharing of disposal sites, and use of clean material for the capping of contaminated material.

Environmental Considerations

Until the confined disposal standards for dredged material are developed and adopted, and institutional roles for their implementation are defined, there is no assurance that contaminated dredged material is being handled in a consistent, environmentally sound manner.

Cost Considerations

Meeting environmental control standards, management and disposal of dredged material with the existing dispersed system is less cost-effective than it might be with a centralized multiuser site system with established standards and a comprehensive management program.

Involvement

Contaminated dredged material management and disposal has included the advice of major stakeholders but not all other users and interested groups. There is no assurance that the interests of all stakeholders are taken into consideration even in an advisory capacity.

AGENCIES AND ORGANIZATIONS WITH INTEREST IN MULTIUSER SITES

A multiuser confined disposal site has many potential stakeholders, i.e., groups and organizations that have an interest in how such a site is managed and regulated.

Stakeholders fall into four major categories:

- Dredgers, agencies or businesses that use disposal facilities either regularly or occasionally
- Regulators charged with some aspect of oversight of dredging activities or dredged sediments disposal facilities
- Environmental groups and the general public
- Current or potential operators of a multiuser disposal facility.

In some cases these categories overlap. For example, a branch of a government agency with regulatory responsibilities may also undertake a dredging project.

Dredgers and Dredging Contractors

Users of the facility are a significant stakeholder because they have the most to gain, or to lose, from a multiuser disposal facility. This category includes the Puget Sound port districts, the Washington Public Ports Association, the Corps, the U.S. Navy, marinas, boat repair facilities, local and state governments, commercial/industrial transporters, other industrial users, and private citizens and developers. Companies that supply dredges, tugs, barges, pipelines, and trucks are included, as well as industries responsible for cleanup of contaminated sediments.

Usage of a multiuser confined disposal site will depend on regulations, costs, and availability of multiuser and single-user sites for contaminated sediments. Dredgers are especially concerned that disposal options be practical, cost-effective, and available when needed, and that the regulatory process be reasonable and consistent. Liability for hazardous substances is a concern as well.

Regulators

The primary interest of regulators is environmental protection, in accordance with their individual mandates. City and county governments are concerned about land use and transportation impacts, which are significant factors for some upland and nearshore sites. The Washington Department of Natural Resources (DNR), the major owner of aquatic lands, also has land use concerns.

Tribal governments are interested in environmental and land use issues and often focus on safeguarding the fishery resource and the ability to fish in their usual grounds without restrictions.

Public agencies with regulatory responsibilities may sometimes have their own dredging projects and share the concerns of other dredgers. Agencies may own and/or operate multiuser disposal sites (particularly landfills), facing the same issues as other owners and operators. DNR has particular liability concerns because they manage state-owned lands on which aquatic, nearshore, and upland disposal sites may be located.

Environmental Groups/General Public

The third major group of stakeholders is environmental organizations, who represent the general public in many ways. Several individuals with specific expertise and concerns about the environment have been highly involved in sediment and dredging issues.

The general public has shown relatively little interest in general sediment, dredging and disposal issues. Dredging and disposal activities have relatively low visibility and the environmental issues can be complex. Water quality has been the public's primary concern, and the importance of sediment contamination is not widely understood.

Community members have become more active when specific issues arise. Examples include potential damage to crabs in Port Gardner, possible interference with fishing activities, or perceived beach contamination from the Fourmile Rock disposal site. Community interest will peak when specific locations for disposal sites are being identified.

Owners and Operators

A wide variety of entities could potentially operate a multiuser confined disposal site. A user, such as a port, is one possibility. A regulatory agency, such as a local or tribal government or DNR, is another option. A private company could also take on the responsibility. Existing multiuser sites at municipal and demolition debris landfills are operated by county governments or private disposal companies. Alternatively, a new entity could be created to develop and/or operate the facility.

The primary concerns of a potential facility operator would most likely be liability for the hazardous substances, costs, marketing, regulatory requirements, and operational feasibility. Property owners would share many of these concerns, especially liability and economic risk. Owners of possible sites include DNR, counties, owners of existing landfills, and the private sector.

ROLES AND FUNCTIONS OF STAKEHOLDERS

Roles

The roles that stakeholders might have in an institutional arrangement fall into three broad categories, lead responsibility, joint responsibility, and mixed responsibility.

Lead responsibility refers to one stakeholder having the prime responsibility and authority for implementation of a function. The lead agency may delegate the execution of functions to other entities or may carry them out itself.

Joint responsibility refers to two or more agencies responsible for particular functions with one agency designated as lead. It differs from the lead responsibility in that the relationship among those entities in a joint role is a formally recognized organizational unit formed for this specific function. An example of this concept is PSDDA, a cooperative effort by the Corps, EPA, DNR, and Ecology. The Corps is designated as the lead.

Mixed responsibility refers to the stakeholders having the same responsibilities but for different specific sites. For example, the ports, local government, and private enterprise could all own and operate different sites.

In reality, the roles would be more complex when implementing the functions described in the following section. For example, several permits at the federal, state, and local level are required to implement a dredging and disposal project and, therefore, several entities have a lead responsibility for permitting. There are also different levels of regulatory oversight responsibilities among federal, state, local, and tribal governments.

Functions

Contaminated dredged material management and disposal functions are categorized into five broad headings:

- Planning/regulation
- Siting
- Operation
- Closure/post-closure
- Advisory.

The functions included under each of the headings are described below.

Planning/Regulation

Coordinated Management Plan—A coordinated management plan function refers to developing a comprehensive coordinated program for handling contaminated dredged material from the time it is dredged and disposed of to the closure and post-closure of disposal facilities. The plan would identify and develop projections of volumes, users, contamination levels, identify siting needs, and coordinate disposal activities.

Standards—Standards refer to the setting of confined disposal standards including the definition of dredged materials that require confined disposal, specification of testing and monitoring requirements, development of siting guidelines, and site closure and post-closure requirements.

Oversight Regulation—This term refers to overseeing compliance with regulatory requirements of users, owners, and operators. There may be varying levels of oversight regulation at each governmental level. For example, Ecology has an oversight responsibility for solid waste disposal but the counties and cities have the daily responsibility and authority.

Liability Management—Liability management refers to the legal framework of disposal management designed to minimize liability, identify specific liability responsibility, and determine how liability should be financed, including the apportionment of shares among those involved. Input from Ecology indicates that all those involved in the dredging, transportation or disposal of contaminated sediments could be held liable. The process of determining proportionate shares of liability is therefore left up to a future negotiating or decisionmaking process.

Siting

Site Selection—The site selection function refers to determining the need for sites, the required capacities, developing alternative site options, environmental and cost analyses, site recommendations, and obtaining all necessary permits. *Siting* includes the process of obtaining community acceptance for the location of particular facilities in or near a community.

Construction—Construction refers to both design and construction of specific facilities.

Permitting—Permitting refers to the activities of agencies that have the responsibility for issuing the final permit for a site.

Operation

Ownership and Operation—Ownership/operation refers to the daily operation of a facility, permit renewals, and responsibility for costs and revenues. Although it is possible that one entity might own a facility and contract out for its operation, this analysis assumes that the two functions are combined. Ownership and operation may be private or public.

Monitoring—Monitoring refers to the operational activities conducted to ensure that the facility meets permit stipulations.

Rate Setting—Rate setting is the establishment of user fees. Rates need to be reassessed periodically to ensure that all costs for operation as well as maintenance, closure and post-closure are taken into consideration.

Closure/Post-Closure

Closure Plan—Closure plan refers to the plan that addresses closure construction, monitoring, and contingency plans in case of failure, as well as plans for financing closure and post-closure requirements.

Liability—Liability refers to the actual assumption of liability responsibility which would be designated through cash payments, insurance, etc. This function would be addressed in the liability management plan.

Advisory

Advisory refers to a broad range of review and advice offered on all functions to those agencies in lead or joint roles. It could include participation by agencies and stakeholders in advisory committees or involvement in plan development.

ALTERNATIVES EVALUATED

Nine institutional options were formulated that span a wide spectrum of various combinations of organizations, roles, and functions. The range of options selected for evaluation covers lead roles for each of the major stakeholders: state government, local government, federal government, ports, private, and new institution. The nine options include the following:

- Status quo
- State/local government/port lead
- State/local government/private lead
- Federal/state/port/local government lead
- Coordinating council lead
- New authority lead
- Federal lead
- Coordinating council lead for all waste
- New authority lead for all waste.

Two forms of a new institution have been considered: a coordinating council and a new authority. *Coordinating Council* describes an entity that coordinates, delegates and oversees the implementing of functions listed under its direction. It may take the lead role in coordinating tasks, may do so jointly with other entities; or it may delegate responsibilities. It has a planning and coordinating role but does not undertake implementing actions. *New Authority* is an entity that can undertake all planning and implementing functions including developing a coordinated management plan, siting, regulation, permitting, construction, ownership, operation, and funding of facilities. As a state-sponsored entity, it could be designed to have preemption authority over local laws.

The last two options, a coordinating council and a new authority for all waste, involve expanding the functions beyond contaminated dredged material to encompass all solid waste or solid waste and hazardous waste. These options are described but not analyzed.

Figure 4 summarizes the list of institutional options and the assigned stakeholder functions. A description of each of these options is provided below. All stakeholders not identified for specific functions would be involved in an advisory capacity for all options except the status quo.

Status Quo

Planning/Regulation—PSWQA is responsible for contaminated sediments and dredging planning although there currently is no requirement for a coordinated management plan. Many

STAKEHOLDERS

- CC - Coordinating council
- F - Federal government
- L - Local government
- P - Ports
- PE - Private enterprise
- N - New authority
- S - State government
- OU - Owners, operators, users
- A - All who do not have a designated lead responsibility
- J - Joint responsibility federal, state, local
- M - Mixed responsibility ports, local, private

	Planning/Regulation				Siting			Operation			Closure/ Post Closure		Advisory
	Coordinated Management Plan	Standards	Oversight Regulation	Liability Management	Site Selection	Construction	Permitting	Ownership/Operation	Monitoring	Rate Setting	Closure Plan	Liability	Involved in Advisory Role
Status Quo	*	*	*	*	*	*	*	*	*	*	*	*	*
Option 1 - State/Local/Ports	S	S	S	S	L	P	L	P	P	P	P	OU	A
Option 2 - State/Local/Private	L	S	S	S	L	PE	L	PE	PE	PE	PE	OU	A
Option 3 - Federal/State/Local	J	J	J	J	J	P	L	P	P	P	P	OU	A
Option 4 - Coordinating Council	CC	CC	CC	CC	CC	L	S	L	L	CC	CC	OU	A
Option 5 - New Authority	N	N	N	N	N	N	N	N	N	N	N	OU	A
Option 6 - Federal Lead	F	F	F	F	S	M	S	M	M	M	M	OU	A
Option 7 - Coordinating Council (All Wastes)	CC	CC	CC	CC	S	L	S	L	L	L	CC	OU	A
Option 8 - New Authority (All Wastes)	N	N	N	N	N	N	N	N	N	N	N	OU	A

* Function varies with disposal environment (See description in text)

Figure 4. Institutional options

elements of such a plan are required in the Puget Sound Water Quality Management Plan, but not all are funded. Ecology is responsible for developing confined disposal standards and siting guidelines.

Oversight regulation is a complex mixture of federal, state, and local government responsibilities involving several different laws and regulations. Liability management has not yet been addressed and liability responsibilities have not been clearly defined. All stakeholders involved in the dredging, transport, and disposal of contaminated sediments have varying degrees of liability.

Siting—Site selection and construction are generally the responsibility of the project proponent and site permitting is the responsibility of local, state and/or federal governments.

Operation and Ownership—Ownership, operation, and monitoring of disposal sites are generally the responsibility of the project proponent or, in the case of Corps dredging, the local sponsor. In the case of municipal landfills currently used for dredged material disposal, local governments and/or private enterprise are responsible.

Rate Setting—Rate setting is currently applicable to municipal landfills only and local governments have that responsibility.

Closure/Post-Closure—Closure is the responsibility of the project proponent but closure plans are not consistently required.

Responsibilities in the existing system vary depending on the disposal environment (i.e., aquatic, nearshore, or upland).

Option 1 - State/Local/Ports

Planning/Regulation—The state has the lead responsibility for developing the coordinated management plan, standards, oversight regulation and liability management.

Siting, Operation, Closure/Post-Closure—Local government has the lead responsibility for site selection and permitting. The ports have the lead responsibility for site construction, operation (including ownership/operation, monitoring, and rate setting), and the closure plan for these facilities.

The most likely state and local agencies for lead responsibility are:

- PSWQA - coordinated management plan
- Ecology - standards, oversight regulation, liability management
- Local planning and health departments - site selection and permitting.

Option 2 - State/Local/Private

Planning/Regulation—The state has the lead responsibility for standards, oversight regulation, and liability management. Local government has the lead for the coordinated management plan.

Siting—Local government has the lead for site selection and permitting and the private sector has the lead for construction.

Operation, Closure/Post-Closure—The private sector has the lead for ownership/operation, monitoring and rate setting, and the closure plan for each facility.

The most likely state and local agencies for lead responsibility are:

- Regional planning agencies such as the Puget Sound Council of Governments - coordinated management plan
- Ecology - standards, oversight regulation, liability management
- Local planning and health departments - site selection and permitting.

Option 3 - Federal/State/Port/Local

Planning/Regulation—A federal/state/port/local entity, such as PSDDA, has joint responsibility for the coordinated management plan, standards, oversight regulation, and liability management.

Siting—Although the organizations that constitute the new entity share responsibility for site selection, the ports have the lead responsibility for site construction. Local governments have the lead responsibility for permitting.

Operation, Closure/Post-Closure—The ports have the lead responsibility for ownership/operation, monitoring and rate setting of particular sites, and the closure plan.

The most likely federal, state, and local agencies for lead responsibility are the Corps, EPA, PSWQA, Ecology, DNR, and the Puget Sound Council of Governments - coordinated management plan, standards, oversight regulation, liability management, site selection.

Option 4 - Coordinating Council

Planning/Regulation—The coordinating council has the lead responsibility for the coordinated management plan, standards, oversight regulation, and liability management.

Siting—The coordinating council is responsible for site selection; the state is responsible for permitting, and local government is responsible for site construction.

Operation, Closure/Post-Closure—The coordinating council is responsible for rate setting and the closure plan. Local government would own, operate, and monitor the site.

The coordinating council is appointed by the state and would have broad representation of stakeholders. The most likely state and local agencies to hold lead responsibilities are:

- Ecology - permitting
- Local public works/health - construction ownership, operation, and monitoring.

Option 5 - New Authority

A new authority is created that has extensive powers to undertake almost all phases of contaminated dredged material disposal, from planning to ownership and operation of sites. A professional staff could provide the technical support necessary to conduct its activities. The new authority could be an entirely new entity or it could be an entity such as a new port authority. The authority has the lead responsibility for all functions of contaminated sediment disposal.

Option 6 - Federal Lead

Planning/Regulation—A federal agency has lead responsibility for developing a coordinated management plan, establishing standards, oversight regulation, and liability management.

Siting—The state has lead responsibility for site selection and permitting. The ports, local governments, and private enterprise have responsibility for site construction.

Operation, Closure/Post-Closure—The ports, local governments, and private enterprise have responsibility for site ownership, operation and monitoring, rate setting and closure plans.

The most likely federal agency for lead responsibility is the Corps.

Option 7 - Coordinating Council - All Waste

A new coordinating council would be formed with broad representation of stakeholders with interest in contaminated dredged material, solid waste, and hazardous waste.

Planning/Regulation—The coordinating council would have lead responsibility for the coordinated management plan, standards, oversight regulation, liability management, and the closure plan.

Siting—The state and local government have lead responsibility for implementing the siting portions of the plan. The state has responsibility for site selection and permitting for all contaminated waste.

Operation, Closure/Post-Closure—Local governments have responsibility for construction, ownership/operation, monitoring, and rate setting.

Option 8 - New Authority - All Waste

This option is similar to Option 7, except that a new authority rather than a coordinating council takes the lead responsibility in all functions.

EVALUATION CRITERIA

The institutional options were evaluated based on their ability to resolve the problems identified with the existing system. Evaluation criteria developed to reflect each of the problems and the overall implementation potential of the option and the factors considered in applying the criteria are presented in Table 9.

EVALUATION OF ALTERNATIVES

The analysis of institutional options was conducted considering the advantages and disadvantages of each option with respect to meeting the criteria. An important aspect of implementing any institutional option will be consensus by the stakeholders. The evaluation presented here is intended as a starting point for arriving at consensus.

In evaluating the options some general assumptions were:

- The status quo is evaluated on the basis of the current situation rather than on its potential.
- A coordinated management plan could be developed in all options. Evaluation is based on the likelihood of successful development and implementation.
- A mechanism for ensuring a consistent and predictable flow of waste to each established disposal site is assumed necessary for all options to ensure a steady stream of revenue for capital investments.

The evaluation of options was conducted for the status quo and Options 1 through 6. An evaluation of options 7 and 8, the all waste options, was beyond the scope of this report.

TABLE 9. CRITERIA FOR EVALUATING INSTITUTIONAL OPTIONS

Criteria	Factors
Siting	Authority to establish siting criteria and standards Effectiveness of siting process Availability of land Ability to manage liability
Coordinated management plan	Ability to coordinate activities for plan development Ability and/or authority to implement the plan Ability to hire and train qualified staff
Environmental considerations	Establishing and enforcing environmental standards for all three site environments in a consistent manner
Cost considerations	Cost effectiveness of developing and managing the overall program Ability to obtain funding
Representation	Involvement of stakeholders in major decisions Equitable distribution of costs and services among users
Implementation	Ease of implementation Compatibility with existing administrative framework and programs Legal authority Political and public acceptability

Status Quo

Advantages

Siting

- The system is in place and has the potential for improvement without the potential disruption posed by a new arrangement.
- PSWQA has an existing coordinating responsibility.

Disadvantages

Siting

- Siting of solid waste facilities is difficult, mostly due to public and environmental group concerns. Siting guidelines will be developed but do not currently exist, and confined disposal standards are presently being developed.

Coordinated Management Plan

- A coordinated dredging management plan does not exist and there currently is no designated entity to develop one. The Puget Sound Water Quality Management Plan contains many of the elements of such a proposed plan but falls short of some required elements and is not fully funded.
- A liability management plan does not exist.

Cost Considerations

- Although dredged material is defined as a solid waste, sites are not consistently permitted, there is inconsistent regulatory oversight of disposal, and little centralized support at the state level to aid local governments.
- Currently planned functions are not adequately funded.

Representation

- Major stakeholders are highly involved but intermediate and small stakeholders are not involved.

General Advantages and Disadvantages to Options 1-6

Certain advantages and disadvantages apply to all of the alternatives to the status quo. These are listed below.

Advantages

Siting

- Development of siting guidelines and a liability management plan would improve the siting process.

Coordinated Management Plan

- A coordinated management plan would be developed and have a reasonable chance for successful implementation.

Cost Considerations

- Funding of the program is more likely because of the coordinated effort among the various agencies.

Disadvantages

Siting

- Although there are some improvements in siting, an effective siting process that involves the concerned public is not ensured.

Representation

- Adequate representation of all stakeholders is not ensured.

Option 1 - State/Local/Ports

Advantages

Siting

- Siting may be improved for aquatic and nearshore sites due to the role assigned the ports in site ownership. Site placement in the more industrialized areas owned by the ports may be more publicly acceptable.

Environmental Considerations

- Environmental consistency would be improved due to the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the three major stakeholders.

Implementation

- The option is fairly compatible with the existing system and therefore easily implemented.

Disadvantages

Coordinated Management Plan/Environmental Considerations/Cost Considerations

- The major disadvantage is the lack of a strong role for the federal government, specifically the Corps and EPA. This could have a negative impact on funding, cost effectiveness, and environmental consistency.

Implementation

- The three major entities have other responsibilities that could divert the focus from contaminated dredged material management and disposal.

Representation

- A key stakeholder, the federal government, and a potential stakeholder, the private sector, do not have significant roles.

Option 2 - State/Local/Private

Advantages

Siting

- The private sector may be more cost effective in developing and operating sites.

Environmental Considerations

- Environmental consistency would be improved due to the development and implementation of siting guidelines, disposal standards, and the broad geographic coverage of the three major stakeholders.

Cost Considerations

- The private sector may own land that could be made available for disposal sites.

Implementation

- The option is fairly compatible with the existing system and therefore easily implemented

Disadvantages

Siting

- The exclusion of a strong role for the ports will have a negative impact on the availability of sites especially in nearshore areas.

Coordinated Management Plan

- A major disadvantage is the lack of a strong role for the federal government, specifically the Corps, EPA, and the ports. This could have a negative impact on funding, cost-effectiveness, environmental consistency, and development of a coordinated management plan.

Representation

- Two key stakeholders, the federal government and the ports, do not have significant roles.

Implementation

- The entities involved have other responsibilities in addition to dredged material and may not maintain a focus on this issue.

Option 3 - Federal/State/Port/Local

Advantages

Siting

- Siting may also be improved because of the coordinated role assigned the four entities in site selection.

Environmental Considerations

- Environmental consistency would be improved due to the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the four major entities.

Cost Considerations

- Funding is more likely because of the more coordinated effort and the inclusion of the federal government
- Services would be centralized.

Representation

- All major stakeholders have key roles, which will improve coordination, funding, etc.

Implementation

- The option is fairly compatible with the existing system and therefore easily implemented.
- The PSDDA-type arrangement has been successfully used in establishing open-water unconfined disposal sites.

Disadvantages

Implementation

- It may lack the focus and authority of an entity established specifically for dredged material management.

Option 4 - Coordinating Council

Advantages

Siting

- Siting may also be improved because of the role assigned the council in site selection which is improved by the centralized site selection function.

Coordinated Management Plan

- Environmental consistency would be improved because of the development and implementation of siting guidelines and disposal standards, and the broad geographic coverage of the major stakeholders.

Environmental Considerations

- Centralized rate setting should improve equity and flow control.

Cost Considerations

- Centralized permitting by the state may be cost effective.

Representation

- There would be maximum stakeholder involvement in all functions.
- Stakeholder representation is increased, thereby ensuring greater equity.

Implementation

- There would be an exclusive focus on dredged material management and disposal.

Disadvantages

Representation

- Ports and the private sector do not have a role in site construction and the ownership/operation.

Implementation

- It is significantly different from the status quo, which could make implementation difficult.
- Obtaining approval for a state level coordinating council may take legislative action to approve the structure and functions.

Option 5 - New Authority

Advantages

Siting

- Siting may also be improved because of the role assigned the authority in site selection.
- Centralized siting authority may enhance the ability to establish sites.

Coordinated Management Plan

- Development and implementation of a coordinated management plan is assured due to specific responsibility and authority.

Environmental Considerations

- Environmental consistency would be improved because of the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the major stakeholders represented by the authority.

Representation

- Representation is improved because the option is designed to include key stakeholders.

Implementation

- There would be an exclusive focus and clear authority with respect to dredged material management.

Disadvantages

Cost Considerations

- Creating a new authority would cost more and funding would be problematic.

Implementation

- Political and public acceptability would be difficult
- It would not be compatible with the existing system
- Legislative action would be required to establish a new authority.

Option 6 - Federal Lead

Advantages

Siting

- Siting ability may be improved because of possible use of federal land for sites.

Cost Considerations

- Funding is more likely because of the federal role.

Implementation

- Some federal agencies (i.e., the Corps) have existing expertise and administrative structures for dealing with dredged material.

Disadvantages

Cost Considerations

- Congressionally-approved funding may be required.

Environmental Considerations

- Federal oversight regulation may not ensure consistent implementation because of actual or perceived remoteness of federal government from local issues.

Representation

- The federal government may not be perceived as representing local stakeholder interests because of their actual or perceived remoteness from local issues.

Implementation

- It is not compatible with the existing system.
- There would be difficulty with political and public acceptance.
- The entities included in this option have other responsibilities and maintaining focus on dredged material management may be difficult.
- Special congressional authorization and funding may be required.

PUBLIC EDUCATION AND INVOLVEMENT PLAN

The Multiuser Confined Disposal Sites Program will present for public review new concepts regarding a complex subject. Numerous stakeholders are potentially affected but may not be aware either of the project or of its potential impacts on them. Therefore education and increased awareness are important to Ecology's development of acceptable and successful recommendations.

This public involvement and education program describes the affected groups and recommended activities to inform them about sediments issues in general, and the multiuser confined disposal sites program in particular. Activities are also suggested to involve the affected groups in developing Ecology's recommendation to PSWQA. Since public education and involvement will be critical to a successful siting process, it is important that the initial planning be done in consultation with interested organizations. This section summarizes the information presented in the *Issues Assessment and Public Involvement/Education Plan* (Hall & Associates 1989).

INTEREST GROUPS

The multiuser confined disposal sites program has many potential stakeholders, people, or organizations who have an interest, or a stake, in the existence of such a facility. Stakeholders fall into four major categories:

- Dredgers, agencies, or businesses who use disposal facilities either regularly or occasionally (e.g., Puget Sound port districts, Washington Public Ports Association, the Corps, marinas, U.S. Navy, local governments) and dredging contractors.
- Regulators charged with some aspect of oversight of dredging activities or dredged sediments disposal facilities (e.g., Indian tribes, EPA, Ecology, Department of Fisheries, city and county governments, the Municipality of Metropolitan Seattle)
- Environmental groups and the general public (e.g., Washington Environmental Council, Audubon Society, Sierra Club)
- Current or potential operators of multiuser disposal facilities.

In some cases these categories overlap. For example, a branch of a government agency with regulatory responsibilities may also undertake a dredging project.

A consensus-building process is recommended to bring these stakeholders together to develop recommendations and solidify support. Under Ecology's guidance, dredgers, regulators, tribes, and environmentalists will discuss topics such as the utility and viability of a multiuser facility, institutional arrangements, stakeholder roles, and liability concerns, This intensive, broad-based participation will improve the quality and feasibility of the recommended approach.

OBJECTIVES

The public education and involvement objectives are:

1. To supplement existing efforts to educate interested and affected individuals, agencies, and organizations about contaminated sediments and their management and disposal

2. To educate and inform stakeholders about the advantages and disadvantages of multiuser sites and how they may be affected by the sites

3. To provide opportunities for public comment to assist Ecology in making recommendations to PSWQA.

A moderate level of public involvement, accompanied by education on sediment issues, is recommended. This effort should be focused especially on two groups that may be directly affected but who are not presently involved in sediment issues: local government decisionmakers, small and intermediate dredgers, and citizen groups concerned with water quality.

Background Information on Sediment Issues

The first objective is to assure that stakeholders receive the background information on contaminated sediments to respond to the public review report on the multiuser site program. The proposed educational activities will build on and supplement other sediment-related educational activities.

Several educational activities have already begun through other projects:

- Ecology held a workshop in late June 1989 to provide basic background information on sediments and on the development of standards for confined disposal. Many of those potentially interested in multiuser disposal sites participated in this workshop.

- PSWQA presented a day-long seminar on sediments in early June. Many of the multiuser site stakeholders attended.

- Ecology has compiled a sediments mailing list of 3,200 people and organizations interested in sediments or Puget Sound water quality. Most of the multiuser site stakeholders are likely to be included on this list.

- Ecology has mailed a general fact sheet on its sediment projects to 400 people. Another update is being prepared.

- A glossary and fact sheets on sediments and on development of contaminated disposal standards are being prepared.

- Two advisory groups have been involved with the issue of multiuser confined disposal sites. The Agency Forum for Sediment Issues, with representatives from federal, state, and local agencies and the ports, has met as needed to provide input into the multiuser sites study. The Sediments Advisory Group, representing a variety of agencies and industry and environmental groups, is also kept informed of the project and will review the issue papers.

Additional recommended educational activities are the following:

- Review Ecology's sediment mailing list to identify stakeholders; add names and organizations that are missing; divide the list to make a sub-list specifically for this project.

- Send background educational materials to people on the project mailing lists; this would include the Ecology *Updates*, and the fact sheets on sediments and disposal standards.

- Prepare a slide show presenting an overview on sediments, their importance and status in Puget Sound, and the studies by Ecology and other agencies. Solicit opportunities to give these presentations to interested organizations such as environmental or water quality groups; go to their meetings rather than rely on public meetings.

- Target presentations to groups that have not been very involved in existing sediment activities, i.e.:

  - Small and intermediate dredgers such as marinas

  - Local government decisionmakers who are not accustomed to considering sediments but would be responsible for issuing a permit for a multiuser disposal site

  - Citizen groups concerned with water quality.

Information on Multiuser Confined Disposal Sites

The second objective is to educate identified stakeholders specifically about multiuser confined disposal sites and the decisionmaking process for this project.

- Develop a fact sheet discussing the reasons for the study, the decisionmaking process, and the schedule. This will be focused on stakeholders, telling them how they may be affected and why they should be interested. Distribute the fact sheet to the project mailing list.

- Conduct a survey of small and intermediate dredgers such as marinas, boat repair facilities, and industrial firms to determine their dredging plans and disposal preferences. The survey can be an effective means to increase awareness by distributing information on the sediments studies and on dredged material management, as well as obtaining information on dredging projections, practices, and preferences.

- Distribute the executive summary of the report. Publicize the availability of the report to the media and to people on the mailing list.

- Include multiuser site issues in the slide show and present it to groups such as city and county officials and marina owners.

Opportunities for Public Comment

The third objective is to provide opportunities for public comment on the draft report.

- Solicit written comments through the fact sheet and the announcement of the report's availability. Include an address for comments in all mailings.

- Notify key groups of the availability of the report and send information for their newsletters; make follow-up telephone calls to answer questions.

- Contact key groups to arrange presentations on the report. Representative groups may be the Commencement Bay Citizens Advisory Group, the Washington Public Ports Association, trade associations, environmental groups, county solid waste advisory committees, and associations of city and county officials.

- Compile all written and verbal comments and summarize the findings for Ecology's use in preparing final recommendations to PSWQA.

Additional involvement, such as informal meetings with the public or specific groups, may be done as part of the consensus-building process. Further activities, possibly including public meetings and hearings, will be planned in coordination with PSWQA following Ecology's recommendation.

CONCLUSIONS

The conclusions from the assessment of needs, environmental and public health, cost analysis, funding analysis, institutional options, and public involvement/education issue papers and a discussion and conclusions that can be drawn at this stage of the multiuser site process on the utility and viability of establishing a multiuser site program are presented below.

ASSESSMENT OF NEEDS

- There is a significant need for disposal sites in nearshore, aquatic and upland areas over the next 20 years. This need can be met by either:
  - Continuing the existing practice of project by project determination of sites
  - A programmatic approach to the overall management of disposal such as is being investigated in the multiuser confined disposal site study.
- Projected volumes of dredged material requiring nearshore, upland, or confined aquatic disposal for the 20-year planning period 1989 through 2008 are 7.2-10 million cubic yards, representing an average yearly generation rate of approximately 360,000-500,000 cubic yards. The range of projections result from using both PSDDA (1988b, 1989) and URS (1989) as a basis for calculation. The difference is probably not significant considering the large number of other assumptions involved and the basic uncertainty in 20-year future projections. The projections do not include dredged material that may result from Superfund projects such as in Commencement Bay.
- During the 4-year period of 1985-1988, approximately 122,160 cubic yards per year were generated that required upland, nearshore, or confined aquatic disposal. Generally, more restrictive open-water unconfined disposal criteria were in effect at that time. The volume was low with respect to the 20-year projections either because these were low dredging volume years or the 20-year projections are high.Not all of the projected volume may require disposal in accordance with the confined disposal standards. Volumes were estimated based on exceeding open-water unconfined disposal guidance.

- The need for disposal capacity for the 20 year planning period exceeds the existing and currently planned capacity by a factor ranging from 3.6-5 if it is assumed that:
    - The use of municipal and demolition landfills for disposal of contaminated sediments continues at the rate occurring during the 1984-1988 periods
    - The total planned capacity for new dredged material disposal sites is approximately 2 million cubic yards and half of the material to be disposed of in those sites is contaminated.

- Based on volume projections the areas of the sound requiring disposal sites are prioritized below:

Based on PSDDA (1988b, 1989)	Based on URS (1989)
Elliott Bay and vicinity	Elliott Bay and vicinity
Commencement Bay and vicinity	Southern Puget Sound
Southern Puget Sound	Northern Puget Sound
Northern Puget Sound	Port Gardner and vicinity
Port Gardner and vicinity	Commencement Bay and vicinity

  Elliott Bay and vicinity had the major need (68 percent). The other areas had approximately equal needs.

- User categories of sites were determined to be the Corps, ports, marinas, boat repair facilities, local governments, industrial/commercial transportation, and the U.S. Navy.

- For all of Puget Sound, industrial/commercial transportation (23-27 percent), the Corps (24-30 percent), and the ports (19-21 percent) are the largest projected generators of dredged material that may require confined disposal, followed by marinas (15-17 percent), boat repair facilities (7-8 percent), the U.S. Navy (3 percent), and local governments (2 percent). The U.S. Navy category does not include dredging projections for Sinclair Inlet, which may be significant.

- Percentage of projected generation by user category varies with geographic area. Based on PSDDA (1988b, 1989), Corps generation varies from 65 percent in the Commencement Bay and Port Gardner areas to 21 percent in northern Puget Sound. Port generation varies from approximately 37 percent in northern Puget Sound to 7 percent in the Port Gardner area. Marina generation varies from 19 percent in the Elliott Bay area to 3 percent in the Commencement Bay area. Boat repair facility generation varies from 9 percent in the Elliott Bay area to 1 percent in the Commencement Bay area. Local government generation is in the 1-2 percent range in all areas. The commercial/industrial transportation category varies from 29 percent in the Elliott Bay area to 5 percent in the Commencement Bay area. The U.S. Navy is a significant generator in northern Puget Sound (24 percent), a contributor in the Elliott Bay area (percent undetermined), and has no dredging in the Commencement Bay area or southern Puget Sound.

- Municipal landfills are currently used for disposal of contaminated sediments and represent a viable continuing disposal option subject to local government requirements. Forty percent of the dredged material exceeding an open-water unconfined disposal criteria was placed in landfills during the 1985-1988 period.

- Disposal on user-owned or other private property is a significant current practice. The future of this practice will probably depend on the requirements of the confined disposal standards and the relevant economics of allowed disposal options.

- Several nearshore disposal areas for potential future use were identified. One site at the Port of Everett, the Terminal 90/91, and two unidentified sites in Seattle are in areas where contaminated sediment disposal or use is likely. No upland sites were identified although new sanitary or demolition landfills were not included in the survey and represent an undetermined capacity for dredged material disposal. The lack of proposed upland sites reflects the priority of the Ports and others to use dredged material to fill nearshore areas for planned expansions and probably the increased transportation and disposal costs for upland disposal and the difficulty in overcoming public opposition to sites. Potential sites previously identified in the Commencement Bay area are now planned for other uses. If the preferred alternative for the Commencement Bay Superfund project is implemented, significant impact on available nearshore sites and potential confined aquatic sites in the area will occur.

ENVIRONMENTAL AND PUBLIC HEALTH ISSUES

- The environmental and public health issues associated with the disposal of contaminated sediments are, in general, the same for multiuser sites as for sites established on a project by project basis.

- The key difference for a multiuser site program is that the number of sites is minimized by operating larger sites over a long period (e.g., 20 years). The use of fewer sites would result in fewer areas disrupted by site construction and operation. The efficiency and effectiveness of site selection, monitoring, and regulatory oversight, would be greater with multiple sites. On the other hand, the potential impacts on areas where multiuser sites are located could be much larger than at single project sites.

- Although some release of contaminants is technically unavoidable, mitigation measures, including siting requirements, engineered design of the facility, other technology controls, operations procedures, and regulatory controls, could be implemented to prevent or minimize impacts.

- Siting a multiuser site is a key mitigation measure. Sites should be located in areas where the impact of contaminant release on environmental resources and human health, should it occur, is minimized.

- The use of cells or mounds that are filled and closed sequentially over the life of the facility is a viable concept for multiuser sites. The use of cells is common practice at sanitary landfills and could be applied similarly to an upland multiuser site. Serially closed mounds should be required at aquatic sites to limit the time that the disposal material is exposed. The environmental benefit of serial cells in nearshore areas needs further examination.

- Aquatic sites have the fewest number of pathways for release of contaminants and receptors to impact, the lowest potential for release, but are more difficult to monitor and have limited mitigation options and remedial alternatives in the event of failure.

- Upland sites have the highest number of pathways for release and types of receptors to impact, and the highest potential for release, but have the most mitigation options and remedial alternatives in the event of failure. The siting process can be very effective in avoiding habitats of concern, and surface and groundwater.

- Nearshore sites are in between aquatic and upland sites with respect to pathways, receptors, and mitigation. It is more difficult to avoid sensitive habitat areas in selecting a site and, therefore, the impact of habitat loss is more significant than for either aquatic or upland sites.

- Monitoring programs and contingency plans should be required that specify actions to be taken if monitoring yields results or if structural failure occurs.

COST ANALYSIS

- The planning level cost estimates of the four generic sites indicate a range of $17.2-$45.7 million for life cycle costs and $14-$37 per cubic yard for disposal. The results of this analysis suggest that disposal will be significantly more expensive than the costs projected by PSDDA and Tetra Tech, Inc. in their recent studies. However, the costs are in line with the experience of the Port of Seattle at Terminal 90/91.

- The nearshore saturated disposal site would be the most expensive option due primarily to land acquisition, habitat mitigation, berm construction, and capping requirements. The life cycle cost of $45.7 million translates to a disposal cost of $37 per cubic yard.

- Confined aquatic disposal is a the other end of the cost spectrum with a life cycle cost of $17.2 million and a disposal cost of $14 per cubic yard. The confined aquatic option is considerably less expensive due to relatively low site development and operation costs. The costs are somewhat offset by the relatively high closure and monitoring costs.

- An upland site is estimated to have the second highest cost with a $38.7 million life cycle cost and $31 per cubic yard for disposal. The costs of an upland site are influenced by the high transportation costs, which can be attributed to the additional costs of hauling dredged material over land by truck.

- A nearshore unsaturated site is estimated to cost $34 million over the life of the project and $27 per cubic yard for disposal. The costs of a nearshore unsaturated site are comparable or lower than the costs of a nearshore saturated site with significantly lower cell capping costs.

- Several key variables have a significant impact on costs. These variables are the source and cost of capping material, the cellular design of nearshore sites, the transport distance to the disposal site, predredging testing requirements and site acquisition costs.

- Coordination between dredging projects such that clean material that is dredged can be used for capping should be cost effective.

- Site-specific factors that cannot be addressed in this generic analysis may have a significant impact on cost.

FUNDING ANALYSIS

- The feasibility of funding multiuser confined disposal sites depends on the economic impacts on users and public and private institutions. The funding analysis provides an estimate of the range of costs to users and public and private institutions. The estimates of user fees resulting from this analysis appear to be reasonable when compared to current costs for solid waste disposal. For the eight combinations of site type and funding mechanisms examined user fee estimates range from $17-$82 per cubic yard or $14-$68 per ton. Disposal fees for solid waste disposal at landfills in the Puget Sound region are in the $20-$40 per ton range. However, disposal fees at demolition landfills are less ranging from $6-$8 per cubic yard. Hazardous waste disposal fees are often over $100 per ton.

- Funding feasibility is affected by several factors that cannot be defined or estimated at this stage in the study. These include factors affecting public and private institutions, factors affecting users, and risk and liability issues.

- The feasibility for public and private institutions responsible for providing for disposal of contaminated sediments is affected by factors such as

  - Overall debt capacity and financial conditions

  - Availability of and authority over suitable sites

- Authority to control or regulate users (flow control)
- Capital planning capabilities
- Ability to assume liability for risks
- Ability to handle siting process.

Because most of these factors will depend on the specific institution, their impact on the feasibility of funding multiuser disposal sites cannot be assessed until a specific institution is designated.

- The feasibility for users is affected by factors such as:
  - Economics of the dredging project (e.g., source of funding for public users, return on investment for private users)
  - Other dredging costs, such as sediment testing and transport of dredged material
  - Available alternatives for disposing of dredged sediments.

  Some of these user factors are project specific and can only be assessed on a project by project basis. However, a better assessment of these factors could be developed by surveying users and inventorying specific alternative disposal sites.

- The feasibility of funding confined disposal sites is also affected by risk and liability such as:
  - Unpredictability of siting costs
  - Unpredictability of customer user
  - Potential liability for system failure
  - Regulatory risks.

  Some of these risk and liability issues are being addressed in the context of this and other studies on contaminated sediments. As these issues are resolved, a better assessment of the overall funding feasibility can be made.

- Confined aquatic disposal financed with tax exempt revenue bonds, is the least cost (1989 present value for life cycle costs) option of the eight disposal site funding scenarios examined.

INSTITUTIONAL OPTIONS

- The major problems identified with the existing institutional arrangement are:
  - Lack of capacity and increasing difficulty in siting facilities for solid waste and contaminated dredged material

- Lack of a coordinated management plan for dealing with contaminated dredged material
- Lack of assurance regarding the consistency and standards for disposing of dredged material in an environmentally sound manner (until standards are adopted)
- Lack of assurance that the current method of disposal results in the most cost-effective means of disposal
- Inadequate involvement by some stakeholders in disposal planning and decisionmaking.

■ The highest priority problem is the inability to site disposal facilities to ensure long-term disposal capacity. This problem is due in large part to citizen opposition to sites in their neighborhoods and a distrust of government agencies in ensuring that citizen interests are adequately protected. A new institutional arrangement would not necessarily resolve this problem. A more effective siting process, public education on the issues, and trust building, and authority are required regardless of the institutional arrangement.

■ A coordinated management plan is a need that could be met regardless of the institutional option. Many elements of such a plan already exist in the Puget Sound Water Quality Management Plan.

■ Enhanced funding and effective involvement of all stakeholders are necessary for the successful implementation of any institutional option.

■ Some mechanisms of ensuring a predictable revenue flow such as flow control, prepurchase of disposal capacity or government subsidies may be necessary regardless of the institutional option.

■ The status quo or existing system was evaluated based on current status and therefore has many disadvantages. However, some improvements are underway and more are possible. An enhanced status quo, although not presented or evaluated other than as in Options 1, 2, and 3, may be a viable alternative.

■ Of the options analyzed, an interagency combination has the most advantages. Option 3, a PSDDA-type of structure appears to be the most promising option for a new institutional arrangement based on the level of analysis conducted for this report. This option has the potential for a coordinated effort by the major stakeholders without the disruption and time delays inherent in the establishment of a totally new institution such as the new authority option. In addition, PSDDA is working in establishing an open-water unconfined disposal program. However, a PSDDA-like option would lack the advantages of a more focused, centrally-controlled option. It would require stakeholder buy-in and a strong regulatory oversight function for success.

- The ports and DNR should be key stakeholders in any institutional option because sites in industrialized port areas and aquatic areas have the greatest chance of success.

- Institutional options that vary with the disposal environment and by geographic area of the sound should be considered but only along with a centralized support and oversight structure.

- Prior to implementing the coordinating council or new authority options consideration should be given to expanding their roles to cover all wastes. An evaluation of the all-waste options is beyond the scope of this report.

- Identification of the problems with the existing system and selection and evaluation of institutional options is highly judgmental and successful implementation of any institutional option will require the involvement of the stakeholders in selecting the option to be implemented. This report should be used only as a basis for receiving broad input on institutional issues prior to Ecology's recommendation for implementation.

PUBLIC INVOLVEMENT

- Review of the issues, the current public involvement activities and the interested parties indicates that public involvement will be essential to developing an appropriate and well-accepted recommendation regarding multiuser confined disposal sites and to the successful implementation of a multiuser site program if a decision to implement is made.

- A moderate level of public involvement, accompanied by education on sediment issues, appears to be most suitable during the recommendation development process. This effort should be focused especially on groups that may be directly affected but who are not now actively involved in sediment issues: local government decision-makers, small and intermediate dredgers, and environmental organizations.

UTILITY AND VIABILITY

The utility and viability of multiuser sites depends on the answer to three questions:

- Is there a need for disposal capacity for contaminated dredged material?

- Would multiuser sites be used if they were established?

- Can multiuser sites be established?

A significant need exists for confined disposal sites in aquatic, nearshore, and/or upland areas over the next 20 years. The projected volume of dredged material requiring confined disposal for the 20 year planning period 1989-2008 is approximately 7-10 million cubic yards, representing an average yearly generation rate of 360,000-500,000 cubic yards per year. The projection does not include dredged material that may result from superfund projects such as in Commencement Bay. The majority of the need (68 percent) is in the Elliott Bay area of Puget Sound. The remainder of the need is fairly evenly distributed among the Commencement Bay area, southern Puget Sound, northern Puget Sound, and the Port Gardner area.

The extent to which multiuser sites are used may not be known until sites are actually established. The use of multiuser sites should they be established depends on the cost effectiveness and convenience from the users point of view and on the real or perceived liability of sharing a disposal site with others who are disposing of materials containing contaminants. None of these factors can be adequately evaluated at this time. Cost effectiveness and convenience will depend on a cost comparison of alternatives available to the project proponent and will be project specific. Alternatives available to a project proponent include disposal at a municipal sanitary or demolition landfill, use of a project specific private site and use of the dredged material for a beneficial use such as fill for the creation of useable land. Although the cost and funding analysis completed as part of this report indicate that user costs for a multiuser site may be comparable to current disposal charges at a municipal sanitary landfill, comparisons to disposal at an independent user developed site would involve many site specific factors and the availability of costs associated with implementing the confined disposal standards that are now being developed by Ecology. Convenience to the project proponent has both time and cost considerations. If a multiuser site was available those needing to dispose of contaminated sediments would avoid the time and resource commitment necessary to establish a project specific site.

The location of multiuser sites will be a factor in determining cost effectiveness. If one site were located in Elliott Bay where the major need is, transportation costs from projects located in northern and southern Puget Sound will have a substantial impact on costs.

The disposal environment in which multiuser sites may be established will also impact cost effectiveness among alternatives that may be available to project proponents. The planning level cost analysis indicates that confined aquatic disposal site user fees would be approximately $14 per cubic yard, compared to $27 and $31 per cubic yard for nearshore and upland sites respectively.

The liability aspects of multiuser site use are probably a deterrent at this time. Those needing to dispose of contaminated sediments at the low end of the contamination range may be reluctant to use a facility that also receives sediments that are more contaminated.

The viability of a multiuser site program involves the likelihood of getting sites established and keeping them operational for any given planning period. Viability depends on the utility discussed above but also on the environmental and public health impacts and available mitigation, the cost and availability of funding to establish and operate sites, the ability to establish sites when there is growing opposition to any new sites involving waste disposal, and the ability to establish appropriate institutional arrangements to develop, regulate and implement a multiuser site program.

Confined aquatic disposal appears to be the best disposal option with respect to potential environmental impacts provided that acceptable sites can be found. However, it is the option with the least Puget Sound area implementation history and the failure of the proposed use of this option for the Navy Homeport project may be a difficult precedent to overcome. Confined aquatic sites may also be the most publicly acceptable because they are not located in or near residential neighborhoods , truck traffic is not an issue assuming that dredged material is barged to the site, and there is generally no potential for groundwater contamination.

Nearshore sites may be the second best choice if sites in industrialized areas such as ports that are planned for filling for beneficial use can be utilized and if environmental impacts such as loss of habitat can be avoided or adequately mitigated. As with aquatic sites truck traffic and groundwater contamination would generally not be an issue.

Upland sites would be the most difficult to implement. Although these sites can be designed to contain contaminants public concerns over groundwater, traffic volumes and noise and the general reluctance to accept any kind of a waste facility any where near residential areas will be difficult to overcome. Use of municipal or demolition landfills, especially if the dredged material can be used for cover material may be a viable option. Upland sites located in industrialized areas such as ports may also have more of a chance for acceptance.

The generic cost and funding analyses conducted as part of this study indicate that funding based on user fees may be feasible for multiuser sites. However these analyses are limited as the actual cost of complying with the forthcoming confined disposal standards are estimated, liability cost are not known and have not been included, costs that may be site specific are not known and therefore not included, and the actual use of the sites, i.e., revenue cannot be guaranteed. The analyses also did not include the cost of the regulatory system to oversee the system.

Several institutional arrangements to develop and implement a multiuser site system are possible. The options range from enhancement of the existing system to creation of a new authority at the state level that would have responsibility for the disposal of all waste including contaminated dredged material.

Funding for the selected institutional option has not yet been addressed except for the establishment of disposal sights. Funding for the entire multiuser site program including development of the required standards and guidelines, a coordinated dredging management plan, a liability management plan, and the regulatory oversight structure will be required.

Public education and involvement and a major involvement by stakeholders in developing the program will be a major factor in the viability of a multiuser site program.

RECOMMENDATIONS

This report presents an analysis of the issues involved in the establishment of a multiuser confined disposal site program for contaminated sediments and draws general conclusions on the utility and viability of a multiuser site program. The decision process on the utility and viability of a multiuser site system will be iterative with recommendations to proceed or not proceed with the study made based on information available at the time. Based on the definite need for disposal site capacity for contaminated dredged material in Puget Sound, it is recommended that the multi-user disposal site program study proceed. A key consideration for future activities is where to focus limited resources. Three categories of recommendations and a timeframe of implementation of each are made, as follows:

1. Recommendations based on proceeding as rapidly as possible to address confined disposal needs in parallel with the public review process for this report. This category should be implemented immediately and the results used in formulating a recommendation to the Puget Sound Water Quality Authority.

2. Recommendations related to the confined disposal standards process. This category should be implemented as soon as possible, subject to available resources and priorities.

3. Recommendations on expanding the information base on which the draft report is based and updating the draft report to reflect the status of the confined disposal standards. This category is lower in priority and should be implemented after the categories above.

Category 1

- Implementing the public education and involvement plan to provide involvement and education of agency decisionmakers, stakeholders, special interest groups, and the general public on the characteristics of contaminated sediments and on disposal issues is recommended.

- Integration of public involvement and education for multiuser site programs into an overall program for sediments is recommended.

- Implementing a consensus building process on the multiuser site program including institutional options is recommended. It is recommended that consensus building occur in two integrated steps:

1. Consensus building with a group such as the Agency Forum for Sediment Issues but with broader representation

2. Involvement of major stakeholder decisionmakers (e.g., local government councils, and of Tribes, environmental groups, and the general public).

- Viability of multiuser sites may depend on those entities planning large projects or conducting routine dredging involving contaminated sediments being willing to allow use of project disposal sites as multiuser sites. It is recommended that the larger ports, the Corps, and perhaps the U.S. Navy, be approached on such a concept and that incentives such as shared liability be considered to encourage their participation if that is necessary.

- Examination of the feasibility of funding a PSDDA like process to locate one or more aquatic, nearshore or port area upland sites in Elliott Bay, develop a coordinated dredging management plan and develop a liability management plan is recommended.

- An analysis to determine the potential available capacity for contaminated sediments in existing municipal and demolition landfills, the extent to which planned new facilities are considering capacity for contaminated sediments, and a technical feasibility and cost analysis for the use of contaminated sediments as interim and partial final cover at municipal landfills are recommended.

Category 2

- Siting is a key problem and a major mitigation measure. Siting guidelines and development of a siting process are recommended.

- The cell structure assumed in this report for nearshore site design is costly but may be practical for early beneficial use of filled areas and in consideration of unpredictable long term use of sites. Monitoring requirements will be dependent on design requirements. A detailed analysis of design and operation is required. For aquatic sites the period of time that a cell can remain open should be determined and monitoring requirements that reflect the cellular design should be developed. It is recommended that the confined disposal standards address multiuser site design and operations.

- If multiuser sites are to be designed in accordance with the proposed functional standards the need for multiuser sites may be dramatically impacted by the volume of dredged contaminated sediments that falls within the proposed criteria band allowed for use of the functional design. Clarification on whether multiuser sites will be functionally-based, effects-based, or both, is recommended.

Category 3

- More accurate information on the future volume of dredged material requiring confined disposal is needed. An inventory of existing sediment data combined with a survey to determine future dredging projects might be useful. The survey would be a necessary part of the coordinated dredging management plan recommended in Category 1. The inventory of existing data would probably be limited by the lack of data on tests that are now being required and proposed to characterize sediments for disposal purposes. It is recommended that consideration be given to enhancing the sediment quality database, once testing requirements are determined.

- One of the key factors in the utility and viability of multiuser sites is whether use of such sites would provide a cost effective alternative to dredgers of contaminated sediments. The cost and funding analysis could be updated when the confined disposal standards effort has considered the design and operational aspects of multiuser sites and the related costs. A cost comparison between alternate disposal options such as a project specific site and use of a multiuser site would be ideal but is probably not practical due to the number of project specific variables that would be involved for a wide range of projects and the fact that multiuser site locations are unknown. It is recommended that updating the cost and funding analysis and cost comparisons on alternative disposal options be considered later in the program.

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