PTI ENVIRONMENTAL SERVICES

Final Report

Multiuser Confined Disposal Sites Program Study

For

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Olympia, Washington

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FINAL REPORT

MULTIUSER CONFINED DISPOSAL SITES PROGRAM STUDY

By

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LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPN	citizen/proponent negotiation
Corps	U.S. Army Corps of Engineers
DNR	Washington Department of Natural Resources
Ecology	Washington Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
MCUL	minimum cleanup level
MOU	memorandum of understanding
MTCA	Model Toxics Control Act
PLP	potentially liable party
PSDDA	Puget Sound Dredged Disposal Analysis
PSWQA	Puget Sound Water Quality Authority
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
WAC	Washington Administrative Code
WSR	Washington State Register

EXECUTIVE SUMMARY

The Washington Department of Ecology (Ecology) is currently studying the utility and viability of establishing a system of multiuser confined disposal sites for contaminated sediments dredged from Puget Sound. The study is being conducted as required by the 1989 Puget Sound Water Quality Management Plan, under the Contaminated Sediments and Dredging Program. Results of the study will form the basis of recommendations to the Puget Sound Water Quality Authority for the establishment of the multiuser sites program.

The objectives of the Multiuser Confined Disposal Sites Program Study are to identify the issues and to make a recommendation regarding the utility and viability of multiuser sites for the confined disposal of contaminated sediments in upland, nearshore, and aquatic areas. Initial efforts involved developing issues 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 report. Seven issues papers were developed to support the conclusions and recommendations contained in this report. The issues papers, which can be obtained from Ecology, are:

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

This report presents the main findings of the issues papers and conclusions and recommendations on the utility and viability of establishing a multiuser site program. The report is organized into sections that correspond in general to the issues papers prepared as part of this study.

ASSESSMENT OF NEEDS

From 1985 to 1988, approximately 1.2 million cubic yards of dredged material was placed in confined disposal sites. It is projected that during the period 1989-2008, up to 10 million cubic yards of contaminated sediments from navigational dredging projects will require confined disposal. In addition, cleanup activities at contaminated sediment sites under federal and state hazardous waste programs could generate over 70 million cubic yards of material requiring confined disposal (assuming all contaminated sites will be dredged).

Seven potential sites have been identified for disposal of contaminated sediments from navigational dredging projects, but the total combined capacity of these sites is only about 1 million cubic yards. No sites have been identified for the disposal of contaminated sediments from site cleanup activities. Use of municipal landfills as disposal sites is not likely to remain a viable option, largely due to shrinking capacity and bans on importation of out-of-county wastes.

ENVIRONMENTAL AND PUBLIC HEALTH ISSUES

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 major 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 or potentially affected by site failure.

The environmental and public health issues associated with disposal of contaminated sediments differ among the three types of disposal sites (i.e., aquatic, upland, and nearshore sites). The major differences stem from the number and types of receptors in the vicinity of the site, the number of contaminant transport pathways, mitigation measures, and the potential for contaminant release. In general, aquatic sites have few contaminant transport pathways and a low potential for long-term release of contaminants, largely because the physical and chemical environments of the disposal site and dredging sites are similar. However, aquatic sites are difficult to monitor and have limited mitigation options and cleanup alternatives in the event of failure. Upland sites have many contaminant transport pathways, but have more mitigation options and cleanup alternatives in the event of failure. Nearshore sites are exposed to active water exchange due to tidal activity and rank between aquatic and upland sites in terms of the numbers of contaminant transport pathways and the availability of mitigation options.

COST ANALYSIS

Estimated base-case costs range from $17 million to $46 million for 1,250,000 yards of dredged material for the three confined disposal sites (nearshore saturated and unsaturated sites are analyzed separately). The nearshore saturated option is the most expensive and the confined aquatic alternative is the least expensive. The cost model used for estimating these costs is highly sensitive to changes in the discount rate and the unit cost for land transportation. Total costs increased from 0-64 percent based on the particular cost factor being evaluated. Dredging cost increases cause overall cost increases for all options, although the increase for the confined aquatic disposal option is the largest. The greatest change in estimated costs occurs when the assumed cost of land transportation increases. High land transportation costs makes the upland disposal option the most expensive alternative under all sensitivity analyses. Increased costs for habitat mitigation result in a minor overall cost increase for the nearshore alternatives, while additional design and permitting costs for the nearshore alternatives result in a negligible increase in total costs.

A worst-case cost analysis showed that changes in factors other than the unit cost for transportation, even when combined together, do not have a significant effect on total costs. With the exception of the upland disposal option, increases in total costs ranged from 12 percent to 21 percent. Under the worst-case analysis, the upland disposal option increases by 72 percent and becomes the most expensive option; the confined aquatic option remains the least expensive.

FUNDING ANALYSIS

The major factors affecting the selection of funding alternatives for the multiuser sites program include costs, ownership and operation options, financing techniques, funding sources, and the economic impacts on users and public and private institutions. Although a preferred funding alternative cannot be recommended based on the analysis in this report, there are two major factors that are likely to favorably influence the selection of one or more alternatives: 1) present and future disposal needs and 2) the high cost of landfill disposal.

The use of public or private institutions as a source of funds for the multiuser sites program is affected by factors such as overall debt capacity and financial condition, availability and authority over suitable sites, authority to control or regulate users (flow control), capital planning capabilities, ability to assume liability for risks, and ability to facilitate the siting process. The availability of users fees as a source of funds is affected by the overall economics of specific dredging projects and the availability of alternatives for disposing of dredged sediments. The selection of funding alternatives for the multiuser sites program is also affected by risk (e.g., the unpredictability of siting costs, inability to control customer use, and regulatory uncertainty) and liability issues.

The funding analysis indicates that private financing is more expensive than tax-exempt revenue bonds for all siting options, depending on the validity of certain assumptions contributing to this conclusion. Tax-exempt aquatic disposal appears to be the least costly to finance, followed by private aquatic disposal, tax-exempt nearshore unsaturated disposal, tax-exempt upland disposal, tax-exempt nearshore saturated disposal, private upland disposal, and private nearshore unsaturated disposal. Private nearshore saturated disposal was determined to be the most expensive to finance.

INSTITUTIONAL OPTIONS

Eight institutional options were developed and evaluated for their adequacy in addressing major problems identified within the existing system and the interests of agencies and organizations (stakeholders). The major problems with the existing system include lack of coordination, lack of stakeholder representation, and environmental inconsistency.

Option 3 consists of program management by a coordinated entity formed by federal, state, and local governments with ensured participation of ports and solid waste disposal interests in decision-making. This option appears to have the greatest potential for dealing with problems of the existing system. The major stakeholders will be represented in one entity, which should improve the coordination of the entire program. The remaining options either lack the representation of one or major stakeholders or call for the creation of a new stakeholder (i.e., coordinating council or new authority). Obtaining political and public acceptance of a new stakeholder may be difficult and expensive.

Consideration should also be given to enhancing the existing system. Improvements such as the development of confined disposal standards are currently under way. Additional actions such as increased stakeholder representation (e.g., local government and private solid waste disposal interests) and community involvement could improve the current dredged material management system and make it more suitable to a multiuser site program.

LIABILITY ISSUES ANALYSIS AND MANAGEMENT PLAN

Although regulatory liability standards will affect the viability of the multiuser sites program, the standards can be accommodated with a sufficiently protective program and should not deter program development. Generally accepted interpretations of the liability provisions of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Model Toxics Control Act indicate there are few legal or regulatory limitations on liability for multiuser site program stakeholders. However, both statutes are designed to promote the development and use of operational and managerial techniques to minimize the risks of participation in inherently dangerous activities. In addition, CERCLA has been interpreted to allow contractual agreements to effect an equitable allocation of liability risks among stakeholders.

The best guarantees against liability may be those gained through legislatively sanctioned protections. The possibility of providing statutory bases for exemptions should be examined further, especially if such exemptions can be structured to promote development of and adherence to higher safety standards. Transfers of liability from stakeholders to a pollution liability fund [e.g., see CERCLA Section 107(k)(1)], may be desirable under certain circumstances. The feasibility and methods of gaining such legislative protection may be one of the most important topics for future investigation.

Aside from the possibility of legislative protection, the best liability management plan will adopt appropriately high standards of design, construction, operation, management, and closure of the site, with provisions for updating those standards in accordance with technological advancements. Optimally, the program will evolve from reasonable worst-case scenarios that could result in the adoption of more stringent standards than those currently required under any federal or state law.

PUBLIC EDUCATION AND INVOLVEMENT PLAN

A public education and involvement plan is the primary tool for obtaining public acceptance of a multiuser confined disposal sites program. Varying degrees of public acceptance are likely to be required for program development activities including, in particular, funding methods, proposed legislation, and siting. A specific level of public education and involvement is likely to be required as part of the State Environmental Policy Act process. However, additional efforts are strongly recommended to address the increasingly heightened public concern regarding the siting of all types of disposal facilities.

Public education and involvement during the screening phase of the siting process should focus on the continuation of efforts to identify entities likely to have an interest in contaminated sediment issues, the development of materials describing the program, dissemination of those materials to the public so that informed decisions are possible, and preparation of other materials for public presentation. It may be necessary to tailor the distribution and presentation of materials to meet the needs of particular interest groups, or to meet changing geographical and technical needs of the program.

During implementation of the siting process, it may be appropriate to investigate the value of establishing a forum for arriving at negotiated settlement between public interests and the stakeholders. Ecology's Citizen/Proponent Negotiation process provides a model that can be adopted for use in the multiuser sites program.

CONCLUSIONS AND RECOMMENDATIONS

This phase of the program study focused on the viability and utility of establishing a system of multiuser confined disposal sites for the disposal of contaminated sediments. It was concluded that such sites are needed and that the urgency will only increase as the volume of dredged material requiring confined disposal increases. A primary cause of the increase in volume can be attributed to the additional activities that will result from the cleanup of contaminated sediments that threaten the environmental, economic, and social health of Puget Sound.

Future issues most likely to affect the successful development of the multiuser sites program are siting, liability management, funding, and choice of institutional management option. There is a need for an expanded evaluation of each of these issues to facilitate the development of the program. Development of a comprehensive siting process and a liability management plan may need to be addressed during the next phase of program development. In addition, funding methods should be explored in connection with the expanded study of siting. Finally, designation of the institutional management option is likely to be a threshold issue that will determine how siting, liability management, and funding efforts progress. It is likely that a consensus-building effort, similar to the one used to study viability and utility of the program, will also be required during the next phase.

1. 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 (referred to as multiuser sites in this report) 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 acceptable for disposal at 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 1988a,b). Disposal requirements for contaminated sediments not acceptable for open-water unconfined disposal are currently being addressed by Ecology.

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; sediment testing for determining contamination levels; and the design, operation, closure, and postclosure 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 has occurred at sites established on a project-specific basis, especially for larger dredging projects. 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 that requires confinement. 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 objectives of the Multiuser Confined Disposal Sites Program study being conducted by Ecology are to identify the issues associated with confined disposal and to make a recommendation regarding the utility and viability of multiuser sites for the confined disposal of contaminated sediments in upland, nearshore, and aquatic areas. Initial efforts involved developing issues papers on the environmental, economic, and institutional aspects that need to be considered in adopting and implementing a multiuser sites program, and producing this report. Seven issues papers were developed to support the conclusions and recommendations contained in this report. The issues papers, which can be obtained from Ecology, are:

- *Assessment of Needs* (PTI 1990)
- *Environmental and Public Health Issues* (GBB 1989a)
- *Cost Analysis* (GBB 1989b)
- *Funding Analysis* (CCA 1989)
- *Institutional Analysis and Options* (Fernandes Associates and PTI 1989)
- *Liability Analysis and Liability Management Plan Outline* (Henson and Booth 1990)
- *Issues Assessment and Public Involvement/Education Plan* (Hall and Associates 1989)

This report presents the main findings of the issues papers and conclusions and recommendations on the utility and viability of establishing a multiuser site program. The report is organized into 10 sections, corresponding in general to the issues papers prepared as part of this study. Section 2 presents a brief history of contaminated sediments disposal in Puget Sound and documents events that have led to the investigation of the feasibility of a multiuser sites program. Historical disposal practices, including volumes of dredged and contaminated material and disposal sites, are discussed. Section 2 also presents a projection of dredging volumes by user group and potential sites over a 20-year planning period to indicate the future requirements for multiuser sites. Section 3 presents the environmental and public health issues associated with constructing and operating multiuser sites in aquatic, nearshore, and upland environments. Section 4 presents a discussion of costs and comparison of costs among alternative sites. Section 5 presents and evaluates funding alternatives for a multiuser sites program. Section 6 presents and evaluates institutional options for siting, owning, operating, and regulating multiuser sites. Section 7 presents a discussion of issues regarding liability and presents the outline for a liability management plan. Section 8 presents recommendations for public education and involvement in conjunction with a multiuser sites program. Section 9 presents conclusions regarding the utility and viability of a multiuser sites program, presents recommendations for the next phase of the program study, and restates issues requiring resolution by decision-makers.

2. ASSESSMENT OF NEEDS

This section presents a brief description of dredged sediment disposal 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; future requirements for disposal of contaminated dredged sediments; and a description of the geographic areas and types of confined disposal sites that could be used for multiuser sites. The discussions of past practices for dredged sediment disposal focus on navigational dredging because this activity has historically been the predominant source of sediments. However, future disposal sites will also have to accommodate increasing quantities of contaminated sediment generated as a result of site cleanup under federal and state programs.

DREDGED SEDIMENT DISPOSAL IN PUGET SOUND

Puget Sound is a major corridor for interstate and international marine transportation. A reliable system of navigable waterways is needed to ensure the continued viability and expansion of the economic base of the Puget Sound region and the state as a whole. Navigable waterways need periodic dredging to remove sediments that accumulate on the bottom. Much of these sediments are transported into Puget Sound by rivers and by storm water runoff from urban areas. Due to the industrial character of many urban areas and the chemical and physical properties of contaminants, sediments that accumulate in urban areas are often contaminated with a variety of substances.

More that 50 miles of navigation channels require dredging in Puget Sound. In addition, there are 34 port districts with approximately 10 miles of port terminal ship berths and over 200 small boat harbors that require regular maintenance dredging. In the next 20 years, an estimated 35 million cubic yards of material will be dredged from Puget Sound waterways for navigation purposes. Of this amount, up to 10 million cubic yards may require confined disposal.

The maintenance of navigation channels in Puget Sound has been historically 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. Most 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 and have used local sanitary landfills or nearshore or aquatic sites when 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.

Environmental impacts from the disposal of dredged sediments in Puget Sound became an issue in the early 1980s. 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, scientific studies revealed contaminants in marine sediments and biological abnormalities such as liver tumors in bottom fish.

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

In 1985, the PSDDA study was initiated as a multiagency effort between the U.S. Army Corps of Engineers (Corps), EPA, Ecology, and Washington Department of Natural Resources (DNR). The objectives of the study were to identify acceptable locations for open-water, unconfined disposal of sediments; to develop adequate site management plans; and to define consistent and objective evaluation procedures for dredged material proposed for open-water, unconfined disposal. Phases I and II of the study have been completed. Phase I resulted in the successful designation of open-water, unconfined disposal sites in central Puget Sound. Phase II addresses 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.

RECENT 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 Issues Paper* (PTI 1990).

Disposal Site Users and Volumes of Dredged Material

The following groups have historically used disposal sites for dredged material:

- Corps
- Ports
- Marinas
- Boat repair facilities
- Local governments
- Commercial and industrial transporters
- U.S. Navy
- Log storage facilities
- Private citizens and developers.

Table 1 presents the total volume of dredged material disposed of during 1985–1988 in upland, nearshore, or confined aquatic sites; the volume of contaminated material; and the location of the dredging projects 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 both confined and unconfined 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 548,809 cubic yards of material in upland or nearshore sites; 53,904 cubic yards (9.8 percent) of this material was designated as contaminated (i.e., unsuitable for open-water unconfined disposal). Dredgers other than the Corps dredged 664,856 cubic yards of material and disposed 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 Washington Department of Transportation has conducted dredging at its ferry terminals throughout Puget Sound; however, material dredged from these locations has not required confined disposal.

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.

TABLE 1. DISPOSAL OF DREDGED MATERIAL IN UPLAND, NEARSHORE, AND CONFINED AQUATIC DISPOSAL SITES, 1985-1988 (cubic yards)

	Corps		Ports		Marinas		Boat Repair Facilities		Local Governments		Commercial and and Industrial Transportation		Log Storage		U.S. Navy		Private Citizens and Developers		Total	
Dredging Location	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
San Juans																			0	0
Port Angeles			36,494	1,944							20,000								56,494	1,944
Port Townsend					4,600														4,600	0
Admiralty Inlet	30,466	0																	30,466	0
Whidbey Island															54,000	54,000			54,000	54,000
Sinclair/Dyes Inlet	4,000														70,200	70,200			74,200	70,200
Port 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
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
Total Confined	548,809	53,904	278,194	225,244	92,665	25,020	4,420	12,820	3,552	3,552	107,675	43,900	25,400		124,200	124,200	8,750		1,213,66	488,640
% User Contaminated[d]		10%		81%		27%		53%		100%		41%				100%				NA[e]
% of Contaminated[f]		11%		46%		6%		3%		<1%		9%				25%				40%

[a] T - total.

[b] C - contaminated.

[c] Contaminated material exceeded any one of the following: Puget Sound interim criteria, Fourmile 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 contamination for all user categories.

User Category	Percent
Ports	46
U.S. Navy	25
Corps	9.8
Commercial and 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 types, 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 presented is for the north, central, and south areas of the sound, illustrated in Figure 1. Municipal landfills are currently used for disposal of contaminated sediments; however, due to capacity and policy limitations, they do not present 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.

Northern Puget Sound—During the study period, 132,415 cubic yards of contaminated dredged material was placed in upland, nearshore, or confined aquatic disposal sites. Of this quantity, 24,000 cubic yards was designated as contaminated based on Port Gardner criteria, 54,415 cubic yards was designated as contaminated based on Puget Sound interim criteria, and 54,000 cubic yards was designated as contaminated based on PSDDA guidance. (Although PSDDA disposal sites were not available for use in 1988, PSDDA guidelines were available for the designation of dredged material.) Only three sites in the northern Puget Sound area accepted dredged material that exceeded Puget Sound interim criteria. The Port of Port Angeles and the Naval Air Station on Whidbey Island placed contaminated dredged material on upland portions of their properties, and the Port of Anacortes used a nearby upland site (the Scott Paper site).

Central Puget Sound—The central Puget Sound region had the greatest volume of contaminated dredged material placed in upland, nearshore, or confined aquatic disposal sites (351,185 cubic yards). Of this quantity, 192,093

TABLE 2. DISPOSAL OF CONTAMINATED MATERIAL IN UPLAND, NEARSHORE, AND CONFINED AQUATIC DISPOSAL SITES, 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	Open	Landfill	Whidbey NAS[b]								54,000		54,000
Puget	Open	Upland	Port of Anacortes[c]	40,711	24,000		11,700						76,411
Sound			Port of Port Angeles[d]		1,944								1,944
Central	Closed	Landfill	Kent-Highlands			3,000							3,000
Puget	Closed	Nearshore	Terminal 90-91		115,500								115,500
Sound			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	Closed	Upland	Private fill			1,200							1,200
Puget	Closed	Aquatic	Budd Inlet			3,900							3,900
Sound													
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, Fourmile 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.

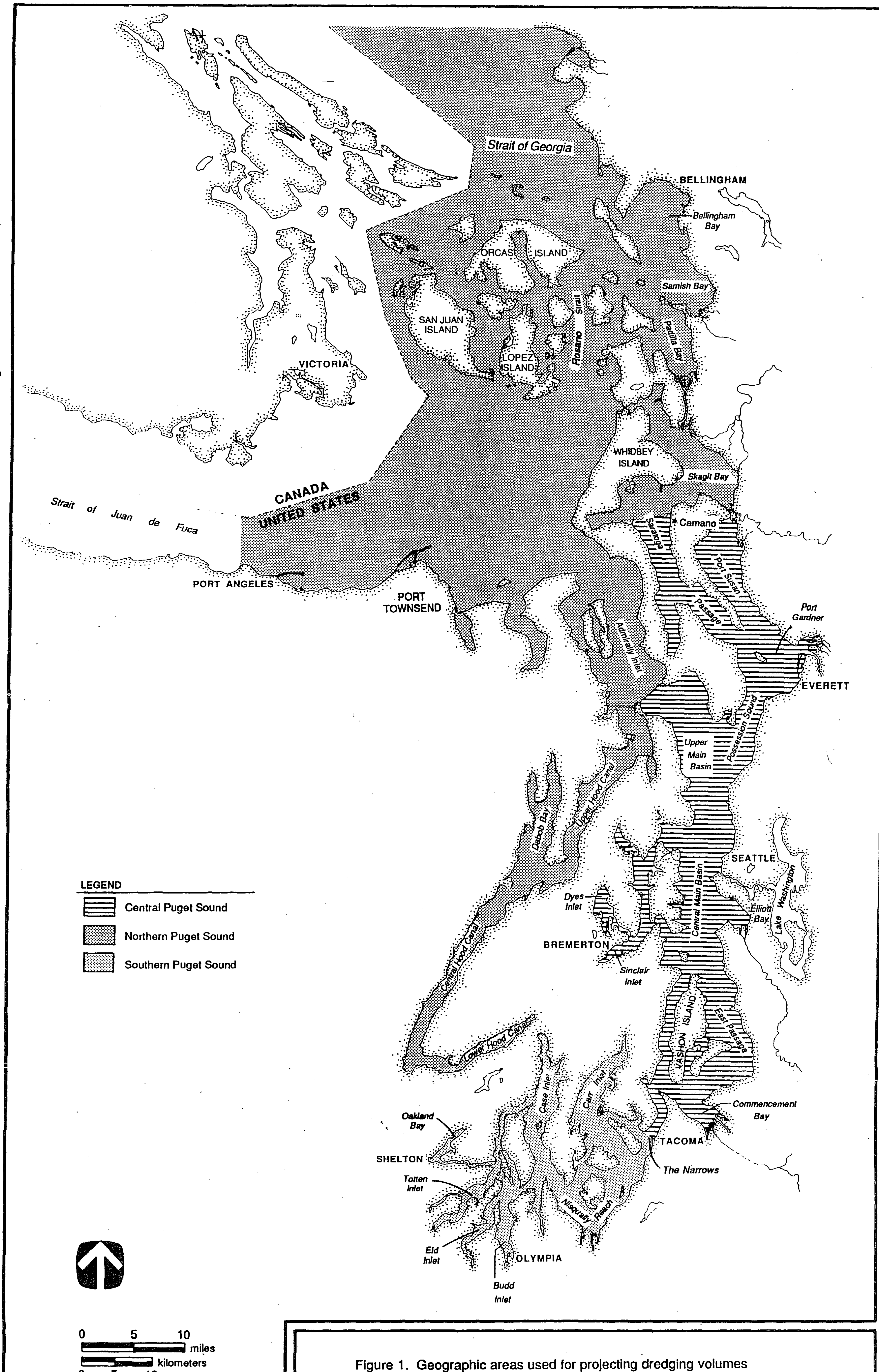

Figure 1. Geographic areas used for projecting dredging volumes

cubic yards of material exceeded Puget Sound interim criteria and 138,100 cubic yards exceeded Fourmile Rock criteria. The contaminant characteristics of the remaining 20,992 cubic yards were not determined. Numerous sites accepted contaminated material for disposal, including 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 potential, but limited 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), and 5) Cathcart landfill (Snohomish County).

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 Puget Sound 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 landfill and subsequently covered it with an asphalt parking lot.

FUTURE REQUIREMENTS

This section develops estimates of volumes of contaminated sediment that will be generated by future navigational dredging projects and cleanup of contaminated sites, and presents discussions of the locations of potential disposal sites and implications of contaminant concentrations on management strategies for confined disposal.

Volume Estimates for Navigational Dredging Projects

The volume projections for navigational dredging projects for 1989–2008 are based on the assumption that all material not suitable for open-water, unconfined disposal will require confined disposal. The volumes of dredged material requiring confined disposal are projected for each user group by geographic area. Two sets of projections are presented in Table 3 and are based on estimates from URS (1989) and PSDDA (1988a, 1989) of the percentage of material estimated to fail criteria for open-water, unconfined disposal. The estimates are presented as a range in the following discussions.

The total projected volume of contaminated dredged material for Puget Sound is 7.2-10 million cubic yards. The volume represents an average yearly disposal rate of 0.36-0.5 million cubic yards. Approximately 68 percent of the material

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

	Corps		Ports		Marinas		Boat Repair Facilities		Local Governments		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	0	0	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	1,198	2,313	220	152	7,194	9,987

[a] URS - Calculated from *Standard Development for Confined Disposal of Contaminated Sediment Review of information.* Draft Final Report. February 1989.

[b] PSDDA - Calculated from: 1) *Final Environmental Impact Statement - Unconfined Open-Water Disposal Sites for Dredged Material - Phase I* (June 1988); 2) Evaluation Procedures Technical Appendix - Phase I (June 1988); 3) *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.

would be generated from the Elliott Bay 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, ports, marinas, and commercial and industrial transporters are the major dredgers. Each group is projected to generate approximately 20-28 percent of the total volume. The commercial and industrial transporter category includes companies with shoreside facilities (e.g., docks and piers) that are used for transportation of raw materials or finished products. The projected volumes of contaminated material 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) is generated in northern Puget Sound. The U.S. Navy is the primary generator (24-58 percent of the contaminated material), and the ports and the Corps generate 37 and 21 percent, respectively. The commercial and industrial transporter 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) is generated in this area. Commercial and industrial transporters (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.

- 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) is generated in this area. Based on the PSDDA projections, contribution by user category is as follows: the Corps (21 percent), ports (21 percent), marinas (19 percent), boat repair facilities (9 percent), commercial and industrial transporters (29 percent), and local governments (2 percent). Dredging activity in Sinclair Inlet performed by the U.S. Navy is not included in the projections.

- 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) is generated in this area. The primary generators 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 and industrial transporters (0-5 percent) are other generators.

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

Volume Estimates for Site Cleanup

In addition to navigational dredging projects, a large volume of contaminated sediment is likely to be generated by future site cleanup actions [(e.g., cleanup pursuant to the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also known as Superfund) and the state Model Toxics Control Act (MTCA)]. Under the direction of the 1987 Puget Sound Water Quality Management Plan (PSWQA 1987), Ecology is developing sediment quality standards and a decision process for managing contaminated sediments. As part of this process, Ecology has produced a draft environmental impact statement (EIS) that evaluates the impacts of implementing several alternative sediment quality standards (Ecology 1990). The sediment quality standards identify chemical concentration limits for sediments and alternative tests for biological effects. The standards provide cleanup objectives (i.e., sediment quality standards), higher trigger levels to determine when cleanup is needed (cleanup screening levels), and minimum cleanup levels that must be achieved by all cleanup activities [minimum cleanup level (MCUL)].

The preferred alternative standard for sediment cleanup (i.e., the MCUL) is comparable to the standard used for determining if dredged sediments can be disposed of in open-water, unconfined sites under PSDDA [i.e., Site Condition II; please see PSDDA (1988a,b) and Ecology (1990) for more detail].

Ecology (1990) used environmental data from 10 areas of Puget Sound to estimate the areal extent of potential sediment cleanup actions under each of the alternative MCULs. Potential worst-case estimates of the future need for confined disposal can be derived from these calculations by assuming that each cleanup area will need to be dredged to a depth of 4 feet (the average depth of a clamshell dredge lift). Table 4 presents estimated areas and volumes requiring cleanup pursuant to Ecology's proposed sediment quality standards for Puget Sound.

Ecology (1990) extrapolated the 10 case study estimates to all of Puget Sound by multiplying the average area represented by each sampled station (190,594 square yards) by the total number of stations at which a sediment standard was

TABLE 4. ESTIMATED AREAS AND VOLUMES REQUIRING CLEANUP UNDER ECOLOGY'S PROPOSED SEDIMENT CLEANUP STANDARDS FOR PUGET SOUND

Site	Area (square yards)	Volume (cubic yards)[a]
Bellingham Bay	1,968,715	2,624,953
Eagle Harbor	524,390	699,187
Elliott Bay (outer)	2,047,661	2,730,215
Everett Harbor	646,716	862,288
Head of Hylebos	111,579	148,772
Hylebos Waterway	1,245,818	1,661,091
Magnolia Bluff	0	0
Ruston Shoreline	1,324,500	1,766,000
Sinclair Inlet	4,537,057	6,049,409
Sitcum Waterway	53,415	71,220
Total	12,459,851	16,613,135

[a] Assumes that 4 feet of sediment will be dredged from the entire area (Ecology 1990).

exceeded. Using this approach, it was estimated that 55 million square yards (or 73 million cubic yards) of Puget Sound sediments may eventually require cleanup and confined disposal if the PSDDA-comparable alternative is implemented.

These area and volume estimates should be considered as illustrative only. They were derived using limited data and may vary significantly from actual areas and volumes calculated in the future from a refined database. Although it is possible that the estimated cleanup volumes will increase as more contaminated areas are discovered, the actual volume of sediments generated by cleanup activities alone may be smaller than that presented above because:

- Some sediments identified for cleanup may nevertheless meet criteria for open-water, unconfined disposal based on the results of alternative biological effects tests
- Some areas with contaminated sediments may be cleaned up by *in situ* capping rather than by dredging and disposal (although wide-spread capping is not an acceptable cleanup alternative under the sediment management standards being developed by Ecology)
- Cleanup exemptions may be provided for areas where sediments are expected to recover naturally within 10 years (i.e., slightly contaminated areas may not require active cleanup).

In addition, the 10 case studies include (to varying degrees) contaminated areas that will be subject to navigation dredging. Therefore, total confined disposal needs are somewhat less than the sum of the needs arising from navigation dredging (presented in the previous section) and site cleanup.

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 capacities of these three sites range 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 have been identified in Commencement Bay for disposal of contaminated sediments generated by cleanup activities at the Superfund site.

Contaminants and Confined Disposal Management

Dredged material to be placed in upland, nearshore, or confined aquatic sites may range in the degree of contamination from clean material that can be placed in nearshore and upland sites for a beneficial use or for economic considerations, to material that fails open-water, unconfined disposal criteria, 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 less restrictive than the current PSDDA guidance for open-water, unconfined disposal, the volume projections for dredged material requiring confined disposal will be lower than those presented above.

The degree of contamination of dredged material may affect the continued use of existing disposal sites. For example, King County allows material in its demolition landfills that contains 10 percent or less 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.

The degree and nature of contamination may also affect 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 contaminant characteristics on disposal site design.

Potential Disposal at Municipal Landfills

One potential alternative to a multiuser site is to dispose of dredged sediments at existing landfills. This alternative was investigated by Ecology in December 1989 (CEC 1989). Ecology interviewed environmental health and solid waste regulatory agencies to determine their ability and willingness to accommodate dredged sediments at municipal landfills, either as solid waste or as cover material. The agencies were questioned about existing and prospective plans to accommodate dredged sediments, current and planned landfill capacities, current sources of cover material, and the acceptability of using dredged sediments as cover material.

Only one agency had addressed the incorporation of dredged sediments in its solid waste disposal plans. The failure of the other agencies to develop disposal plans may be due in part to the lack of specific regulatory provisions regarding dredged sediments. Currently, dredged sediments are classified at the state level as "problem" wastes, under the Minimum Functional Standards for Solid Waste Handling (173-304 WAC), and no regulations currently exist for managing problem wastes.

In general, the agencies are reluctant to accept dredged sediments for disposal at municipal landfills. The greatest concern is the lack of current capacity and the difficulty of siting new landfills. Most of the landfills in Puget Sound have estimated life spans of less than 10 years. Some agencies are either reluctant or unable (for policy reasons) to accept out-of-county wastes, for example, several counties have banned the disposal of wastes generated outside the county because of a lack of capacity.

Beneficial use of dredged sediments as cover material is also not generally acceptable. Although Ecology could permit the use of dredged sediments as cover so long as contamination levels in the sediments did not reach dangerous waste standards, local health departments have the authority to set their own higher standards that may preclude such use. In general, landfill operators will not accept dredged sediments unless the sediments have been dewatered. In addition, most landfills have onsite sources for cover material that can be exploited at no or little cost. Four of the 14 agencies interviewed import their cover material. Of those four agencies, three import less than 30 percent, while the fourth imports 85 percent of its material from a reliable, low-cost source (less than $4.00 per cubic yard).

SUMMARY

Dredging is necessary in Puget Sound to keep waterways open for ports, naval facilities, and over 200 small boat harbors. Historical practices of disposing of dredged material are no longer acceptable due to public awareness and concern over potential environmental and public health risks from contaminated sediments. The federal and state agencies responsible for environmental issues related to Puget Sound are exploring the feasibility of a coordinated management program for disposing of contaminated sediments.

From 1985 to 1988, approximately 1.2 million cubic yards of dredged material was placed in both confined and unconfined disposal sites. Although the Corps is the largest single generator of dredged material, the bulk of the contaminated sediments comes from port dredging. It is projected that from 1989-2008, up to 10 million cubic yards of contaminated sediments will be dredged from Puget Sound for navigational purposes. In addition, site cleanup actions may generate more than 70 million cubic yards of contaminated sediments.

Seven potential sites for disposal of contaminated sediments have been identified, but the total combined capacity of these sites is only about 1 million cubic yards. Use of municipal landfills as disposal sites is not likely to remain a viable option, largely due to shrinking capacity and bans on importation of wastes.

3. ENVIRONMENTAL AND PUBLIC HEALTH ISSUES

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 major difference for a multiuser site program is that operating large sites over a long period (e.g., 20 years) minimizes the number of areas disrupted by site construction and operation. This section identifies the environmental and public health issues for each site environment, compares the environmental and public health effects among sites, and identifies potential mitigation measures that could effectively reduce or prevent effects.

GENERIC SITE DESCRIPTIONS

Aquatic, nearshore, and upland multiuser sites were evaluated in this study based on environmental and economic considerations. Descriptions of these types of sites are provided below.

Confined Aquatic Disposal

Confined aquatic sites are disposal facilities located in the subtidal marine environment. Contaminated sediments would be dredged from multiple locations and transported by barge for confined disposal at a single aquatic location. The disposal site would be large enough to accommodate the material dredged from many projects and remain active for approximately 20 years. The contaminated dredged material would be discharged from a bottom-dump barge into either an excavated or naturally occurring depression, or on a relatively flat bottom to form a mound. Whenever possible, the discharge of sediments would occur during slack tides or periods with slow tidal currents to minimize the dispersal of sediments. Specialized equipment such as a diffuser (in conjunction with a downpipe) or silt curtain could also be used to reduce dispersion.

Upon completion of an individual project or group of projects occurring within a limited time frame (e.g., 1-2 months), the dredged sediments would be capped with clean material. The cap material would be obtained by dredging nearby clean sediments or by importing clean material from upland sources. For the cap material that is dredged, it is assumed that both hydraulic and clamshell technologies would be used as appropriate on a project-by-project basis. Placement of a cap would minimize exposure of the surrounding biota to the contaminated sediments and reduce 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 bottom-dump barge and a silt curtain or from a barge using clamshell or hydraulic techniques until the final elevation is higher than the high tide elevation (final elevation can be achieved by moving capping material with a bucket and dragline). Nearshore sites may be saturated or unsaturated. 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 low tide will remain saturated, and the intermediate layer will be alternately unsaturated and saturated depending on tidal elevations. Nearshore sites are typically graded to allow a beneficial use of the site after completion.

Upland Disposal

Upland disposal sites are located in the terrestrial environment and are not directly influenced by tides. An upland disposal site would contain dikes to confine the dredged material and would be capped at the completion of the fill. The site would probably be developed in stages or cells, and would be filled and closed serially over the 20-year life of the site. The design standards would probably be comparable to the minimum functional standards for sanitary landfills (Chapter 173-304 WAC), and would require liners, monitoring to detect liquids (leachate) seeping into underlying soils, groundwater monitoring, and collecting and treating leachate. No separate dewatering facility would be required. Excess water would be handled by the leachate collection system and would be either treated and discharged to surface water or treated and discharged to a municipal wastewater treatment plant system.

FACTORS THAT INFLUENCE THE MOBILITY OF CONTAMINANTS

Five factors influence the mobility of contaminants in dredged material and during dredging and disposal operations: 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 contaminant losses.

Physical and Chemical Properties of Dredged Material

Several physical and chemical characteristics of aquatic environments influence the mobility (e.g., potential for release) of contaminants in sediments. These characteristics should be considered when making decisions about disposal options. For example, metals tend to remain tightly bound to sediments under anoxic conditions, but may go into solution and become mobile when exposed to oxygen. When sediments containing metals are removed from the anoxic environment on the sound bottom to an upland site, they may dry and become exposed to oxygen, allowing metals to be released when the sediments are exposed to water (i.e., rainfall). In addition, pH may drop when the sediments dry, favoring the release of some contaminants. Organic compounds are more mobile where a greater exchange of water occurs within the sediment. The degree to which contaminants are bound to sediments also depends on the organic matter content and texture of the sediments. For example, coarse-grained sediments low in organic matter will not bind many contaminants as tightly as fine-grained sediments with high clay and organic matter content. It has been suggested (PSDDA 1986) that, due to these characteristics, sediments contaminated with metals should be disposed of in water or in a site that remains saturated, and sediments contaminated with organic compounds should be disposed of above water. However, contaminated sediments in Puget Sound usually contain both metals and organic compounds, making such suggestions difficult to implement.

Level and Type of Contaminants

In general, the potential for contaminant release and adverse impact increases with increasing contaminant concentration in sediments. Contaminants 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 adverse effect on environmental or human health
- A potential for remaining toxic for a long time in the environment (persistence)
- A potential to enter and accumulate in the food web (bioaccumulation).

Conditions at Disposal Site

The behavior of contaminants in sediments is influenced by the conditions at the disposal site. As indicated above, release or loss of contaminants from the sediments is minimized when sediments remain saturated, in an anoxic condition, and at a neutral Ph. At a confined aquatic site or at a saturated nearshore site, the sediments would likely remain saturated and anoxic and have a neutral Ph. These conditions would tend to inhibit contaminant mobility. At upland and nearshore unsaturated sites, contaminated sediments may be exposed to oxic and low Ph conditions where the mobility of some contaminants may be enhanced. Comparisons of contaminant mobility among the various site alternatives would require specific information on a variety of factors, including contaminant characteristics and mitigation measures.

Dredging, Transport, and Disposal Activities

Release and loss of contaminants can occur during dredging, transport, and disposal of contaminated sediments. The potential for release depends largely on the type of equipment used (e.g., hydraulic or clamshell dredge) and other dredging practices. 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 during each phase must be evaluated for potential impacts and necessary mitigation. The potential impacts of the contaminant losses will be 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 during dredging and disposal may be unavoidable. Siting is a vital mitigation measure; 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 careful selection of methods and equipment for dredging, transport, and disposal; application of technologies to contain the dredged material, such as the use of liners and leachate collection and treatment at upland sites; operational 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 postclosure 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 5. 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 bottom fish 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, such as grasses, shrubs, and trees and a wide range of

TABLE 5. POTENTIALLY AFFECTED RECEPTORS AND RESOURCES

Receptor/Resource	Dredging	Transport	Confined Aquatic Disposal	Nearshore Disposal	Upland Disposal
Marine biota	X	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	X

animals, such as insects and large animals (e.g., 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.
- 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 (e.g., oceans, streams, lakes, and reservoirs). Surface waters serve as a habitat for plants and animals and as a resource for recreation, water supply, and other uses.
- Groundwater is the water beneath the surface of the land and may be a major source of drinking water. Groundwater may serve as a 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 types of sites are discussed below. Figure 2 shows pathways for contaminant transport to the environment for each disposal scenario (e.g., upland, nearshore, and confined aquatic).

Dredging and Transport

Contaminants within the sediments can be released to the environment during dredging and transport activities. With the exception of the need for truck transport for upland sites, the same potential environmental and public health impacts during dredging and transport apply to each type of disposal site.

The principal impact of dredging is the loss or disruption of benthic biota and habitat in the dredge area. Other potential impacts of dredging are the exposure of benthic biota to contaminated sediments that may become suspended and settle to the bottom, short-term exposure of water column biota to released contaminants, and short-term increases in turbidity and low dissolved oxygen in the water column. Short-term exposure of water column biota to contaminants may result in toxicity and bioaccumulation. The dredging method (hydraulic or mechanical dredge) can influence contaminant losses at both the dredging and disposal sites.

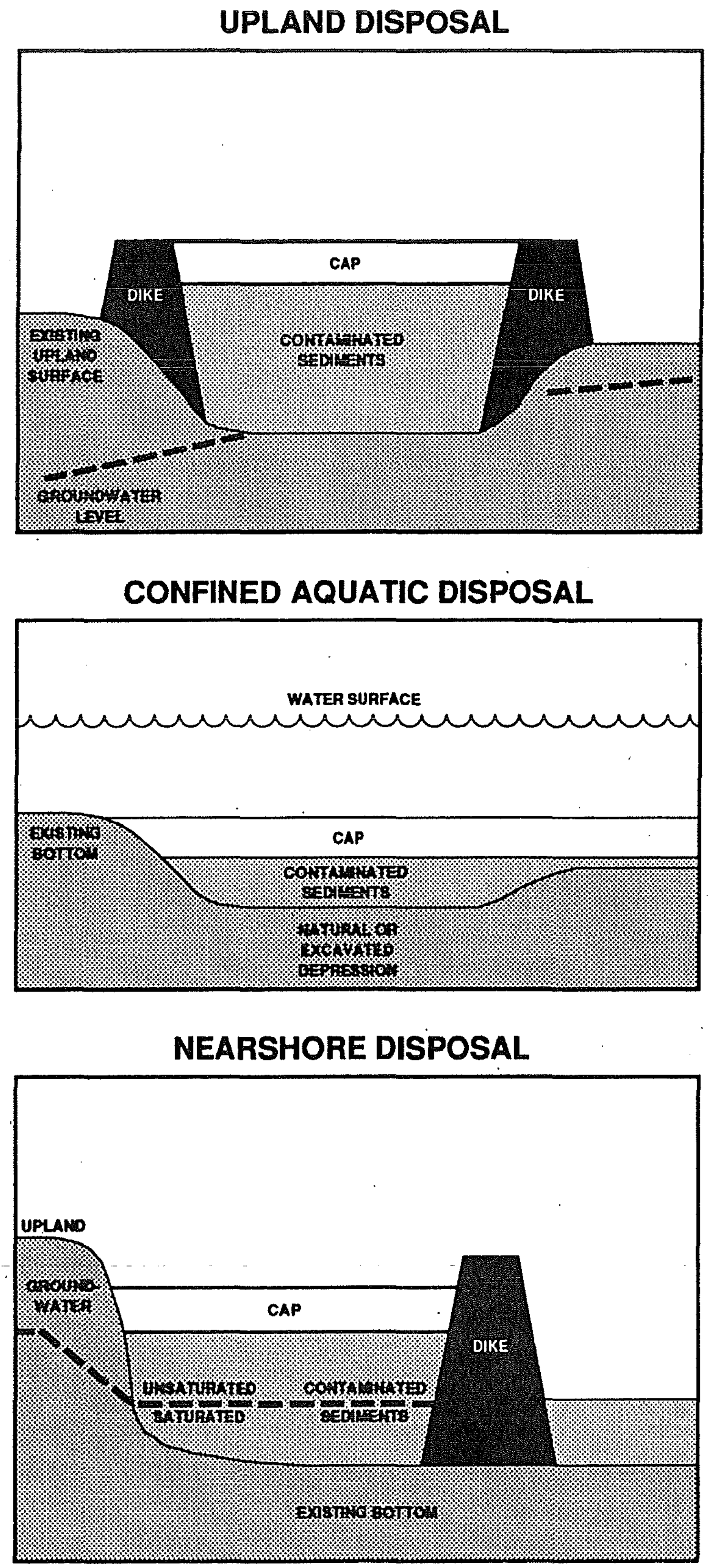

Figure 2. Upland, confined aquatic, and nearshore disposal sites

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 loss of dredged material and contaminants to the water column (e.g., during pipeline transport of sediment slurry from hydraulic dredging to a nearshore site) and volatilization, or escape of contaminants to the air, which can occur during barge or truck transport. Barge workers and nearby animals could inhale volatile 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 expose upland biota to toxic contaminants or affect surface waters.

The mitigation measures available include selection of the dredging method to be used (considering the type of material to be dredged, the nature of the contamination; and the disposal site 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 dredged from multiple locations within Puget Sound would be transported by barge for disposal at a specific aquatic location. The major impact associated with the construction and operation of an aquatic site is the burial and smothering of benthic biota during site excavation, construction, and discharge of the dredged material. Additional potential impacts are 1) effects on water column biota and esthetics from turbidity, 2) exposure of benthic and water column biota to contaminants and bioaccumulation of contaminants in the food chain, and 3) exposure of humans to contaminated fish and shellfish (through seafood consumption).

Cap design and siting are two important activities that can affect short-term and long-term impacts at aquatic sites. 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 impedes the migration of contaminants. Disposal site selection is critical especially for minimizing impacts to benthic biota. Sites should be located in noncritical habitat areas. Benthic biota are expected to repopulate a site after placement of the cap. Site location is also important for minimizing construction requirements, loss of contaminants during disposal and prior to and after capping, and in maintaining cap integrity (e.g., locating sites in a low-energy depositional environment). Monitoring should be done to test for impacts of capping and cap failure. Changes in disposal operations or site cleanup (e.g., placement of additional cap material) may be required if monitoring detects 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. Sediments are transferred from the barge to the disposal site using a clamshell or hydraulic pump, or in some cases using a bottom-dump barge (e.g., during the initial stages of a fill between piers). The most significant impact of developing a nearshore site is the destruction of existing marine and intertidal habitat. Other impacts could include exposure of marine and intertidal species to contaminants that may be released during disposal and exposure of humans to contaminants of concern through direct contact, inhalation of organic vapors or windblown dust, consumption of contaminated fish and shellfish, and drinking contaminated groundwater.

Environmental and human 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 surface water management 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 into the air and release of contaminants to surface water runoff. Placing a final cap onsite minimizes exposure of land-based biota to contaminants and creates the potential for beneficial use of the site. Monitoring for contaminant losses can be required during site operation and after site closure to assess potential 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 area where the material is transferred to trucks and hauled to an upland facility. Upland disposal involves the placement of dredged material in an environment that is not affected by tides. The major consideration in developing an upland disposal site is 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 nearby surface waters; 2) exposure of plants to contaminated sediments leading to 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, or drinking contaminated water.

As in confined aquatic and nearshore disposal, site selection is a critical mitigation measure. The impact of removing existing 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 controls. Upon completion of each dredging project, interim capping with clean material would minimize the exposure of contaminated sediments to wind and precipitation. A final cover could be placed once a cell is filled. A monitoring program could be designed to track the effects of any contaminant losses both during operation and after the site closure period. Changes in disposal operations can be made if monitoring indicates any significant impacts. 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 postclosure period.

SUMMARY

The environmental and human health issues associated with disposal of contaminated sediments differ among the three types of disposal site. The major differences pertain to receptors in the vicinity of the site, the number and significance of contaminant migration pathways, mitigation measures, and the degree of potential for contaminant release. In general, aquatic sites have few pathways for contaminant transport and have the lowest potential for long-term release of contaminants. However, aquatic sites are difficult to monitor and have limited options for mitigation and cleanup alternatives in the event of failure. Upland and nearshore sites may have a greater potential to affect more environmental media and types of biological receptors than aquatic sites, but many mitigation options and cleanup alternatives are available for upland and nearshore sites in the event of failure. The siting process for upland disposal can be very effective in avoiding habitats of concern and mitigating or avoiding impacts to surface water and groundwater. In contrast, it may be difficult to avoid sensitive habitat areas in the nearshore environment.

4. COST ANALYSIS

Total project 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 for each disposal site. The results of this base-case cost analysis provide planning level costs and allow for comparison of costs among disposal alternatives. The remainder of this section presents the framework for analyzing costs, a comparison of costs among alternative disposal scenarios, a sensitivity analysis of the cost model, and a worst-case analysis of costs.

COST ANALYSIS FRAMEWORK

Costs were organized according to the major 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
  - Disposing sediments at the multiuser site

  - Providing daily or intermediate cover after dumping operations
  - Monitoring disposal sites during the active life of the facility
  - Operating, maintaining, and administrating the facility

- Closure (costs associated with closure of the entire site or individual cells within the site):
  - Capping the entire site or individual cells
  - Revegetating and draining upland and nearshore sites as appropriate

- Postclosure:
  - Monitoring after facility closure
  - Site maintenance (excludes costs of postclosure failure and any subsequent cleanup).

Assumptions

Assumptions relating to the definition of typical sites, predredging 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.

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

The design parameters of the disposal facility affect the facility size and requirements for structural improvements. It is assumed that each of the four types of disposal facility are designed 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, such as a dike or underwater excavation, is anticipated. Leasing costs of the site are not included.

The operation of the disposal site is straightforward, with sediments deposited in mounds using a bottom-dump barge. Deposited sediments are capped after each project or group of projects occurring within the same time frame (1-2 months). Dumping will preferably occur 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 dredged cap material, 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 focus on the most recent sediment deposits, with every new mound tested 1, 2, 3, 5, 7, and 10 years after capping.

Nearshore Saturated Disposal—A typical nearshore saturated site is located in an intertidal zone near high-volume dredging areas. The site consists of a series of diked cells, filled to the high water level with contaminated sediments and then covered to the desired grade with clean material to prepare 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) would be purchased at $435,000 per acre (PSDDA 1988c) and that subtidal acreage is available at no cost.

For the purposes of this analysis, it is assumed that sediments will be deposited in the cells using a bottom-dump barge and a silt curtain to reduce loss of contaminants, and, once sediments are in the cell, a drag line with a bucket is used for material movement within the site. Nearshore disposal projects may require the use of clamshell or hydraulic techniques to transfer sediment from a barge or dredging site, which may be more costly than the process modeled here.

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

Habitat mitigation (e.g., 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 per linear foot of shoreline, represents the approximate market value of shoreline (PSDDA 1988c).

Nearshore Unsaturated Disposal—The design and operation of a nearshore unsaturated site is similar to that of the saturated facility, with some specific differences. The most important difference results from the placement of contaminated sediments in both the saturated and unsaturated zones of a diked cell, which increases the capacity of each cell. Because fewer cells are needed, construction costs are decreased and less capping material is necessary to prepare the site for future use. On the other hand, operating costs are likely to increase once the level of material in each cell reaches the mean higher high water level. Sediments deposited above that level must be capped after each disposal episode.

Upland Disposal—The typical upland site is assumed to be approximately 50 acres located within 50 miles of the dredging site. The site is to be constructed to meet the state's minimum functional standards for sanitary landfills with leachate collection and treatment systems, bottom liner, capping, and groundwater monitoring. Land costs are assumed to be $25,000 per acre (Tetra Tech 1988). It is assumed that no upland site would be located in sensitive or critical habitats, because of regulatory restrictions. Therefore, no costs for habitat mitigation at upland sites are provided.

The operation of this facility is less complicated than operation of a standard sanitary 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 leachate will be required at all upland facilities and leachate collection and treatment systems will be installed during site construction. The leachate treatment system is designed 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 postclosure 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 6. The ranking of sites is similar for both 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 per 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 per cubic yard. 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. A nearshore unsaturated site is estimated to cost $34.0 million over the life of the project and $27 per cubic yard for disposal.

The results of this analysis suggest that disposal will be significantly more expensive than that projected by recent studies. However, the cost estimates are in line with the experience of the Port of Seattle at Terminal 90/91 and the added expenses 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 variables that affect disposal system economics and the uncertainty associated with many of the cost components.

The variables affecting the costs of the alternative sites are:

- All sites
  - Predredging 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 number of cells
  - Depth of site
  - Source of cap material

TABLE 6. DISPOSAL SITE COST ESTIMATES (1989 DOLLARS)

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

- 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 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, cleanup) 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 7. In all categories, with the exception of closure, postclosure, 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 habitat mitigation costs. In comparison to the nearshore unsaturated site, the costs of 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 (the additional costs of hauling the dredged material over land by truck).

SENSITIVITY ANALYSIS OF KEY COST FACTORS

The multiuser confined disposal cost model relies on assumptions about the following key variables:

- Discount rate
- Dredging costs

TABLE 7. COST COMPARISON OF DISPOSAL ALTERNATIVES (1989 DOLLARS)

Operation Phase	Confined Aquatic	Nearshore Saturated	Nearshore Unsaturated	Upland
Site development	583,000	13,917,501	10,490,521	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	17,396,415	12,733,500	9,232,263
Disposal/construction Treatment/operation and maintenance/dewatering Mitigation/dewatering				
Closure	7,386,842	3,460,077	514,034	575,131
Cell capping/other				
Monitoring	2,505,261	753,884	575,839	264,872
Postclosure	332,383	239,848	244,717	149,885
Contingency	2,243,991	5,965,210	4,436,960	5,052,081
TOTAL	17,203,930	45,733,278	34,016,692	38,732,618
Relative rank (1 = highest cost)	4	1	3	2

[a] Costs borne directly by dredger.

- Inland transportation costs
- Habitat mitigation costs
- Design and permitting costs.

The sensitivity analysis was undertaken after extensive discussion with the Port of Seattle, which has operated a nearshore disposal facility for several years and is considering construction of an additional disposal site. The port's operational experience provides valuable data on actual costs. These data have previously only been available as estimates.

The sensitivity analysis used a 7 percent cost of capital. Thus the cost comparisons presented in this section are present value figures with all future expenditures discounted at 7 percent. If a lower rate had been used (e.g., 3 percent), the total cost for each sensitivity analysis would be higher than that reported here, but relative cost ranking would not change.

Discount Rate

The base case cost analysis used a discount rate (or real cost of capital) of 7 percent. This rate was selected as a risk-adjusted best estimate of the cost of capital to a public sector entity. Confined disposal sites have never been constructed before; therefore, costs and revenue are highly uncertain. Using a discount rate of 7 percent accounts for some of this uncertainty.

However, it can be argued that a lower rate is more appropriate. The real cost of capital for the public sector is not adjusted for risk and is 3-4 percent (these figures reflect recent debt issues yielding 7-8 percent minus 3-5 percent annual inflation). Accordingly, costs were calculated using a discount rate of 3 percent. The increased costs due to the 3 percent discount rate are (all numbers were rounded to two significant figures):

Disposal Option	1989 Dollars (in millions)	Percent Increase
Confined aquatic	7.6	47
Nearshore saturated	8.8	26
Nearshore unsaturated	12	26
Upland	10	26

A lower discount rate increases the relative importance of future costs in any net present value calculation. Therefore, the present value costs calculated at 3 percent are significantly higher than those calculated at 7 percent. Using the lower discount rate, costs for all disposal options are increased by at least 26 percent. The largest increase is in the cost of the confined aquatic disposal option (47 percent) because future costs represent almost all of the total costs associated with this option. Note that the lower rate does not indicate that more money will be spent on the project. Rather, the sensitivity analysis indicates that as assumptions about relative value versus future expenditures change, the calculated present value figure changes accordingly. The relative cost ranking, based on cost effectiveness, remains the same regardless of discount rate.

Dredging Costs

Dredging costs for small projects may be higher than those assumed in the base case cost analysis. An initial cost of $1.50 per cubic yard was used in the base case analysis. Based on the experience of the Port of Seattle, actual dredging costs may be as high as $6.00 per cubic yard. The revised cost estimates using a dredging cost of $6.00 per cubic yard are:

Disposal Option	1989 Dollars (in millions)	Percent Increase
Confined aquatic	3.0	18
Nearshore saturated	3.0	6.5
Nearshore unsaturated	3.0	8.8
Upland	3.0	7.7

Because it is assumed that equal amounts of sediments are dredged in each case, the absolute change in cost is constant across all four options. The percent increase varies among the options because of differences in the ratios of dredging costs to total cost. The relative cost ranking is not changed by increased dredging costs.

Transportation Costs

The base-case cost analysis assumed upland transportation costs of $0.25 per cubic yard per mile. However, the cost to ship contaminated sediments to an upland facility in watertight container trucks could be substantially higher. This increased cost would effect only the upland disposal alternative because the three other alternatives do not require upland transportation of dredged material. Total costs calculated for the upland disposal option were based on transportation costs of $1.00 per cubic yard per mile.

Using the higher transportation costs, the total costs for the upland disposal option increase 64 percent from \$39 million to \$64 million. With increased upland transportation costs, the relative cost ranking changes; the upland option becomes the most expensive of the four disposal options. The nearshore saturated option is the next most costly, followed by the nearshore unsaturated and confined aquatic options.

Habitat Mitigation

The cost of habitat mitigation applies only to the nearshore saturated and unsaturated options. The cost of habitat mitigation is highly uncertain and speculative in an analysis of costs for generic sites. The base case cost analysis assumed a cost of \$1,000 per linear foot for habitat mitigation (based on the approximate market value of shoreline). A habitat mitigation cost of \$2,000 per linear foot was assumed for the sensitivity analysis.

With the higher cost per linear foot, present value costs increase to \$2 million and to \$3 million for the nearshore saturated and unsaturated options, respectively. On a percentage basis, these increases are 4 percent of total costs for the nearshore saturated option and 9 percent of total costs for the nearshore unsaturated option. The relative cost ranking is unchanged; although the nearshore unsaturated option now costs almost as much as the upland option.

Design and Permitting

The base case cost analysis assumed design and permitting costs of \$538,000 for the nearshore saturated option and \$353,000 for the nearshore unsaturated option. Based on the complexity of constructing a nearshore disposal facility and the Port of Seattle's planning estimates for a new disposal site, the sensitivity analysis used a revised cost of \$1 million for designing and permitting a new nearshore disposal facility. The confined aquatic and upland disposal options have design and permitting costs included in the base case cost analysis and have not been identified as requiring additional design and permitting costs.

Using the increased design and permitting costs, the total increased cost is \$491,000 (or <1 percent of total costs) for the nearshore saturated option and \$647,000 (or 3 percent of total costs) for the nearshore unsaturated option. The increased costs do not change the relative cost ranking of any of the four disposal options.

WORST-CASE COST ANALYSIS

The worst-case analysis combines the higher cost assumptions used in the sensitivity analysis for dredging, land transportation, habitat mitigation, and design and permitting into one scenario. These costs are then discounted at 7 percent and 3 percent.

Results of each worst-case cost analysis are presented in Tables 8 and 9. Using the 7 percent discount rate, cost increases range from 17 percent for confined disposal to 72 percent for upland disposal. In dollar terms, these increases range from $3 million to almost $28 million. As the sensitivity analysis indicated, the greatest single change in costs is associated with increasing the assumed unit costs for transportation in the land disposal option. The magnitude of the increase (an increase of $25 million or 64 percent) overshadows all the other changes tested in the sensitivity analysis. Accordingly, in the worst-case scenario, the relative ranking changes with upland disposal becoming the most expensive, nearshore saturated second, nearshore unsaturated third, and confined aquatic disposal the least expensive.

Using the 3 percent discount rate, present value cost increases range from 43 percent to 127 percent above the base case cost analysis. Present value cost increases range from $12 million to $49 million. The relative rank of each option does not change, however.

SUMMARY

Estimated base case costs ranged from $17 million to $46 million for the four confined disposal options for contaminated sediments. Under the base-case scenario, the nearshore saturated option is the most expensive and the confined aquatic alternative is the least expensive. By evaluating key cost factors, the sensitivity analysis found that the cost model is highly sensitive to changes in the discount rate and the unit cost for land transportation. Total costs increased from 0-64 percent based on the particular cost factor being evaluated.

The base case costs and increased costs due to changes in key cost factors are outlined below in millions of 1989 dollars. Cost increases are new total costs; percentage increases are new total cost over base case:

Cost Factors	Confined Aquatic	Nearshore Saturated	Nearshore Unsaturated	Upland
Base case	17	46	34	39
Discount rate	25 (47%)	58 (26%)	43 (26%)	49 (26%)
Dredging cost	20 (18%)	49 (6%)	37 (9%)	42 (8%)
Transportation	17 (0%)	46 (0%)	34 (0%)	64 (64%)
Habitat mitigation	17 (0%)	48 (4%)	37 (9%)	39 (0%)
Design and permit	17 (0%)	46 (0%)	35 (3%)	39 (0%)

TABLE 8. WORST-CASE COST ANALYSIS AT 7 PERCENT DISCOUNT RATE (1989 DOLLARS)

	Confined Aquatic	Nearshore Saturated	Nearshore Unsaturated	Upland
Base case total	$17,203,930	$45,733,278	$34,016,692	$38,732,619
Cost Increases				
Dredging Cost Sensitivity	$ 2,979,567	$ 2,979,567	$ 2,979,567	$ 2,979,567
Transportation Cost Sensitivity	0	0	0	$24,829,721
Habitat Mitigation Sensitivity	0	$ 2,031,897	$ 3,386,493	0
Design and Permitting Sensitivity	0	491,257	$ 646,721	0
Worst Case Total	**$20,183,497**	**$51,235,999**	**$41,029,473**	**$66,541,907**
Percent Increase Over Base Case	**17.3%**	**12.0%**	**20.6%**	**71.8%**
Worst Case Relative Rank[a]	4	2	3	1
Base Case Relative Rank	4	1	3	2

[a] 1 = highest cost.

TABLE 9. WORST-CASE COST ANALYSIS AT 3 PERCENT DISCOUNT RATE (1989 DOLLARS)

	Confined Aquatic	Nearshore Saturated	Nearshore Unsaturated	Upland
Base Case Total at 7%	$17,203,930	$45,733,278	34,016,692	38,732,619
Cost Increases				
Base Case Total at 3%	$ 7,640,466	$12,328,339	$ 8,849,565	$10,063,831
Dredging Cost Sensitivity	$ 4,184,290	$ 4,184,290	$ 4,184,290	$ 4,184,290
Transportation Cost Sensitivity	0	0	0	$34,869,082
Habitat Mitigation Sensitivity	0	$ 2,592,449	$ 4,320,747	0
Design and Permitting Sensitivity	0	491,257	$ 646,721	0
Worst Case Total	**$29,028,686**	**$65,329,613**	**$52,018,015**	**$87,849,822**
Percent Increase Over Base Case	**68.7%**	**42.8%**	**52.9%**	**126.8%**
Worst Case Relative Rank[a]	4	2	3	1
Base Case Relative Rank	4	1	3	2

[a] 1 = highest cost.

The use of the 3 percent discount rate results in sharply higher present value costs for all options. Dredging cost increases lead to overall cost increases for all options, although the increase for the confined aquatic disposal option is the largest. The greatest change in estimated costs occurs when the assumed cost of land transportation increases. The increased unit cost makes the upland disposal option the most expensive alternative under all sensitivity analyses. Increased costs for habitat mitigation results in a minor overall cost increase for the nearshore alternatives, while additional design and permitting costs for the nearshore alternatives results in a negligible increase in total costs.

The worst-case cost analysis showed that changes in factors other than the unit cost for transportation, even when combined together, do not have a significant effect on total costs. With the exception of the upland disposal option, increases in total costs ranged from 12 percent to 21 percent. This difference is within the margin for error associated with planning level cost projections (e.g., $\pm$50 percent). The upland disposal option costs increase by 72 percent under the worst-case cost analysis due to the unit cost for transportation. Under the worst-case analysis, the upland disposal option becomes the most expensive, while the confined aquatic option remains the least expensive.

5. FUNDING ANALYSIS

Several alternatives for funding multiuser sites were developed and evaluated. The evaluation of alternatives is based on the planning level costs described in the previous section and incorporates alternative financing assumptions (e.g., investment and borrowing rates).

In general, the major factors affecting funding alternatives for the multiuser sites program are:

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

The influence of each factor on the ability to finance a multiuser disposal site is discussed below.

COSTS

The funding analysis is based on cost estimates for the four types of confined disposal sites (aquatic, nearshore unsaturated, nearshore saturated, and upland) developed in the previous section. Each of these site types has a different profile of costs. For example, upland sites have relatively large development costs and would require borrowing large amounts of capital, which would result in higher long-term debt than less capital-intensive sites such as aquatic sites. The operating costs for the four disposal sites also differ.

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

The following costs are included in the analysis:

- Capital costs associated with siting and initial site construction that require debt financing.

- Operating costs such as periodic cell construction and closure costs over a 20-year period.

- Costs associated with postclosure monitoring, site maintenance, and administration for a 10-year period after closure. These costs are assumed to be funded through a financial assurance account, which is accumulated during the operating lifetime of the facility.

OWNERSHIP AND OPERATION OPTIONS

The institutional frameworks for siting, construction, and operation have a potential impact on funding. Regardless of the institutional framework used, it is assumed that the owner/operator has:

- 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.

The options for ownership and operation range from public ownership with public operation to private ownership with private operation. Eight options are summarized below:

- Option 1—Total public option, where the public entity is directly responsible for financing, contracting for independent design, obtaining competitive construction bids, and operating the facility.

- Option 2—Turnkey service option, where the private sector provides a turnkey service (design-build), turning the facility over to the public entity for operation.

- Options 3 and 4—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—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—Private, full service option, where the private entity finances, designs, builds, owns, and operates the facility. This option is applicable to upland and nearshore sites only.

- Option 8—Variation on the private full service option that applies particularly to aquatic sites, because these sites are all under state ownership. Under this option, the private entity leases the site from the state, finances any construction costs, and operates the facility.

Advantages and Disadvantages of Private Ownership

The 1986 federal tax reform act eliminated financial incentives for private industry to build and operate public facilities in cooperation with public agencies. In the absence of tax-based (i.e., income-sheltering) incentives, private industry is likely to invest in a public project primarily because of 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. Additionally, private participation 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 relationships that allow tax-exempt financing. Restrictions on tax-exempt financing, however, limit the flexibility of such arrangements.

Areas of Risk

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

1. Unpredictability of siting costs—Delays and difficulties in siting a facility can significantly increase the costs of development.

2. Unpredictability of use—A multiuser site that is dependent on income from user fees may experience cash flow problems and difficulty in meeting debt repayments if use is consistently erratic.

3. Potential liability for facility failure—If the responsibility for liability is undefined or unlimited, the owners, developers, operators, and users of a site are vulnerable to significant economic risk.

4. Regulatory risk—New environmental regulations could be imposed on the facility retroactively, resulting in unanticipated operational 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 methods 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. A pooled insurance fund could also be used to address costs from additional unpredicted regulations.

FINANCING TECHNIQUES

Financing techniques for capital projects 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 authorized cash surplusses that had been accumulated from other funding sources.

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 borrowing large amounts and incurring higher long-term debt. In contrast, aquatic disposal sites are less capital-intensive. Sites with relatively high operating costs will be more affected by inflation. The relationships among the capital and operating costs requirements of each type of site and their corresponding sensitivity to financing costs and inflation are presented in Table 10. As indicated in the table, all of the site options are affected by a change in the cost of capital or inflation. The cost of the upland option would be affected the most, due to the associated high transportation costs.

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

TABLE 10. 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

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.

FUNDING SOURCES

Funding sources may include user fees, a wide range of taxes or assessments, and state or federal assistance. There are a variety of policy issues related to the question of whether the cost of a multiuser site should be funded solely from user fees. These issues, which fall under the two categories of cost allocation and risk and 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 the contributors to the problem and the potential beneficiaries of the solution. Contributors to the contamination of sediments include all sources of discharges into Puget Sound waters. Because it is generally not feasible to make direct claims of liability on individual prior contributors, alternatives for recovering costs need to be developed and may include:

- Use of existing or new general fund resources, based on the argument that the public bears a general responsibility for contamination of sediments.
- Use of taxes or assessments generally related to sources of contamination in the Puget Sound region, such as sewer discharges (e.g., a tax on sewer utilities), surface water runoff (e.g., a tax on developed properties), and commercial and industrial establishment discharges (e.g., business and occupation tax).
- Use of a regional tax (e.g., sales tax, gas tax, property tax), based on the argument that the 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 public benefits could be considered in allocating costs by having different fees for public-purpose users (e.g., the Corps, ports) and private-purpose users (e.g., marinas, boat repair facilities). Some alternatives for allocating costs among the beneficiaries include:

- Recovery of a portion of the costs through a general tax, in recognition of the general benefit to the public of environmentally safe disposal options, with recovery of the remaining costs through user fees.

- Recovery of costs through a sliding scale of user fees, with lower fees for users that serve a regional public purpose.

- Recovery of a portion of the costs through benefit assessments related to the purposes served by dredging (e.g., assessments of ships based on hull depths for ensuing navigational benefits, assessments of waterfront or flood zone properties for ensuing flooding and erosion control benefits). It is likely that a portion of cleanup costs will be funded by state and federal cleanup accounts established under CERCLA and MTCA. Funding of multiuser sites through these accounts will tend to mitigate economic impacts imposed by other private and public funding mechanisms [see Mausolff et al. (1989) for more information regarding funding sources for sediment cleanup].

Risk and Liability Issues

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

RESULTS OF FUNDING ANALYSIS

The economic impacts to users and public and private institutions will have a great deal of influence on the selection of funding alternatives for the multiuser confined disposal sites program. The significance of the economic impacts can be determined by balancing the willingness of users to dispose of dredged materials at the price required to support all facility costs with the ability of institutions responsible for facility construction and operation to bear the debt and risk burdens without undue financial hardship. The need for disposal capacity and the rising costs (and decreasing availability) of landfill disposal are likely to weigh significantly in the development of one or more funding alternatives. The funding analysis provides an estimate of the range of costs to users and public and private institutions.

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
- Ability to facilitate the siting process.

Factors affecting users include:

- Source of funding for public users and return on investment for private users
- 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 postclosure 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 bound (private financing) and lower bound (tax-exempt revenue bonds) 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.

Funding Analysis versus Cost Analysis

Although the figures developed in the cost analysis provide the basis for costs used in the funding analysis, a direct comparison between numbers from the two different analyses (e.g., for total present value figures) is not appropriate. The cost analysis develops order of magnitude estimates for all the costs of dredging and disposing of sediments. The funding analysis takes the information from the cost analysis and applies various assumptions to estimate actual annual costs for operating a multiuser sites during the operating life of the facility. The costs shown in the funding analysis include financing costs (to fund development costs), construction reserve contributions (to finance periodic construction costs), costs for establishing postclosure reserves (as required by state law) and a profit margin for the private ownership options. The costs in the funding analysis do not include costs unrelated to facility operations, such as testing, dredging, and transportation costs.

Another difference between the cost analysis and the funding analysis is that the funding analysis includes an estimate of inflation for future years (at an annual rate of 5 percent). An inflation factor is used to provide consistency with other assumptions (such as financing costs and returns on investments) that are based on actual rates which reflect real world assumptions about risk, including the risk of inflation. In summary, the flow of costs considered in the funding analysis is derived from, but differs significantly from, that shown in the cost analysis.

The cost analysis includes a sensitivity analysis of key cost factors: discount rate, dredging costs, inland transportation, habitat mitigation costs, and design and permitting costs. The funding analysis would not be affected by variations in dredging costs or transportation costs. The discount rate used for the funding analysis is 8 percent; because the funding analysis cash flow projections include inflation at 5 percent, this discount rate is comparable to a *real* discount rate of 3 percent, the lower rate used in the sensitivity analysis. The 8 percent discount rate is a realistic rate, based on the return on capital for public agencies.

Increases in habitat mitigation costs and design and permitting costs would also increase the present value for nearshore saturated and unsaturated options. The impact on the funding analysis for these options would depend on when these costs are incurred and whether they are financed as part of the development costs or included as annual operating costs.

The results of comparisons of user fees and present value and annual costs for each funding alternative are presented in Tables 11 and 12. Comparisons of user fees presented in Table 11 are shown for Year 1 and Year 15. For some facilities, costs in Years 16-20 are lower due to reduced costs for cell construction and closure, because the last cells are built 2-4 years before closure. Comparisons of user fees for Years 1-15 (1989 dollars) show the contrast between 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, shows an increase in user fees; the other options all show a decrease. The comparisons of present value and annual costs presented in Table 12 are calculated over 20 years and discounted to 1989 values assuming a discount rate of 7 percent (i.e., the estimated cost of borrowing money).

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

TABLE 11. COMPARISONS OF USER FEES[a] BY FUNDING ALTERNATIVE (DOLLARS PER CUBIC YARD)

	Inflated Dollars[b]		1989 Dollars[c]	
Alternative	Year 1	Year 15	Year 1	Year 15
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
Upland disposal/tax-exempt	40.47	51.21	38.54	24.63
Upland disposal/private	55.51	75.11	52.87	36.13

[a] User fees reflect estimated tipping fees for disposal but do not include the costs of testing, dredging, or transportation that are direct costs to the user.

[b] Based on annual rate of inflation of 5 percent.

[c] Based on constant 1989 dollars with no inflation.

TABLE 12. COMPARISON OF PRESENT VALUE AND ANNUAL COSTS[a] BY FUNDING ALTERNATIVE ($ MILLIONS)

Alternative	1989 Present Value[b]	Year 1 Inflated Cost	Year 2 Inflated Cost	Year 20 Inflated Cost
Aquatic disposal/tax-exempt	17.8	1.1	1.2	3.8
Aquatic disposal/private	19.7	1.2	1.3	4.2
Nearshore saturated/tax-exempt	35.4	3.9	3.9	1.9
Nearshore saturated/private	56.4	5.1	5.3	3.9
Nearshore unsaturated/tax-exempt	25.5	2.4	2.5	1.9
Nearshore unsaturated/private	39.1	3.8	3.8	2.6
Upland disposal/tax-exempt	27.1	2.5	2.6	2.8
Upland disposal/private	36.4	3.5	3.5	3.9

[a] Costs for funding multiuser disposal sites differ from costs shown in the *Cost Analysis* section. Funding costs exclude testing, dredging, or transportation, but include financing costs and cost for establishing postclosure reserves, as required by state law.

[b] Discount rate = 7 percent.

analysis that affected the outcome was that no increased efficiencies would be realized under private ownership. Also, the aquatic disposal costs do not include leasing costs. Based on the present value, the ranking of options from lowest to highest cost is 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
- Nearshore unsaturated, private
- Nearshore saturated, private.

In general, the development and selection of funding alternatives 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 lower than current disposal rates for solid waste and hazardous waste in the Puget Sound region. The user fee estimates for Year 1 range from $17 to $82 per cubic yard. Dredged sediment weighs an average of 1.2 tons per cubic yard; based on this average, user fees would range from $14 to $68 per ton. Disposal fees for solid waste at landfills in the Puget Sound region range from $34 to $90 per ton. However, no solid waste facilities in the Puget Sound area are willing to accept dredged material that is not dewatered. Dewatering would add substantially to the cost of land disposal. For comparative purposes, hazardous waste disposal fees range from $460 to $2,030 per ton. However, fees for disposal of dredged material at construction and demolition debris landfills are much less, ranging from $30 to $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).

SUMMARY

Development and selection of funding alternatives for the multiuser confined disposal sites program will be affected by 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 from this analysis compare favorably to current costs for solid waste disposal. Although the funding alternatives are likely to be affected by several factors, the growing need for disposal sites and the high costs of currently available disposal options are likely to favorably influence the development of one or more funding alternatives.

Public or private institutional funding of the program is likely to be affected by factors such as overall debt capacity and financial condition; availability and authority over suitable sites; authority to control or regulate users (flow control); capital planning capabilities; ability to assume liability; and ability to facilitate the siting process. User funding of the program is likely to be affected by the overall economics of specific dredging projects and the availability of alternatives for disposing of dredged sediments. Other significant risk issues with potential effects on funding decisions include the unpredictability of siting costs and customer use, potential liability for system failure, and regulatory uncertainties (i.e., the risk that regulatory requirements will change after a facility has begun operation).

The funding analysis indicates that private financing is more expensive than tax-exempt revenue bonds for all siting options, depending on the validity of certain assumptions contributing to this conclusion. Tax-exempt aquatic disposal appears to be the least costly to finance, followed by private aquatic disposal, tax-exempt nearshore unsaturated disposal, tax-exempt upland disposal, tax-exempt nearshore saturated disposal, private upland disposal, and private nearshore unsaturated disposal. Private nearshore saturated disposal was determined to be the most expensive to finance.

6. INSTITUTIONAL OPTIONS ANALYSIS

Eight institutional options for dredged material management were developed after reviewing the existing dredged material management system (existing system or status quo) and interviewing several representatives of the waste management industry (e.g., solid, mineral, hazardous wastes). The options were developed to address major problems identified within the existing system and the concerns of agencies and organizations (stakeholders) with roles and responsibilities for dredged material disposal. The following assumptions were made to limit the number of possible institutional arrangements:

- The implications of disposal environments or geographic locations on institutional arrangements were not considered
- Only the most likely and appropriate stakeholders (as determined with the concurrence of Ecology) were considered.

Eight options were developed that include lead roles for federal, state, and local governments, ports, and private industry. It is assumed that stakeholders not identified for specific functions would be involved in an advisory capacity for all options except options involving the formation of new institutions. The eight options and the existing system were then evaluated for their advantages and disadvantages.

EXISTING SYSTEM AND MAJOR STAKEHOLDERS

The existing system for managing dredged material consists of several agencies with varying degrees of overlapping responsibilities depending on the disposal environment (i.e., aquatic, nearshore, upland) and the level of contamination in the dredged material. Nearshore and aquatic disposal are regulated by the Corps, DNR, Ecology, Washington State Departments of Fisheries and Wildlife, and local governments. Upland disposal is regulated by the Corps, Ecology, local health departments, tribal governments, and federal agencies. Disposal of material classified as dangerous waste is regulated by Ecology. The cleanup of contaminated material is regulated by Ecology and EPA; however, standards have not been promulgated for confined disposal of contaminated dredged material. Each agency responsible for an aspect of a proposed confined disposal project applies its own regulations and best professional judgment to the disposal of contaminated material. Conflicts can arise when regulations adopted by one agency differ from regulations adopted by another agency.

Problems with Existing System

Problems that are currently encountered in the existing management system include increasing difficulty in establishing disposal sites, lack of coordinated management, lack of consistency in the consideration of environmental impacts and cost, and inconsistent stakeholder representation.

Increasing Difficulty in Siting—Site selection is the most significant problem under the existing system. Historically, siting a waste disposal facility entailed identification of possible sites based only on technical criteria and availability. However, these criteria are now merely a starting point in the community negotiation process for site determination. Communities oppose locating sites in their "backyards" because of concerns about environmental and public health impacts. Communities lack trust in the public or private entities responsible for siting and managing sites and are fearful that promises of best available safeguards will be overridden by cost-cutting considerations, the lack of solid waste expertise, and the inability to carry out actions stipulated by the permitting agencies. Communities are also concerned that knowledge regarding environmental impacts may not be sophisticated enough to detect all potential hazards and may not accurately reflect long-term damages or risks. Communities may be more willing to accept siting decisions made by institutions with historically established credibility than institutions with a poor track record. In addition to community acceptance, disposal facility siting is hindered by the decreasing availability of land and concerns of stakeholders regarding liability.

Lack of Coordinated Management—There is little coordination among the stakeholders regarding dredged material disposal activities. Consequently, the existing system is not as efficient as a system with provisions for coordinated timing of dredging, sharing of disposal sites, and use of clean material for the capping of contaminated material. There is also a need for coordinating the management of liability. Entities considering owning or operating facilities must identify long-term environmental and human health risks and determine how responsibilities might be equitably distributed among stakeholders.

Environmental and Cost Considerations—There are currently no confined disposal standards for dredged material and no provisions for implementing standards. Therefore, there is no assurance that contaminated dredged material is or will be consistently handled in an environmentally sound manner. Although standards are under development, a centralized multiuser site system with established standards and a uniform management program may be more cost-effective for stakeholders who currently are responsible for ensuring environmental safety (e.g., testing and monitoring) on a project-specific basis.

Stakeholder Representation—Under the existing system, there is no assurance that the interests and advice of users and interested groups other than major stakeholders will be taken into consideration when managing and disposing of contaminated dredged material.

Major Stakeholders

The major stakeholders in dredged material management are: the federal government (e.g., Corps, EPA, National Oceanic and Atmospheric Administration, U.S. Navy, National Marine Fisheries Service, U.S. Fish and Wildlife Service); state government (e.g., Ecology, Washington Departments of Fisheries and Wildlife, DNR, PSWQA); local government (e.g., city and county government health, planning, and public works departments); tribal governments; ports (Washington Public Ports Association and local ports); marinas and boat repair facilities; private enterprises that depend on marine transportation; and general public and environmental organizations (e.g., Sierra Club, Washington Environmental Council).

Each major stakeholder falls into one or more of four categories: dredgers and dredging contractors, regulators, environmental groups and the general public, and owners and operators.

Dredgers and Dredging Contractors—This category includes local and state governments, port districts, the Washington Public Ports Association, the Corps, and the U.S. Navy, marinas, boat repair facilities, commercial and industrial transporters, other industrial users, and private citizens and developers. Companies that supply dredges, tugs, barges, pipelines, and trucks, and industries responsible for cleanup of contaminated sediments are also included in this category.

As users of a confined disposal site, dredgers are especially concerned that the regulatory process for dredging and dredged material disposal will be reasonable, consistent, practical, cost-effective, and available when needed. An additional concern of dredgers is the possibility of assuming liability for hazardous substances. The willingness of dredgers to use confined disposal sites will depend on reasonable regulations and costs and the availability of multiuser and single-user sites for contaminated sediments.

Regulators—This category includes federal, state, and local government agencies whose primary interest is to protect the environment in accordance with their individual mandates. For example, city and county governments are typically concerned about land use and transportation impacts (significant factors for some upland and nearshore sites), but may also have significant roles in water quality management. DNR is the major owner of aquatic lands and has land use and environmental concerns. Tribal governments are interested in environmental and land use issues and often focus on safeguarding fishery resources and the ability to harvest aquatic resources without avoidable restrictions.

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

Environmental Groups and the General Public—Several environmental groups, Indian tribes, and individuals with specific expertise have been closely involved in sediment and dredging issues. The general public has shown relatively little interest in general sediment, dredging, and disposal issues, probably because dredging and disposal activities have relatively low visibility, the environmental issues concerning sediment contamination are not widely understood. However, the general public has actively participated in several specific issues including perceived threats to shellfish from dredged material disposal in Port Gardner, interferences with fishing, and perceived beach contamination from the Fourmile Rock disposal site. Community interest is likely to peak when potential locations are identified for disposal sites.

Owners and Operators—Any major stakeholder could potentially own or operate a multiuser confined disposal facility. Existing solid waste multiuser facilities, such as municipal and demolition debris landfills, are operated by county governments or by private disposal companies. The primary concerns of potential facility operators and owners include costs, marketing, regulatory requirements, operational feasibility, and liability for hazardous substances.

MANAGING CONTAMINATED DREDGED MATERIAL

The management of contaminated dredged material involves several functions that must be completed by the various stakeholders. These functions can be organized into five categories: planning and regulation, siting, operations, closure and postclosure, and advisory.

Planning and Regulation

As mentioned above, the current management system lacks several functions that are essential for the success of a multiuser program:

- Confined Disposal Standards—There is a need to develop confined disposal standards that include: 1) the definition of dredged materials requiring confined disposal, 2) specification of testing and monitoring requirements, 3) development of siting guidelines, and 4) site closure and postclosure requirements (these standards are currently under development by Ecology).
- Oversight of Regulatory Compliance—There is a need for regulatory oversight to ensure compliance 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 county and city governments have the daily responsibility and authority for site management.
- Liability Management—There is a need to minimize liability risks by identifying specific liability responsibilities and developing methods for apportioning and financing liability. Each party involved in the dredging, transportation, or disposal of contaminated sediments could be held liable for damages incurred as a result of a release of contaminated material.

Siting

Siting functions include selecting the site, constructing the facility, and granting permits. The stakeholder(s) responsible for selecting the site must complete several tasks including: 1) determining the need for sites and their required capacities, 2) developing alternative site options, 3) evaluating environmental and cost issues, 4) making site recommendations, 5) obtaining permits, and 6) obtaining community acceptance for the location of a facility.

Operation

Functions in this category include all daily activities conducted at a multiuser facility, specifically:

- Operation and Ownership—Responsibilities include overseeing daily operations of a facility, permit renewals, costs, and revenues. Although it is possible that one stakeholder might own a facility and contract out its operation, this analysis assumes that the two functions are combined. Ownership and operation may be private or public.
- Monitoring—Operational and environmental monitoring of activities is necessary to ensure that the facility meets permit stipulations.

- Rate Setting—User fees must be established by setting rates. Rates should be reassessed periodically to ensure that all operation, maintenance, and closure and postclosure costs are taken into consideration.

Closure and Postclosure

Functions in this category include developing a closure plan and managing liability. A closure plan should address all planning and design issues that could affect closure including construction, monitoring, financing, contingency plans, and postclosure issues (e.g., monitoring, future use of the site). In addition, methods of apportioning postclosure liability and other aspects of liability management should be addressed in a liability management plan.

Advisory

Responsibilities of this function include reviewing all other roles of stakeholders and providing advice to those agencies in lead or joint roles. This function may also include participation by agencies and stakeholders in advisory committees or involvement in plan development.

Major stakeholders could assume one of three levels of responsibility for any management function:

- Lead responsibility—A single stakeholder has primary 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—Two or more agencies are responsible for particular functions with one agency designated as lead. Joint responsibility differs from 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, for which the Corps is the designated lead agency.
- Mixed responsibility—Stakeholders have the same responsibilities but for different specific sites. For example, the ports, local government, and private enterprise could all own and operate different sites.

The responsibilities are likely to be very complex when implementing the functions described above. For example, several permits at the federal, state, and local level are required to implement a dredging and disposal project, resulting in several entities having a lead responsibility for permitting. There are also different levels of regulatory oversight responsibilities assumed by federal, state, local, and tribal governments.

CRITERIA FOR EVALUATING INSTITUTIONAL OPTIONS

Criteria for evaluating the eight institutional options were developed based on several requirements for a multiuser program and on major problems of the existing system (Table 13).

Siting

The ability of an institution to site a facility depends on adequate institutional authority, community acceptance, availability of land, and adequate liability management:

- An institution must have the necessary authority to establish a disposal site, including authority to preempt local land use and zoning ordinances and authorize the development and implementation of siting criteria.
- Community acceptance may be impossible without a comprehensive community involvement program. The process considered to have the greatest chance of success is the negotiated siting process, in which the number and size of mitigation measures and compensations are negotiated with communities (see *Public Education and Involvement* section).
- The ability to site a facility is affected by the availability of land. Institutions that own land or have the ability to make land available may have an advantage over institutions that must acquire land.
- Liability management is a significant factor of the siting process, in part because the short-term and long-term hazards of contaminated dredged material disposal and management are not fully known. A liability management plan will have to accommodate a wide range of needs among stakeholders, and stakeholders' needs may vary according to site location.

Coordinated Management

Coordinated management depends on the vested authority of an institution to develop and implement program plans that will define the working relationships and activities of and allocate staff resources among supporting agencies.

TABLE 13. 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	Ability to coordinate activities
	Ability and authority to implement plan
	Ability to hire and train qualified staff
Environmental considerations	Establishment and enforcement of environmental standards for all 3 environments in a consistent manner
Cost considerations	Cost effectiveness of developing and managing the overall program
	Ability to obtain funding
Stakeholder 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

Environmental and Cost Considerations

In order to protect public health and the environment, an institution must have the ability to implement standards consistently on a regional or statewide basis. In addition, the institution must have the ability to manage environmental issues at upland, nearshore, and aquatic disposal sites.

The two major cost considerations are cost effectiveness and funding. Cost effectiveness may vary depending on the centralization or decentralization of services. Decentralization, for example, could result in the duplication of functions such as oversight, coordinated management planning, and liability management, leading to increased costs. Effective program management will also depend on the ability of an institution to raise funds through its bonding authority, access to grants, and authority to charge user fees.

Stakeholder Representation

A multiuser program must equitably represent the entire region and the diverse stakeholder interests. Stakeholders must be assured that costs and services are equitably distributed and that their needs are being met. For successful program management, the lead institution should have a good record of representing stakeholders.

Implementation

The success of any institutional option depends in part on its implementability. A new institutional arrangement may have fewer problems becoming established if it is compatible with the existing administrative framework and programs. Shifting responsibilities from one agency to another may make implementation more difficult. Some institutional options may require legislative action to give the institutions the authority to take on new responsibilities. Some institutional options may not be politically or publicly acceptable, even though they offer several advantages over other options (e.g., creating new institutions is not usually looked upon favorably in the political and public arenas).

EVALUATION OF INSTITUTIONAL OPTIONS

Eight institutional options for managing a multiuser site program are evaluated below:

- Option 1 - State/local government/port
- Option 2 - State/local government/private
- Option 3 - Federal/state/local government

- Option 4 - Coordinating council
- Option 5 - New authority
- Option 6 - Federal
- Option 7 - Coordinating council for all kinds of wastes
- Option 8 - New authority for all kinds of wastes.

Options 1-6 and the existing system (i.e., the status quo) were evaluated using the following general assumptions: 1) the status quo is evaluated based on actual advantages and disadvantages; 2) evaluation of the coordinated management program is based on the likelihood of successful development and implementation in each option; and 3) a method for ensuring a consistent and predictable flow of waste to each established disposal site is necessary for all options to ensure a steady stream of revenue for capital investments.

Two new options are identified that involve the creation of institutions or stakeholders for managing dredged material: a coordinating council and a new authority. The coordinating council would coordinate, delegate, and oversee the implementation of functions listed under its direction. The council may share, delegate, or take the lead in coordinating tasks. The council's authority involves planning and coordinating actions but not implementation actions. The new authority would undertake all planning and implementing functions. As a state-sponsored entity, the new authority could be designed to have preemptive authority over local laws.

Figure 3 summarizes the list of institutional options and the assigned stakeholder functions.

Status Quo

Under the status quo, PSWQA is responsible for contaminated sediments and dredging planning and Ecology is responsible for developing confined disposal standards and siting guidelines. Stakeholder responsibilities vary depending on the disposal environment. Oversight regulation involves several different laws and regulations with responsibilities assumed by federal, state, and local governments. Liability management responsibilities are not specifically addressed; all stakeholders involved in the dredging, transport, and disposal of contaminated sediments may have varying degrees of liability.

The project proponent usually selects the site and constructs, owns, operates, and monitors the facility. The project proponent is also responsible for closure plans and closure. However, when Corps dredging is involved, the local sponsor is the responsible entity, and local governments or business enterprises are the

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/ Postclosure		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/F	P	P	P	P	OU	A
Option 2 - State/Local/Private	L	S	S	S	L	PE	L/F	PE	PE	PE	PE	OU	A
Option 3 - Federal/State/Local	J	J	J	J	J	P	L/F	P	P	P	P	OU	A
Option 4 - Coordinating Council	CC	CC	CC	CC	CC	L	S/F	L	L	CC	CC	OU	A
Option 5 - New Authority	N	N	N	N	N	N	N/F	N	N	N	N	OU	A
Option 6 - Federal	F	F	F	F	S	M	S/F	M	M	M	M	OU	A
Option 7 - Coordinating Council (All Wastes)	CC	CC	CC	CC	S	L	S/F	L	L	L	CC	OU	A
Option 8 - New Authority (All Wastes)	N	N	N	N	N	N	N/F	N	N	N	N	OU	A

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

Figure 3. Institutional options for managing a multiuser confined disposal sites program

responsible entities for disposal at solid waste facilities. Permitting is the responsibility of local, state, and federal governments. Rate setting is currently applicable to municipal landfills only, and local governments have that responsibility.

The major advantage of maintaining the status quo is that the system for siting is already in place and could be improved with a minimal amount of disruption (Table 14). Another advantage is that PSWQA, an existing, well established institution, is assigned coordinating responsibilities.

There are many disadvantages to maintaining the status quo (see Table 14). The most serious disadvantage is probably the lack of coordinated management. Other disadvantages of the status quo include: 1) inconsistent permitting and regulatory oversight even though dredged material is currently defined as solid waste by state law, 2) difficulty in siting disposal facilities due to public concerns and lack of siting guidelines, and 3) inadequate or inconsistent stakeholder involvement.

General Advantages and Disadvantages to Options 1-6

There are certain advantages and disadvantages that apply to Options 1-6 (Table 15). It is assumed that siting guidelines, confined disposal standards, coordinated management programs, and liability management plans will be developed regardless of the option selected. The siting process should be improved through the development of siting guidelines and standards. Environmental consistency should also be improved when standards are developed. In addition, development of programs addressing coordinated management and liability issues should facilitate efforts to obtain funding and, therefore, increase the likelihood of receiving such funding.

The major disadvantages of all options are that they do not *de facto* ensure adequate representation of stakeholders and an effective siting process that includes the public. However, these disadvantages could be addressed by the management plan.

Option 1 - State Government/Local Government/Ports

Under this option, the stakeholders with lead responsibilities are the state and local governments and the ports. The state has lead responsibility for coordinated management, standards, oversight regulation, and liability management; local governments have lead responsibility for site selection and permitting; and the ports have lead responsibility for site construction, operation (including ownership and operation, monitoring, and rate setting), and the closure plan. The most likely state and local agencies for lead responsibility are: PSWQA (coordinated

TABLE 14. ADVANTAGES AND DISADVANTAGES OF THE STATUS QUO OPTION

Factors	Advantages	Disadvantages
Siting	System is in place and has the potential for improvement with minimal disruption	Siting of disposal facilities is difficult because of public and environmental group concerns
	PSWQA has the existing coordinating responsibility	Siting guidelines do not currently exist (but are to be developed)
		Confined disposal standards are still being developed.
Coordinated management		Coordinated management of dredging does not exist to a great extent and there is no designated entity to develop a plan
		The Puget Sound Water Quality Management Plan contains many elements designed to facilitate coordinated management but is not comprehensive
		A liability management plan does not exist
Environmental considerations		Sites are not consistently permitted even though dredged material is defined as sold waste by state law
		Regulatory oversight of disposal of dredged material is inconsistent
Cost considerations		There is little centralized support at the state level to aid local governments
		Currently planned functions are not adequately funded
Stakeholder representation		Major stakeholders are highly involved but intermediate and small stakeholders are not involved

TABLE 15. GENERAL ADVANTAGES AND DISADVANTAGES OF OPTIONS 1-6

Factors	Advantages	Disadvantages
Siting	Development of siting guidelines and a liability management plan would improve the siting process	Although there are some improvements in siting, no option will ensure that there is an effective siting process that involves the concerned public
Coordinated management	A program to achieve coordinated management would be developed and have a reasonable chance for successful implementation	
Environmental considerations	Consistency should be improved by confined disposal standards	
Cost considerations	Funding of the program is more likely because of the coordinated effort among the various agencies	
Stakeholder representation		Adequate representation of all stakeholders is not ensured

management); Ecology (standards, oversight regulation, liability management); and local planning and health departments (site selection and permitting).

The advantages and disadvantages of this option are summarized in Table 16. The major advantage of this option is that the ports have been assigned the ownership role and they own some aquatic and nearshore lands in industrialized areas. The public may more readily accept a facility located in an industrialized area than in a suburban or rural area. Another advantage of this option is that it is fairly compatible with the existing system and will be easily implemented. Environmental consistency would probably be improved over the status quo due to the broad geographic interests of the three major stakeholders.

The major disadvantage of this option is that the federal government is not assigned any lead responsibilities, which may have negative impacts on funding, cost-effectiveness, and environmental consistency. For example, opportunities for federal funding of the management plan may be jeopardized by the lack of a strong federal role. Similarly, cost effectiveness may be adversely impacted if federal concerns are not fully considered during program development. Environmental consistency may also be jeopardized if federal environmental concerns are not fully accounted for. Another disadvantage of this option is that the three stakeholders with lead responsibilities have other commitments that could divert their attention from contaminated dredged material management.

Option 2 - State Government/Local Government/Private Industry

Under this option, state and local governments and private industry have been assigned lead responsibilities. The state has lead responsibility for standards, oversight regulation, and liability management; local government has lead responsibility for coordinated management, site selection, and permitting; and the private sector has lead responsibility for construction, ownership/operation, monitoring, 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); Ecology (standards, oversight regulation, liability management); and local planning and health departments (site selection and permitting).

The advantages and disadvantages of Option 2 are summarized in Table 17. The major advantage of this option is that private industry has been assigned the ownership role and may own lands appropriate for development of a multiuser facility. Private industry may also be more cost-effective in developing and operating sites. This option is also fairly compatible with the existing system and will be easily implemented. Environmental consistency may be improved due to the broad geographic interests of the three major stakeholders.

The major disadvantage of this option is that the availability of sites may be negatively impacted (particularly nearshore sites) because the ports are not

TABLE 16. ADVANTAGES AND DISADVANTAGES OF OPTION 1

Factors	Advantages	Disadvantages
Siting	Improved siting for aquatic and nearshore sites due to role assigned the ports in site ownership Placement in more industrialized areas owned by ports more acceptable to public	
Coordinated management		Lack of strong role for federal government (i.e., Corps and EPA) may have negative impact on funding, cost effectiveness, and environmental consistency
Environment considerations	Consistency should be improved due to the broad geographic interests of the three major stakeholders	Lack of strong role for federal government (i.e., Corps and EPA) may have a negative impact on environmental consistency
Cost considerations		Lack of strong role for federal government (i.e., Corps and EPA) may have negative impact on funding and cost effectiveness
Stakeholder Representation		The federal government and private industry do not have significant roles
Implementation	This option is fairly compatible with the existing system and will be easily implemented	The three major stakeholders have other responsibilities that could divert the focus from contaminated dredged material management

TABLE 17. ADVANTAGES AND DISADVANTAGES OF OPTION 2

Factors	Advantages	Disadvantages
Siting	Private sector may be more cost-effective in developing and operating sites	The exclusion of a strong role for ports will have a negative impact on the availability of sites, especially in nearshore areas
Coordinated management		Lack of strong role for the federal government (i.e., Corps and EPA) may have negative impact
Environmental considerations	Consistency should be improved due to the broad geographic interests of the three major stakeholders	Lack of strong role for federal government (i.e., Corps and EPA) may have negative impact
Cost considerations	Private sector may own land that could be made available for disposal sites	Lack of strong role for the federal government (i.e., Corps and EPA) may have a negative impact on funding and cost effectiveness
Stakeholder Representation		The federal government and the ports do not have significant roles
Implementation	Fairly compatible with existing system and easily implemented	Stakeholders involved have completing responsibilities and focusing on dredged material management may be difficult

assigned a major role. Another disadvantage of this option is that the federal government is not assigned any lead responsibilities, which may have a negative impact on funding, cost-effectiveness, and environmental consistency. For example, opportunities for federal funding of the management plan may be jeopardized by the lack of a strong federal role.

Option 3 - Federal Government/State Government/Local Government

Under this option, an entity represented by the federal, state, and local governments has joint responsibility for coordinated management, standards, site selection, oversight regulation, and liability management. The enabling charter or interagency agreements establishing the entity include provisions that ensure adequate participation of ports and the solid waste disposal industry in decision-making. On private land, the ports and the solid waste disposal industry have the option of assuming lead responsibility for construction, ownership/operation, monitoring, rate setting, and the closure plan for disposal sites; however, on state land these functions are assumed by DNR (possibly in association with ports and the solid waste disposal industry). The most likely federal, state, and local agencies for lead responsibility are the Corps, EPA, PSWQA, Ecology, DNR, and the appropriate city or county government (representation by the successor agency of the Puget Sound Council of Governments should also be considered).

The advantages and disadvantages of Option 3 are summarized in Table 18. Of the options considered, this option has the most advantages and appears to be a promising option for a new institutional arrangement. A similar arrangement (i.e., PSDDA) has been successfully used in establishing open-water, unconfined disposal sites. The major advantage of this option is that the major stakeholders have key roles which should result in improved agency coordination and centralization of services. The improved coordination and centralization may lead to increased funding and a more successful siting process. Another advantage of this option is that it is compatible with the existing system and should be comparatively easy to implement. Environmental consistency should also be improved due to the broad geographic interests of the major stakeholders.

A disadvantage of Option 3 is that the entity used may lack the focus and authority of a single stakeholder established specifically for dredged material management.

Option 4 - Coordinating Council

Under this option, the coordinating council has the lead responsibility for the coordinated management, the closure plan, standards, oversight regulation, liability management, site selection, and rate setting. The state is responsible for permitting, and local government is responsible for site construction, ownership/operation, and monitoring. The coordinating council is appointed by the state and

TABLE 18. ADVANTAGES AND DISADVANTAGES OF OPTION 3

Factors	Advantages	Disadvantages
Siting	Government stakeholders will coordinate site selection with input from ports and private waste disposal industry	
Environmental considerations	Consistency should be improved due to the broad geographic interests of the major stakeholders	
Cost considerations	Funding is more likely because of the coordinated effort of the stakeholders, including the federal government	
	Services would be centralized and more efficient	
Stakeholder representation	All major stakeholders have key roles and coordination may be improved	May lack focus and authority of a single stakeholder established specifically for dredged material management
Implementation	Compatible with existing system	
	A similar arrangement (PSDDA) has been successfully used to establish open-water unconfined disposal sites	

has broad representation of stakeholders. The most likely state and local agencies to hold lead responsibilities are: Ecology (permitting) and local public works and health departments (construction ownership, operation, and monitoring).

The advantages and disadvantages of this option are summarized in Table 19. The major advantage of this option is that site selection, permitting, and rate setting are centralized, which should result in a cost-effective and environmentally consistent program. Other advantages of this option are that stakeholder involvement is maximized, which may lead to greater equity; and that there is an exclusive focus of the coordinating council on dredged material issues, which may ease implementation.

The major disadvantage of this option is that the ports and private industry do not have roles in site construction, ownership, and operation; which may lead to decreased availability of land. This option may also be hard to implement because it is significantly different from the existing system and the creation of the coordinating council may require legislative action.

Option 5 - New Authority

Under this option a new authority is created that has extensive powers to undertake almost all phases of the management of contaminated dredged material. A professional staff would provide the technical support necessary to conduct 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.

The advantages and disadvantages of the new authority option are summarized in Table 20. The major advantage of this option is the exclusive focus and clear authority regarding the management of dredged material which should ease implementation and the siting process. Major stakeholders may be involved and environmental consistency should be improved due to the broad geographic interests of the stakeholders.

Creating a new authority would be costly and political and public acceptance may prove difficult. This option is also incompatible with the existing system and legislative action may be required to authorize the new authority.

Option 6 - Federal Government

Under this option, a federal agency has lead responsibility for coordinated management, standards, oversight regulation, and liability management. The state has lead responsibility for site selection and permitting. The ports, local governments, and private enterprise share responsibility for site construction,

TABLE 19. ADVANTAGES AND DISADVANTAGES OF OPTION 4

Factors	Advantages	Disadvantages
Siting	Centralized site selection through council	Ports and private enterprise do not have a role in site construction, ownership, and operation
Environmental considerations	Centralized rate setting may improve equity and flow control	
	Consistency should be improved due to the broad geographic interests of the major stakeholders	
Cost considerations	Centralized permitting by the state may be cost-effective	
Stakeholder representation	Maximum stakeholder involvement in all functions	Ports and private enterprise do not have a role in site construction, ownership, and operation
	Increased stakeholder representation may increase equity	
Implementation	Exclusive focus on dredged material management and disposal	Significantly different from existing system
		Approval for state-level coordinating council may require legislative action

TABLE 20. ADVANTAGES AND DISADVANTAGES OF OPTION 5

Factors	Advantages	Disadvantages
Siting	Authority for site selection centralized	
Coordinated Management	Specific responsibility and authority exists to achieve coordinated management	
Environmental considerations	Consistency should be improved due to the broad geographic interests of the major stakeholders	
Cost considerations		Creation of a new authority would be costly
Stakeholder representation	Key stakeholders may be included	
Implementation	Exclusive focus and clear authority regarding dredged material management	Political and public acceptance may be problematic
		Option is incompatible with the existing system
		Legislative action may be required to establish new authority

ownership/operation, monitoring, rate setting, and closure plans. The Corps is the most likely federal agency for lead responsibility.

A summary of the advantages and disadvantages for this option are provided in Table 21. The advantages of this option include the potential availability of land for multiuser facilities, the increased likelihood of funding, and the expertise and administrative structures of some federal agencies for dealing with dredged material.

The major disadvantage of this option is the federal government's actual or perceived remoteness from local issues, which may lead to environmental inconsistency and a lack of political and public acceptance. Another disadvantage is that congressional authorization may be needed to implement and finance this option. The option may be difficult to implement due to incompatibility with the existing system, difficulties with political and public acceptance, and possible diversion of stakeholders' attention by competing responsibilities.

Options 7 and 8 - Coordinating Council and New Authority for All Kinds of Wastes

Although options for creating a coordinating council and a new authority for all wastes (i.e., solid waste and dredged material) were included in the list, a detailed evaluation of these options was beyond the scope of this report.

SUMMARY

Eight institutional options were developed after reviewing the existing system of dredged material management and interviewing several representatives of the waste management industry. Each option was evaluated for its potential to alleviate the problems related to the existing system for dredged material management. Some problems, such as obtaining community acceptance and the lack of available of land and funding, are common to all institutional options. Other problems, such as lack of coordination, environmental inconsistency, and difficulty in implementation, are specific to one or more institutional options.

Option 3 (federal, state, and local government) appears to have the greatest potential for dealing with the common and specific problems. The major governmental stakeholders will be represented in one entity, which should improve the coordination of the entire program. In addition, there are methods to ensure adequate participation of nongovernmental stakeholders in decision-making. The other options either lack the representation of one or more major stakeholders or call for the creation of a new governmental body (i.e., coordinating council or new authority). Obtaining political and public acceptance of a new governmental body may be difficult and expensive.

TABLE 21. ADVANTAGES AND DISADVANTAGES OF OPTION 6

Factors	Advantages	Disadvantages
Siting	Federal lands may be available	
Environmental considerations		Consistency is not ensured due to the federal government's actual or perceived remoteness from local issues
Cost considerations	Funding is more likely due to federal participation	Funding may require congressional approval
Stakeholder representation		Federal government may not be perceived as representing local stakeholders' interests because of the federal government's actual or perceived remoteness from local issues
Implementation	Some federal agencies (e.g., Corps) have expertise and administrative structures for dealing with dredged material	Option is incompatible with existing system
		Political and public acceptance may prove problematic
		Stakeholders have competing responsibilities and focusing on dredged material management may be difficult
		Special congressional authorization may be required

Another possibility that should be considered is enhancing the existing system. Improvements such as the development of confined disposal standards are currently under way. Additional actions such as increased stakeholder representation (e.g., to include entities with control over potential upland sites) and community involvement could improve the current dredged material management system and make it more suitable to a multiuser site program.

7. LIABILITY ISSUES ANALYSIS AND MANAGEMENT PLAN

Interviews by Ecology of potential multiuser sites program stakeholders indicate that the risk of incurring joint and several liability is a major concern. Although stakeholders already involved in dredging projects are no doubt exposed to liability by their current activities, they have concerns about sharing what they perceive to be the greater risks inherent in a joint enterprise like the multiuser sites program. In particular, dredgers of slightly or moderately contaminated sediments may be unwilling to accept liability for the more highly contaminated sediments of other dredgers. Small-volume dredgers are also concerned about sharing liability with high-volume dredgers. However, it is possible to address stakeholders' concerns with an aggressive plan to manage liability. An important factor in favor of program development is the probability that liability will be decreased as a natural result of the comprehensive regulation of dredging and disposal activities.

This section of the report identifies and evaluates approaches for managing liability within the multiuser sites program. First, a brief background of the legal concept of liability for environmental damages is provided, including statutory and common law liability provisions and potentially liable party (PLP) issues. Second, institutional and operational tools for managing liability are identified. The final section provides an outline of a proposed liability management plan; the outline suggests the timing for application of the institutional and operational tools to the major phases of program development (site development, site construction, operation, closure, and postclosure).

BACKGROUND OF LIABILITY FOR ENVIRONMENTAL DAMAGES

Liability issues for releases of materials containing hazardous substances are notoriously unclear, due in part to overlaps in laws and conflicting court decisions. For purposes of this report, CERCLA was assumed to establish the primary federal basis for liability and MTCA was assumed to establish the primary state basis for liability. Courts have generally interpreted CERCLA's liability provisions (Section 107 et seq.) as requiring strict, joint and several liability standards, although the statute does not mandate a particular standard. In contrast, MTCA Section 4.2 mandates the application of strict, joint and several liability. Other federal and state statutes also provide bases for liability [see Henson and Booth (1990) for a discussion of those bases].

Strict Liability

Strict liability is the standard traditionally imposed on entities who engage in "dangerous" activities (i.e., activities that cannot be conducted with complete safety). Because of the high magnitude of harm that could result from a release of hazardous materials from any type of disposal site, entities involved in the generation, treatment and disposal of such materials are generally subject to strict liability. The main impact of strict liability is that participation alone is enough to establish liability (i.e., without regard to intentional or negligent behavior). Strict liability is one of the main tools used to encourage participants in dangerous activities to adopt protective measures to prevent harm to the public and the environment.

Joint and Several Liability

Joint and several liability is a legal theory applied by courts in cases involving multiple plaintiffs when no accurate way can be found to determine each defendant's contribution to the total harm. Joint and several liability means, literally, that each defendant is responsible for the full amount of damages awarded the plaintiff both as a member of the group of defendants (joint liability) and as an individual (several liability). Although the plaintiff may recover only the amount of damages actually awarded by the court, there are no other restrictions. In effect, the plaintiff may recover 100 percent of the damages from the defendant who is most solvent (i.e., the "deep pocket" defendant), regardless of that defendant's true contribution. In pollution cases, this means that an enforcement agency seeking to recover costs of cleanup from a group of PLPs may recover its full costs, in addition to other statutorily allowed damages, from the PLPs most able to pay. The typical pollution case is a standard joint and several liability situation in that it generally involves multiple PLPs who disposed of wastes at a common site over a period of years.

CERCLA and MTCA Liability

Under CERCLA Section 107(a), PLPs deemed responsible for a release or threatened release of hazardous substances, as defined by the act, may be liable for some or all of the following:

- All removal or cleanup costs incurred by a state, the federal government, or an Indian tribe
- Any other necessary costs of response incurred by any person
- Damages for injury to, destruction of, or loss of natural resources
- Costs of any health assessment performed according to CERCLA Section 9604(i).

All costs include interest on the amounts recovered by the government or tribe. PLPs found liable for a release who do not fulfill cleanup requirements as directed by EPA may also be subject to punitive damages equal to three times the amount of costs incurred by Superfund. Although limits have been established for the amount of monetary damages that can be assessed PLPs for accidental releases from nonincineration vessels, the total liability of each PLP for a release from a facility or incineration vessel is the full amount of response costs plus $50,000,000. Additional civil and criminal penalties may be assessed for failure to comply with EPA cleanup directives.

Under MTCA Section 4.2, [RCW 70.105C.040(2)], PLPs deemed responsible for a release or threatened release of hazardous substances are liable for all resulting cleanup costs and damages to natural resources. In addition, a PLP who fails to comply with Ecology's cleanup directives may be assessed up to three times the costs incurred by the state in accommodating the noncompliance and $25,000 per day for each day the noncompliance continues [MTCA Section 5.1(a) and (b); RCW 70.105C.050(a) and (b)].

Defenses to CERCLA and MTCA Liability

As a general rule, statutory defenses to both CERCLA and MTCA liability are narrowly interpreted by courts and available in very limited situations. Some of the defenses set forth below are explicitly provided in the statutes, while others must be inferred (e.g., parties explicitly excluded from the statutory definition of PLP will not be subject to the liability provisions). Descriptions of CERCLA and MTCA defenses, exemptions, and exceptions are provided below:

- A PLP is not liable for releases caused solely by an act of God, an act of war, or an act of a third party not in a contractual relationship with the party using the defense (CERCLA and MTCA)
- A party who purchased a contaminated site may be exempt from liability if there was no actual knowledge of the contamination, or reason to suspect contamination, prior to the purchase (CERCLA and MTCA)
- A PLP is not liable for a release of pesticides applied in accordance with the Federal Insecticide, Fungicide and Rodenticide Act (CERCLA)
- A state or local government is exempt from PLP liability if it acquires ownership of a contaminated site involuntarily (e.g., through bankruptcy, foreclosure, tax delinquency, or abandonment) (CERCLA and MTCA)
- A natural person (i.e., not a corporation) who uses a hazardous substance without negligence for personal or domestic purposes is exempt from liability (MTCA only)

- A person who uses pesticides or fertilizers without negligence for the purpose of growing food crops is exempt from liability (MTCA only; CERCLA has analogous provision).

- A person who holds a security interest only and does not participate in day-to-day management of the property is excused from liability (MTCA only).

All of the above defenses are available only to those PLPs who did not cause or contribute to the release of contaminants. In addition, MTCA Section 7.2(d) provides Ecology with the authority to use state funds to ameliorate the harsh effects of MTCA liability for certain economically disadvantaged PLPs, if use of the funds would result in enhanced cleanup and prevention or mitigation of economic hardship.

Other limitations on liability may be available, but are not explicitly provided by CERCLA or MTCA. Nonstatutory defenses that may limit or preclude liability are the possibility of apportionment, bankruptcy, sovereign immunity (for a state or federal government PLP), equitable defenses, and contractual defenses. Recent PLP challenges to impositions of liability have been based on constitutional (due process) grounds; the results of those challenges are pending and are likely to be important. The nonstatutory defenses are likely to have limited applicability to the multiuser sites program development phase because they are generally used to challenge liability in the aftermath of a release.

The primary focus of liability management should be prevention of unsafe activities, and not avoidance of culpability. Therefore, a liability management plan committed to that philosophy in both form and substance will provide the best defense for stakeholders.

Proposed Alternatives to CERCLA/MTCA Liability Provisions

The "polluter pays" rationale that underlies CERCLA's liability scheme has not proven as effective as originally intended by Congress. It has been estimated that up to 60 percent of the money set aside for cleanup under Superfund is spent on litigation and administration costs (Greenberg 1989). It has also been estimated that only 14 percent of the money spent on Superfund cleanup has been recovered from PLPs (Cheek et al. 1989). In conjunction with CERCLA's 1991 reauthorization hearings, an industry coalition has launched an effort to impose a no-fault liability scheme that will be funded by a broad-based industrial tax. The no-fault legislation would eliminate the need for PLP searches, except in cases where an enforcement agency (e.g., EPA) has clear and convincing evidence that the PLP was a willful polluter. Although the success of this effort cannot be predicted, there is widespread acknowledgment on the part of state and federal governmental entities, courts, and the business community in general that changes are required so that funds currently consumed by litigation will be available for active cleanup. Any changes to CERCLA subsequent to the 1991 reauthorization hearings are likely to have corresponding implications for MTCA and liability management efforts in general.

Potentially Liable Parties

In accordance with the objective to provide enforcement agencies with vast power over polluters, PLP definitions are extremely broad under both CERCLA and MTCA. Liability under either statute is not defined by levels of fault, which allows enforcement agencies to recover cleanup funds from the PLPs most able to pay. PLP status may also be extended to entities who are not owners, operators, generators, and transporters under MTCA Section 4, if Ecology has "credible evidence" of their liability.

Owner/Operator Liability—MTCA Sections 4.1(a) and 4.1(b) establish liability for present and past owners or operators of facilities. Under Section 4.1(a), a present owner or operator may be held liable regardless of the time of disposal or release of a substance from the facility. Under Section 4.1(b), a past owner or operator of a facility will also be liable for releases that coincide with the period of ownership or operation. CERCLA caselaw is generally consistent regarding ownership liability. Ownership alone has long been held to be sufficient grounds to impose liability, even if the owner did not participate in the management or operation of the business. This is the category most subject to strict liability. To acquire operator status, the PLP must participate at some level in day-to-day management. In general, the greater the level of involvement with the facility, the more likely that PLP status will be found. Courts have failed to designate state agencies operators of sites when activities were limited to site regulation or permitting; however, providing management plans and operational oversight may be sufficient to acquire PLP status.

CERCLA Section 107(k)(1) provides a release from liability for Resource Conservation and Recovery Act (RCRA) permitted facilities (i.e., hazardous waste disposal facilities) that have been permanently closed in accordance with RCRA's strict closure rules. Under this section, the liability of owners and operators under CERCLA, or any other law, for releases from closed RCRA facilities will be transferred to the Post-Closure Liability Trust Fund (CERCLA Section 232). It is assumed that disposal sites developed under the multiuser program will not be classified as hazardous waste disposal facilities [assuming that dredged materials will not contain hazardous substances, as defined by MTCA Section 2(5); RCW 70.105C.020(5)], and therefore Section 107(k)(1) will not apply. Nevertheless, an investigation of the possibility of providing similar releases for owners and operators of closed multiuser disposal sites may be valuable to provide assurance to PLPs that liability can be limited in association with a strict closure plan.

Transporter/Dredger Liability—Transporters may be held liable under MTCA Section 4.1(d), which imposes liability on any person who 1) accepts hazardous substances for transport to a facility from which there is a release, or 2) accepts hazardous substances for delivery to a facility where there are reasonable grounds to believe that the facility is not being operated in accordance with law. Although there is no explicit MTCA section establishing PLP liability for dredgers, they may be found liable under this section or any other applicable section if they operate in multiple capacities (i.e., as owners, operators, or generators).

Generator Liability—Generators of hazardous materials may be held liable under MTCA Section 4.1(c), which imposes liability on any person who owned or possessed a hazardous substance and who, by contract, agreement, or otherwise, arranged for disposal or treatment of the hazardous substance, or who generated a substance that was disposed of at the facility. Upland industrial contributors to the contamination of sediments dredged from Puget Sound may also be defined as PLPs under this section. Generally, establishing a generator as a PLP does not require that the enforcement agency fingerprint wastes (i.e., no extensive analysis of the chemical composition of wastes at the site is needed before joint and several liability can be applied). The government need only show that the generator's wastes were disposed of at a site and that hazardous substances present in the generator's wastes are present at the site.

Contribution Actions

Contribution actions are suits initiated by PLPs against other PLPs for recoupment of cleanup costs and damages that have been assessed by a governmental enforcement agency in the aftermath of a release. Because of the possibility that every entity involved with the multiuser sites program may acquire PLP status with any degree of involvement in the program, issues relating to contribution actions may be relevant for potential proponents. Contribution actions are permitted by CERCLA Section 107(a) and are implicitly permitted under MTCA Sections 4.4(d) and 4.5.

Contribution actions may present the sole opportunity for a full hearing of the nonstatutory defenses discussed earlier. Although nonstatutory defenses are generally not addressed by a court in the government's cost recovery action, they may be used to rebut or limit liability in a contribution action. Evidence of apportionment, contractual defenses, and other mitigating factors are also only relevant in the contribution action.

TOOLS FOR MANAGING LIABILITY

This section discusses common institutional and operational tools that may be used to manage liability risks associated with the treatment and disposal of substances suitable for confined disposal. However, the best liability management program involves a willingness to do more than any existing government rules require, contemplation of reasonable worst-case scenarios, and adoption of stringently protective standards.

Liability management techniques are designed to provide a sufficiently protective program so that the inherent and unavoidable risks of any activity are accommodated. Each of the tools presented in this section will either minimize exposure to liability or provide greater predictability of liability in the event of a release or threatened release. The value of each of the tools presented below will vary, depending on the particular alternatives implemented in the program (e.g., location of site, institutional option, adopted standards). A sufficient evaluation of the protectiveness of any tool may require a painstaking cause-and-effect analysis of the tool in relation to the program as a whole. These tools are proposed from a liability management standpoint; however, other factors may exist that will affect the viability of these tools (e.g., results of costs vs. protectiveness analyses). The institutional tools provide the foundation for the program; the effectiveness of the operational tools may be based substantially on the adequacy of the institutional tools.

Institutional Tools

Institutional tools provide the foundation for the development of safe and efficient operational tools. In general, the institutional tools establish stakeholder functions, operations and management plans, stakeholder and contractor agreements, financial assurance mechanisms, and a public education and involvement program.

Determination of Stakeholder Roles and Responsibilities—As defined earlier in this report, stakeholders may be federal, state, or local agencies, ports, tribal governments, marinas, boat repair facilities, private enterprises, or other entities with a significant connection with the facility. Determination of suitable stakeholder functions is the first priority of the program development phase. Appropriately designated stakeholders will oversee compliance with the program standards established by PSWQA. They will also participate in the development of standards that must be in place prior to the selection of site location and actual construction of the facility.

Ultimate liability under either CERCLA or MTCA is not likely to differ substantially for any of the institutional options described in the previous section. Similarly, providing varying levels of responsibility for each of the options will not affect legal liability. The options may be best assessed for liability purposes by determining the suitability of the stakeholder for the particular function. Suitability is established by balancing a number of factors including statutory authority, level of expertise, relevant experience, availability of appropriate personnel, and the absence of conflicts of interest.

Planning for Liability Risks—As part of the mandate from PSWQA to provide sediment management standards for Washington state, Ecology and the Confined Disposal Workgroup (which is composed of experts on sediment and disposal issues from various state entities) formulated recommendations for the multiuser disposal sites program that will be presented to PSWQA. It was the consensus of the workgroup that program development as a whole and liability in particular could best be managed through the use of a series of plans to guide each phase. Accordingly, the workgroup recommends that development of these plans by program stakeholders be either required or encouraged in the state sediment management regulations. The issues addressed by the workgroup are described below.

Required Plans—The workgroup determined that it was both possible and necessary to limit risks by providing detailed guidance for certain aspects of the program. The workgroup will recommend that program stakeholders be required to develop and submit for approval plans that will address the following issues:

- Sediment Characterization and Testing—Test requirements should be established so that the appropriate disposal standards for sediments may be determined; the tests will also be used to determine the most suitable disposal environment

- Monitoring—Monitoring procedures and responsibilities should be defined in accordance with regulatory requirements

- Dredging and Disposal Methods—Effective and safe dredging and disposal methods should be mandated in plan specifications

- Closure—Requirements for closure of a disposal facility must be developed and approved; criteria should be established for obtaining final approval of closure by the appropriate authority

- Postclosure—Specifications for preparing the site for future use should be established; limitations on future use and postclosure requirements (e.g., monitoring) should be addressed in the postclosure plan

- Contingency Action—Authority for and scope of response actions should be delineated in the event of release or threatened release; methods for funding contingency action plan activities should also be provided in the plan specifications.

Encouraged Plans—The workgroup decided that it may not be possible to fully accommodate the needs of certain aspects of the program through the use of highly specific plan requirements. Therefore, the workgroup will recommend that the sediment management regulations encourage program stakeholders to develop and submit for approval plans that address the following issues:

- Capacity
- Site location
- Construction
- Public involvement.

Other Issues—It was determined by the workgroup that some areas of the project could not be adequately addressed by specific, inflexible criteria to be established in plans. Therefore, the workgroup will recommend to PSWQA that the regulations remain silent on the following issues:

- Disposal site design—Design standards should specify the manner in which equipment, structures, and processes are constructed or implemented. Design standards are difficult to predetermine because other factors (e.g., sediment contaminant levels) will affect them. While specifying the use of "overdesign" (i.e., the use of operational methods that are more protective than those currently required by statute) is an option, the workgroup consensus was that such a specification may be too broad to be an adequate or effective means of setting program guidelines.
- Contractual issues—Contracts and other tools may be used to apportion liability among PLPs, establish expectation levels, and allocate responsibility for the performance of duties. Although essential, contractual tools must be developed on a case-by-case basis to be effective, especially when environmental issues are involved.

Approval by appropriate stakeholders of the elements contained in the proposed plans should be reached in a consensus-building effort. It is important to use a reasonable worst-case scenario when assessing the effectiveness of each of the proposed plans.

Development of Standards for Confined Disposal of Contaminated Sediments—The development of confined disposal standards may be the most important institutional tool for managing liability. The standards for confined disposal of contaminated sediments that are currently being drafted by Ecology (as required by the Puget Sound Water Quality Management Plans of 1987 and 1989), propose to regulate dredged sediments exceeding the contamination limits established for unconfined open water disposal (PSDDA 1988a,b; 1989), but with lower contamination levels than the dangerous waste standards set forth in 173-303 WAC (Parametrix 1990). There is no PSDDA equivalent for the disposal of materials at upland sites. The proposed confined disposal standards will regulate the disposal of dredged sediments at upland sites (Parametrix 1990). Results of sediment characterization tests may be used to determine the applicability of treatment of wastes under the confined disposal standards, PSDDA standards, or state dangerous or hazardous waste regulations [e.g., RCW 70.105.010 (5), (6), and (14)]. The standards will also designate minimum standards for other aspects of dredged material disposal (e.g., dredging and disposal techniques, testing and characterization of sediments).

Financial Assurances—A preliminary assessment should be made of the most desirable means for obtaining financial assurances from PLPs of their ability to pay for damages arising from a release or threatened release at a site. The assessment may require an in-depth analysis of the efficacy of the traditional tools for providing financial assurances, as well as an exploration of statutory provisions. This assessment must take place during the program development stage to provide the foundation for the establishment of a cleanup fund. Establishment of the fund itself is an operational tool and may occur during site development and construction, while maintenance of the fund will continue throughout the life of the program.

Public Education and Involvement Programs—A public education and involvement program will be an essential component of the multiuser sites program. Initial development of a plan to identify affected members of the general public and environmental and other interest groups should begin as soon as the program is approved for development. This program plan should be developed apart from plans to fulfill statutorily-mandated public disclosure periods.

Policy statements issued in conjunction with the public education and involvement program can be important means of addressing specific public safety concerns with increased sensitivity and detail. Policy statements may help to reassure the general public that stakeholders have a strong commitment to the safe operation of the facility. Particularly important policy statements include overt commitments to regulatory compliance, vigilant oversight and monitoring, and regular upgrading of protective measures used at the facility. For substantive use with the plan, the statements will include specific action plans designed to achieve those goals.

Contractual Mitigation Techniques—There is a general consensus among courts that contracts between PLPs are enforceable in the absence of conflicting public policy. While joint and several liability for the government's enforcement action cannot be contracted away, CERCLA (and presumably MTCA) does not preclude or invalidate other lawful means of apportioning liability among PLPs (Boyd et al. 1986). Therefore, while contractual protections may not be used to defend against the imposition of liability in an enforcement action, they may be used to reallocate liability in a subsequent PLP contribution action. Use of contractual tools to establish an acceptable apportionment may also eliminate the need for excessive litigation to define PLP liability.

Contracts may also be the best tool to bring together all of the objectives, expectations, and requirements established by the various program plans (e.g., coordinated management, disposal standards, and closure plan). Particularly valuable contractual clauses for managing liability include indemnification agreements and agreements to apportion liability. Other contractual provisions that may be used to provide protection in the event of liability include alternative dispute resolution clauses, notice provisions, and agreements to adhere to regulatory and program requirements. Each of these contractual methods is discussed in the *Liability Issues Analysis and Management Plan Outline* (Henson and Booth 1990) report. For the greatest degree of protection, it is essential that contracts be in place prior to site construction.

Interagency Memoranda of Understanding—Memoranda of understanding (MOUs) are governmental tools used to define the varying scopes of authority of federal and state agencies and local government involved in joint enterprises. MOUs should be in place soon after the stakeholders are designated (i.e., during program development) so that responsibilities are clearly established prior to any threat of release. MOUs can be used to avoid the delays and confusion that results from multijurisdictional ventures. However, it is important to note that courts may require public comment periods in conjunction with MOUs with potentially harmful effects on the interests of PLPs or other affected entities.

Legislative Exemptions—There may be strong arguments for special legislative exemption of program stakeholders and site users from the liability scheme imposed by MTCA, especially if dredgers are required to use the multiuser site facilities. While CERCLA and MTCA provide some degree of assurance that entities involved in the generation, transport, and disposal of hazardous substances will operate responsibly, neither law was designed to prevent the implementation of publicly beneficial and necessary programs. Although general legislative releases of liability in conjunction with the program may not be palatable to the public (and are not presently permitted by MTCA), the legislature may provide for more liberal use of covenants not to sue to provide a defined level of protection for certain PLPs involved in initiating the program. It is important to stress that a defined and consistently administered program is likely to be more protective than the current dredged material management program, and will benefit the state and the public through more efficient navigational dredging and management of contaminated sediments. If legislative action is sought for protection from liability, the quest should be initiated soon after program development begins.

Operational Tools

Operational tools are specific mitigation measures that may be used to establish appropriate criteria for the safe operation of a facility. The appropriateness of each tool may depend on the alternatives chosen during an earlier phase of program development and on the foundations provided by the institutional tools.

Determination of Appropriate Site Location—Determination of site location may have one of the most significant impacts on liability. In addition to determining threshold questions involving regulatory siting authority, adequately protective performance criteria must be set by assessing a number of factors, including:

- Potential environmental impacts
- Potential for interference with present and future site uses
- Proximity to dredging operations
- Cost and ease of cleanup
- Potential for site failure
- Knowledge of technology for each of the siting alternatives
- Suitability of disposal of materials at the site
- Past use of the site
- Community opposition.

Disposal Site Design—The likelihood and severity of effects of releases from a facility may be minimized through design specifications. The specifications may require design features that will increase the protectiveness of the site. Protective specifications may include storage cells, capping techniques (e.g., timing, cap thickness, and quality of materials), detention ponds, infiltration basins, runoff controls, and leak-proof liners. However, as discussed in Parametrix (1990), disposal site design may depend on a number of variable factors that will preclude the establishment of predetermined or inflexible design standards. From a liability management standpoint alone, a number of smaller disposal sites may be preferred to one large site so that sediments may be disposed of in the most appropriate manner; it may also be possible to apportion contributions of each dredger more effectively if small storage cells are used.

Segregation of sediments posing the greatest risks may also be possible where small storage cells are used. This alternative may also more easily accommodate the use of functional- and effects-based design alternatives. If a more protective disposal site is desired by stakeholders to reduce liability risks, or if sediment contamination levels dictate higher disposal standards, it may be preferable to design dedicated sites. Dedicated disposal sites may also be designed to fulfill the needs of proponents who do not require added protectiveness, or when testing indicates no clear variability of sediments among dredge sites and dredgers. If there is no feasible manner to accommodate the disposal requirements of the contaminants found in the sediments (e.g., there is no effective way of separating contaminants in sediments), this option may not be necessary or economically feasible. Upland disposal of dredged sediments is already regulated by 173-304 WAC. However, 173-304 WAC permits the use of unlined sites (i.e., demolition landfills) with no leachate collection system and minimal siting criteria. The confined disposal standards may specify the use of higher, more protective standards.

Cleanup Funds—There are a number of methods of financing contingent liability for cleanup. Some methods may be more difficult to effect in a political sense than others, especially if liability is specifically earmarked as the funded activity; the public may balk at underwriting what it perceives to be results of negligent or intentional misconduct. Fines collected for failure to adhere to program requirements may be used to finance appropriate program elements. A primary difficulty associated with establishing a cleanup fund is how to correctly estimate need while preserving affordability of the program. Insurance is often recommended when the release is highly contingent (i.e., not likely to occur), because insurers have more experience at estimating risk.

It is not required that liability costs be covered separately from other costs associated with the program. Incorporating liability risks (i.e., as costs of doing business) into the fee structure may be the most viable, and politically acceptable, option. If the site is financed by user fees, a contingency fund may be established by earmarking a percentage of the fee to be placed in a trust.

Insurers are offering pollution coverage again (at significantly varying costs), due to recent court decisions favoring insurers. Insurance may be purchased for the facility itself with cleanup trust fund monies. Proof of individual insurance may be required of all users, but could impede overall program development given that insurance may still be unaffordable by certain small-volume dredgers. Such a requirement may not be ultimately viable without legislative aid (e.g., low-interest loans) to dredgers who cannot afford insurance. It may be advisable to conduct an analysis of the availability and effect of WSR 90-80-085 et seq. (effective 3 April 1990), which establish procedures for the use of reserve funds for a pollution liability insurance program.

Users of a facility may provide adequate financial assurances (e.g., surety bonds, letters of credit, or qualifications of self-insurance) that guarantee ability to pay for the costs of cleanup. These assurances may provide the least secure source of cleanup funds for the program because litigation may be necessary to collect on the guarantees.

If the multiuser sites program is designated a public works project, the legislature may appropriate funds from the state and local toxics control accounts to promote the program. Funds may be available from MTCA toxics control accounts, the State Revolving Fund, and the Public Works Trust Fund.

Construction Plans—Construction oversight is an essential liability management tool and should begin with an evaluation of the suitability of construction and engineering contractors. The factors provided earlier for the designation of stakeholder functions are also appropriate for the evaluation of construction contractors. An oversight committee should provide final approval of construction of the facility. Interim approval of designated phases during construction might also be desirable; however, approval of each phase may also be interpreted as implied acceptance of the structures, including hidden defects. If an indemnification clause is required by the contractor, the clause may be drafted to specifically exclude undiscovered defects.

Construction of the site will depend on the site engineering designs established during program development. Use of fail-safe structural design features may be desirable when balanced against the potential liability for damages to natural resources and cleanup costs.

Sediment Testing and Characterization—In addition to the use of testing and characterization to determine confinement standards and site locations, the results of the tests may be entered into user databases (or other reliable methods of recordkeeping) to prepare for future attempts at legal apportionments. The phased testing approach included in the confined disposal standards (Parametrix 1990) may provide the starting point, but most likely will require upgrading to increase the likelihood that sediments will be adequately fingerprinted for court-approved apportionments. Although the government need not fingerprint wastes to prove its case against a PLP, a higher standard (e.g., clear and convincing evidence of contribution of each dredger) is likely to be required to rebut joint and several liability.

Sediment Dredging, Transport, and Disposal Techniques—There are a number of dredging, transport, and disposal techniques that minimize the possibility of release. All entities performing dredging and disposal can be regulated by predetermined standards set forth in an appropriate agreement or plan (although at least some of the techniques may be site-dependent). Dredging and disposal techniques may include linings for trucks, overflow controls and hydraulic checks, silt curtains, timing of dredging and disposal activities, selection of dredging equipment, interim capping between each disposal episode, electronic positioning systems and taut line buoys to ensure accurate placement of sediments.

While there is concern over the inevitable release of contaminants during the dredging, transport, and disposal process, Parametrix (1990) concluded that sediment loss that occurred during dredging and transport was less than 1 percent using a hydraulic dredge and less than 2 percent using a mechanical dredge. This low level of loss may not lead to legal liability, depending on the level of sediment contamination. (One court ruled recently that some releases may be too small to merit an assessment of liability if the amount released did not pose a threat to the public or the environment; however, jurisdictions vary widely on the interpretation of this issue.)

Monitoring of the Disposal Facility—Vigilant monitoring is an important operational tool for managing liability. Standards should be adopted that designate the method and frequency of, and responsibility for, monitoring. Response triggers, action plans, and notice requirements should also be set forth in the monitoring plan. Monitoring should be required during all phases of the program for all sites (i.e., during site construction, dredging and disposal operations, sediment testing and characterization, during interim and final capping, and postclosure). Monitoring requirements should be evaluated during each phase of operation to determine their effectiveness. In general, monitoring designed to minimize the potential for release will also be effective in limiting liability.

Maintenance and Administration Plans—Maintenance inspections of facility operations should be conducted as part of the system of checks and balances. As part of the overall administrative plan, a fool-proof plan for the maintenance of facility records should be implemented as a means of apportioning contributions of materials. Auditing of facility records may be requested by any stakeholder and should be allowed on a reasonable basis.

Closure Plans—Site closure should be effected in accordance with standards analogous to and affording a similar level of protection as those contained in RCRA (40 CFR Sections 264.110-120). RCRA closure requirements allow owners and operators intending to close or cease the operations of their disposal facilities only two options: disposal closure (i.e., closure with waste in place) and clean closure (i.e., closure by removal). Disposal closure allows an owner or operator to decommission a RCRA-permitted hazardous waste disposal facility by capping the unit with contaminated materials in place. The owner or operator must perform certain precautionary acts to ensure no migration of the wastes for an indefinite time period and to protect against the inappropriate future use of the site. Under this option, the liability of the owner or operator remains as long as the facility remains a potential threat. Clean closure requires that the owner or operator remove almost all of the hazardous material, rendering the site virtually as clean as it was before the disposal facility was located at the site. An owner or operator who complies with the strict clean closure requirements may leave the RCRA regulatory system and will not be subject to further liability.

Because the prospective multiuser disposal site facilities are not intended to be repositories for hazardous wastes, closure by removal may not be necessary or desirable (although it provides the best insurance against future liability). The specific elements of the closure plan should be established during program development, which is generally far in advance of actual closure. It is especially important that the closure plan be updated immediately prior to closure to provide for technological advancements. Important elements of the closure plan include final capping methods (i.e., timing, speed, thickness, and material), and provisions for preparing the site for future use (e.g., revegetation or drainage of upland and nearshore sites), taking into account the particular properties of the contaminated material disposed of at the facility (e.g., migration potential of contaminants vs. prospective use).

Postclosure Plans—Issues arising after closure pertain primarily to long-term responsibility for monitoring and maintenance of the site, and methods of ensuring adherence to restrictions on future use of the site. Monitoring and maintenance plans should be designed to provide an adequate level of protectiveness after the site is closed. Monitoring plans should specify the type and timing of monitoring. Land use restrictions may be placed on the site to prevent inappropriate use of the site, or use permits may be applied for through the permitting agency. As a practical matter, the site may be virtually unmarketable in a commercial sense because joint and several liability can extend to present landowners of sites contaminated in the past.

LIABILITY MANAGEMENT PLAN OUTLINE

Liability cannot be eliminated without legislative exemptions; however, it can be minimized through implementation of the institutional and operational tools described above. These tools are implemented during all phases of the multiuser sites program, including program development, site development, operation, and closure and postclosure. In general, institutional liability management tools minimize liability by carefully defining stakeholder rules and responsibilities and establishing predictable and consistent decision-making procedures. Operational liability management tools minimize liability by providing operational guidelines and criteria that minimize the risk of a release of contaminated sediments (and therefore minimize the risk of impacts to the environment and human health). The remainder of this section provides an outline for implementing institutional and operational liability management tools by phase of the multiuser site program. This outline is intended to serve as a framework for developing a liability management plan. A liability management plan should be developed via a process of consensus building among stakeholders during program development.

Program Development

Institutional Tools—

- Establish stakeholder rules and responsibilities (i.e., evaluate and recommend an institutional option for the program)
- Identify initial users of sites
- Develop required plans and recommended plans if feasible and evaluate the feasibility of developing other plans
- Develop comprehensive program standards in accordance with confined disposal standards and best management practices
- Negotiate the content of contracts with private stakeholders having ownership, operational, and oversight responsibilities (negotiate complete contracts if possible)
- Negotiate MOUs between agencies having ownership, operational, and oversight responsibilities
- Develop a public involvement and education program and implement the program to the extent needed to ensure adequate participation
- Research the possibility for legislature-provided exemptions from liability
- Research financial assurance mechanisms.

Operational Tools—

- Execute contracts establishing stakeholder responsibilities for private entities
- Execute MOUs establishing stakeholder responsibilities of agencies.

Site Development

Institutional Tools—

- Implement the public involvement and education program

- Develop user disposal agreements
- Negotiate construction contracts
- Establish closure plan responsibilities after site location is determined.

Operational Tools—

- Assess site location criteria by oversight stakeholders
- Assess site design criteria by oversight stakeholders
- Establish the closure plan
- Execute contracts with construction contractors and design engineers.

Construction

Institutional Tools—

- Form a committee of stakeholders suitable for overseeing construction phases
- Designate construction phases and set approval criteria.

Operational Tools—

- Monitor construction phases by oversight committee in accordance with predetermined acceptance criteria and monitoring plan
- Review and amend the monitoring plan in accordance with actual condition of site
- Execute initial user disposal agreements.

Site Operation

Institutional Tools—

- Establish facility maintenance and inspection plans
- Designate operational oversight stakeholders

- Establish a monitoring schedule
- Designate response criteria.

Operational Tools—

- Conduct sediment testing and characterization in accordance with disposal standards
- Monitor dredging, transport, and disposal techniques in accordance with plan specifications
- Monitor the facility's adherence to statutory and program requirements
- Collect penalties for failures to adhere to requirements
- Execute disposal agreements with all new users.

Site Closure

Institutional Tools—

- Amend the closure plan as necessary to reflect technological advancements (technology must be generally acceptable by others in industry)
- Propose use limitations
- Negotiate contracts with the entities performing closure.

Operational Tools—

- Perform testing and characterization to establish suitable use limitations
- Approach the permitting authority for authorization of closure
- Execute contracts with entities performing closure
- Oversee closure to ensure adherence to the closure plan.

Site Postclosure

Institutional Tools—

- Update the postclosure monitoring plan and schedule to reflect results of testing and characterization, and establish use limitations pursuant to the closure plan
- Determine applicable insurance coverage and cleanup trust fund amounts.

Operational Tools—

- Request an application for zoning restriction (or other means of limiting future uses of site) from the applicable government entity
- Oversee compliance with the monitoring schedule
- Maintain the cleanup fund through insurance and trust account.

SUMMARY

Although strict, joint and several liability is a significant concern for the multiuser sites program, the risks are capable of being accommodated in program plans and should not deter program development. As provided in the foregoing discussion, generally accepted interpretations of the liability schemes of CERCLA and MTCA indicate there are few legal or regulatory limitations on liability for multiuser site program stakeholders. However, both statutes are designed to promote the development and use of operational and managerial techniques to minimize the inherent risks of such activities. In addition, CERCLA has been interpreted to permit the use of contractual agreements to effect an equitable allocation of liability risks among stakeholders. However, the primary focus of liability management should be the prevention of unsafe activities and not the avoidance of culpability. A liability management plan committed to that philosophy in both form and substance will provide the best defense for stakeholders.

The best guarantees against liability may be those gained through legislatively sanctioned protections. The possibility of providing other statutory bases for exemptions should be examined. A transfer of liability from stakeholders to a pollution liability fund, such as the one provided in CERCLA Section 107(k)(1), may be desirable. The feasibility and methods of gaining such legislative protection may be one of the most important topics for future investigation, especially if use of the facility is mandated by statute.

Aside from the possibility of legislative protection, the best liability management plan will adopt appropriately high standards of design, construction, operation, management, and closure of the site. Provisions for updating those standards in accordance with technological advancements are essential. Optimally, the program will evolve from reasonable worst-case scenarios that could result in the adoption of more stringent standards than those currently required under any federal or state law.

Although the effectiveness of some of the tools presented in this report for apportioning or managing liability have not been fully investigated, they represent the most commonly recommended techniques. Some tools may be preferred because they are more easily implemented and court-accepted (e.g., indemnity clauses), while others will be more costly and time-consuming to implement (e.g., legislative protection).

8. PUBLIC EDUCATION AND INVOLVEMENT

Public acceptance of the multiuser sites program is essential for the program's success. Public acceptance can be enhanced by an effective public education and involvement process implemented during both the program development phase and the siting phase. A detailed public education and involvement plan should be prepared in the early stages of program development. The plan should specify the objectives of public education and involvement and activities to be undertaken at all stages of the program. In general, public education and involvement activities for the multiuser sites program can be grouped into three major elements:

- Activities undertaken to fulfill the requirements of SEPA in the preparation of environmental impact statements
- Future activities during program development to promote wide-spread public acceptance of the multiuser site program
- Future activities during the siting process to promote public support for specific disposal sites.

This section describes the objectives of a public education and involvement plan and outlines activities for each of the major elements.

OBJECTIVES OF PUBLIC EDUCATION AND INVOLVEMENT

Public education and involvement are management tools that are intended to provide secondary stakeholders (e.g., community groups and environmental organizations) with the appropriate and relevant information they need to make informed decisions about the multiuser sites program. Public education and involvement are also the primary management tools available for achieving public acceptance of the program. Obtaining public acceptance of the program is essential for several reasons:

- Development and implementation of the program could require new legislation or new regulations that may be subject to voter approval
- Development and implementation of the program could require new sources of revenue, some of which may also require voter approval (e.g., taxes and other assessments, which may be primary concerns during times of economic recession)
- The siting process cannot be successfully completed without public acceptance.

SEPA-RELATED PUBLIC EDUCATION AND INVOLVEMENT ACTIVITIES

SEPA has several requirements for public involvement during the EIS process. It is likely that an EIS will be required for formal adoption of the multiuser sites program, and project-specific EISs will be required during the siting process. SEPA requirements provide the public with the opportunity to comment on key documents, such as the determination of significance/scoping notice and the draft EIS; all comments must be responded to by the lead agencies (and project proponents) in the final EIS. SEPA also encourages the use of other public education and involvement activities during the EIS process such as workshops, public meetings, and meetings between citizen committees and the applicant.

PUBLIC EDUCATION AND INVOLVEMENT DURING PROGRAM DEVELOPMENT

Ecology performed several public education and involvement activities during the course of the program study. For example, Ecology compiled a mailing list of 3,200 individuals and organizations interested in Puget Sound sediment or water quality issues. A fact sheet describing sediment management projects was mailed to 400 entities on the mailing list. Ecology also conducted workshops and held several meetings with primary stakeholders (through the activities of the Agency Forum for Sediment Issues, the Sediments Advisory Group, and the Confined Disposal Work Group).

The primary objective of public education and involvement during program development is to achieve widespread understanding among all stakeholders and interested parties about the utility and viability of the program. Activities during this phase focus on the dissemination of information. Examples of tasks that should be undertaken during the program development phase are described below.

Update the List of Interested Parties

It is important to identify and become familiar with all interested parties early in the process. This task has been partially completed by Ecology. Ecology's existing mailing list should be expanded to include individuals and organizations with interests in all geographical areas where disposal sites may be located. The mailing list may also include descriptions of the primary interests and backgrounds of the interested parties to facilitate efforts to scope and design information dissemination activities.

Prepare Background Materials

Materials to be provided to the public should contain information on the background of the project, project objectives, accomplishments to date, and plans for future development. An invitation to participate in the development of the program should also be included in the materials. Materials that should be considered for development include:

- Fact sheets and project summaries (e.g., *Executive Summary* and *Conclusions and Recommendations* sections of the program study)
- Educational materials to increase the general public's understanding of contaminated sediment issues and to outline the environmental and social benefits of the program
- Visual materials (e.g., 35-mm slides and viewgraphs for overhead projectors) for public presentation.

There may be a need to identify entities with specific information needs so that materials can be developed to meet those needs. Some materials (e.g., fact sheets) have already been prepared by Ecology, but should be reviewed for their current relevance and suitability.

Plan and Conduct Informal Workshops and Meetings

Planning for informal meetings should begin simultaneously with the preparation of background materials. The format and content of meetings and workshops should be flexible to accommodate the special needs of interested parties. The scope and schedule for meetings and the needs of interested parties can be identified from responses to mailings and by direct contact with interested parties. At a minimum, workshops and meetings should be scheduled for all geographical areas where there will be significant amounts of dredging or cleanup of contaminated sediments, or where disposal site locations are contemplated.

PUBLIC EDUCATION AND INVOLVEMENT DURING THE SITING PROCESS

The bulk of the public education and involvement effort is likely to coincide with development and implementation of the siting process. A siting process will need to be developed during the next phase of the program study and may begin with a screening level analysis of general issues (e.g., environmental and human health, engineering, liability management, cost, and financing) that may affect disposal in aquatic, nearshore, and upland environments. During the screening level analysis, public education and involvement can continue to focus on information sharing by extending the identification, notification, and materials development activities described above.

As the screening effort progressively narrows the list of appropriate sites, public education and involvement activities may expand or shift geographically (e.g., if one geographic area is favored over another) or among particular interest groups (e.g., interest groups concerned about water quality may be more involved if aquatic disposal becomes favored). The siting process may then focus on a detailed evaluation of the preferred locations.

The focus of the public education and involvement plan is likely to be critically important at this time due to the inherent stigma attached to the siting issue. Nationwide attempts to site hazardous waste and solid waste disposal facilities have met with strong and increasingly organized resistance; it is clear that community involvement is essential for achieving public acceptance of sites. Public education and involvement during this time should focus on the development of methods to ensure that public perceptions accurately reflect the environmental and human health risks and economic and environmental benefits of confined disposal. The scope of public education and involvement and community involvement during siting will be determined largely by the site locations under consideration. For example, establishing an upland or nearshore site on public land in a mixed use or rural/residential area may require greater effort than establishing an upland or nearshore site on private land in an industrial area.

In addition to EIS-related activities and pre-scoping public education and involvement, it may be relevant to establish a forum for negotiated settlement of major issues. The Citizen/Proponent Negotiation (CPN) process established by the Washington Dangerous Waste Regulations (WAC 173-303-902) could be used as a model for achieving negotiated settlement of siting issues in the multiuser program. A neutral convener and local negotiating committee are at the heart of the CPN process. A neutral convener is selected by the lead local government to organize and preside over one or more public meetings, assist in selecting the local negotiating committee, and mediate citizen/proponent negotiations. The primary functions of the local negotiating committee are to conduct public information and education activities and negotiate emerging issues and concerns. The committee should consist of representatives from the lead local agency, cities, counties, and Indian tribes in the affected area. The committee should also include representation by academia, business and industry, citizen organizations, environmental groups, agricultural groups, health professionals, emergency response organizations, and fire districts.

Duties of the committee include convening public forums, community gatherings, and meetings with key community leaders; and preparation of a report that synthesizes all resulting negotiations and agreements. In general, issues to be negotiated involve the mitigation of all potential impacts of the facility and can include technical aspects, emergency response, economic and cultural impacts, facility operation and management, site characteristics, transportation, and compliance assurance.

The CPN process provides matching grants (in conjunction with the proponent) to the lead local government for costs incurred during the negotiation process. These grants would not be available to the multiuser site program because the program does not fall under the purview of the dangerous waste regulations. However, it may be feasible to implement a similar grant program, with the cost of the program shared by program stakeholders (e.g., state agencies and private users of multiuser sites).

SUMMARY

A public education and involvement plan is the primary tool for obtaining public acceptance of a multiuser confined disposal sites program. Public acceptance may be needed for obtaining approval of funding methods, new legislation, and siting during the development of the multiuser sites program.

Some degree of public education and involvement will likely be required during program development and facility siting as part of the SEPA process; however, additional activities are recommended. Public education and involvement during the next phase of program development should focus on disseminating information to maximize the ability of public stakeholders to make informed decisions about the program. It may be necessary to tailor the distribution and presentation of materials to meet specific needs of particular interest groups, or to meet changing geographical and technical needs of the program as it develops.

During the siting phase of the program, it may be appropriate to initiate a public education and involvement effort that focuses on providing a forum for arriving at a negotiated settlement between the public and stakeholders. Ecology's CPN process provides a model that can be adopted for use in the multiuser sites program. The CPN process relies on a convener and a local negotiating committee (appointed by the lead local government) to conduct public information and education activities and negotiate settlements on emerging issues and concerns. Implementation of a negotiated settlement process may require state agencies and private sector stakeholders to provide funding to the local lead agency.

9. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The first phase of the program study focused on the viability and utility of establishing a system of multiuser confined disposal sites for the disposal of contaminated sediments. This report concludes that such sites are needed and that the urgency will only increase as the volume of dredged material requiring confined disposal increases. A primary cause of the increase in volume can be attributed to the additional cleanup activities that will result from the mandate by residents of Washington state to clean up contaminated sediments that threaten the environmental, economic, and social health of Puget Sound. A discussion of the report conclusions is set forth below.

A Multiuser Sites Program is Useful

A multiuser sites program for Puget Sound is useful to meet present and future needs for disposal capacity. In addition, a multiuser sites program offers several environmental, economic, and social advantages over the current disposal scheme.

Need for a Multiuser Sites Program in Puget Sound—Existing confined disposal sites cannot accommodate projected dredging or cleanup needs. Navigation dredging in Puget Sound is expected to generate approximately 10 million cubic yards of contaminated sediment over the next 20 years, and cleanup of contaminated sediment sites may generate an additional maximum of 70 million cubic yards of material. Presently identified sites on private property can accommodate less than 2 million cubic yards of material.

A multiuser site program would provide both the private and public sectors with a predictable and consistent option for contaminated sediment disposal. Options for contaminated sediment disposal have narrowed considerably in recent years. The current options consist almost exclusively of sites on private property (e.g., nearshore and upland fill projects on port property). These sites are slated for project-specific use, and site owners are unlikely to allow the disposal of material generated by other dredgers because of inherent liability risks. Disposal of dredged material in solid waste or demolition debris landfills is no longer a viable option. Most landfills will not accept dredged material because of capacity problems or because they ban the import of material. The few available demolition debris landfills are scheduled for closure and they accept very limited amounts of material at one time (e.g., 100 tons). The few landfills in the Puget Sound area that accept dredged material require dewatering, which adds prohibitive costs to disposal.

A multiuser site program would provide a cost-effective disposal option for dredgers. Lack of a cost-effective disposal option could impose economic hardships on all dredgers including water-dependent industries, marinas, and major Puget Sound ports. If a cost-effective disposal option is not found, dredgers could be affected by a reduction in competitiveness (possibly on a regional basis) due to higher operating costs or impaired navigation (e.g., restricting navigation of vessels to periods of high tide). In addition, a failure to develop disposal facilities to accommodate the needs of cleanup dredging will result in ongoing adverse impacts to Puget Sound resources. For example, impacts to the overall health and abundance of marine and terrestrial plants and animals may result in indirect impacts to recreational and commercial fishing, other recreational uses, and cultural resources. A final concern is the risk of increased illegal disposal activity that may result if reasonably-priced disposal facilities are not available to all Puget Sound dredgers.

A multiuser site program would provide a cost-effective disposal option for state cleanup of contaminated sediment sites. Lack of a cost-effective disposal option will impede Puget Sound cleanup. Ecology is in the process of promulgating regulations for the cleanup decision process and will be poised to initiate the cleanup program early in 1991. In addition, DNR is embarking on a program to identify and rank lease sites according to their potential for sediment contamination. Some of these sites may be identified as requiring cleanup. Implementation of state programs for cleanup in Puget Sound depends on the availability of disposal sites for contaminated sediment; such sites are not currently available.

Environmental, Economic, and Social Advantages to Establishing a Multiuser Disposal Site for Contaminated Sediment—A multiuser site program will have a variety of positive environmental consequences; for example, the program will:

- Allow the cleanup of Puget Sound contaminated sites to proceed by providing adequate disposal capacity
- Result in increased consistency of enforcement efforts as a result of the uniform application of standards and criteria and establishment of a thorough environmental review process of site-specific issues
- Potentially enhance environmental safety through a formal environmental review process (i.e., safeguards will be established by a multiagency team of experts during program development)

- Stem the proliferation of relatively small sites that are established for project-specific purposes; such piecemeal siting may result in unacceptable cumulative impacts, such as habitat loss
- Maximize the success of cleanup because of the lower number of sites and comprehensive contingency planning.

A multiuser site program will have a variety of positive economic consequences; for example, the program will:

- Avert or minimize regional economic impacts associated with the current lack of cost-effective disposal options
- Reduce the need for costly project-by-project siting, permitting, and planning that is now required of every project that involves contaminated sediment
- Result in a lower unit cost for disposal (i.e., dollars per cubic yard), particularly for small projects; lower costs would be accomplished by cost-sharing through a user fee system for site development, operation, and closure
- Result in sharing among all stakeholders (including dredgers, site owners, site operators, and transporters of dredged material) of the responsibilities and costs of liability management.

A multiuser site program will have a variety of positive social consequences; for example, the program will:

- Result in social benefits due to cleanup of contaminated sediments through dredging activities and site cleanup
- Maximize the number of sites that can be cleaned up
- Result in a more consistent and streamlined (e.g., reduced duplication of effort) institutional decision-making process.

A Multiuser Sites Program is Viable

Stakeholder comments to Ecology and the analysis of issues presented in this report indicate that a multiuser sites program is viable. However, there are several issues that remain unresolved and should be the focus of the next phase of program development. Conclusions regarding viability are identified below and form the basis for the recommendations presented in the next section.

Environmental and Human Health Issues—No single disposal environment is indicated by environmental and human health considerations alone.

Existing technologies for site management and emergency response are available to safely locate and operate a disposal site in aquatic, nearshore, or upland environments. However, greater logistical difficulties (e.g., accurate placement of material and site monitoring) may be encountered at aquatic sites than at the other locations. Key stakeholders have different opinions about the disposal environment most suitable for location of a multiuser confined disposal site facility. The issue of site location is unresolved and should be addressed in expanded and site-specific studies of siting issues and tradeoffs.

Multiuser Site Costs—Estimated costs for disposal of dredged material at a multiuser site compare favorably to current costs of disposal.

Multiuser Site Funding—Several funding options are available for establishing a cost-effective multiuser sites program. It is estimated that user fees established to cover all costs associated with site construction, operation (with the exception of dredging and transportation costs), and closure will range from approximately $17 per cubic yard (aquatic disposal with tax-exempt public financing) to $53 per cubic yard (upland disposal with private financing). For comparison, current tipping fees at solid waste landfills are in the range of $34-$90 per cubic yard (not including dewatering costs).

Institutional Options for Program Management—An entity composed of representatives from federal, state, and local government with joint decision-making powers (i.e., Option 3) is likely to be the most effective institutional arrangement for establishing and managing a multiuser sites program. However, it is essential that other major stakeholders, such as dredgers, have strong representation at all appropriate phases of program development. This institutional arrangement is similar to the PSDDA structure that has been very successful in establishing open-water, unconfined disposal sites in Puget Sound. Although this report suggests the general framework for institutional management, much work is still to be done in carefully defining participants roles and responsibilities, and establishing an administrative and procedural agenda.

Liability Management—Although regulatory liability standards will have a significant impact on the viability of the multiuser sites program, they are capable of being accommodated with a sufficiently protective program and should not deter program development. The primary environmental statutes that impose liability are assumed to be CERCLA and MTCA. Both statutes are designed to promote the development and use of operational and managerial techniques to minimize the risks of participation in inherently dangerous activities, and not to obstruct the development of publicly-beneficial waste disposal options.

The best guarantees against liability may be those gained through legislatively sanctioned protections and the possibility of seeking such protection is an issue for future action. In general, however, the best liability management plan will adopt appropriately high standards of design, construction, operation, management, and closure of the site, and include mechanisms for updating those standards in accordance with technological advancements. Optimally, the program will evolve from reasonable worst-case scenarios that could result in the adoption of more stringent standards than those currently required under any federal or state law.

Public Involvement and Education—Successful program development will depend in part on securing public acceptance. Public acceptance is essential during program development when issues such as financing will be decided (e.g., some financing alternatives could burden the general public). Public acceptance is also essential, and public debate is likely to peak, during the site selection process of program development. A comprehensive public involvement and education plan should be established early in the next phase of program development.

RECOMMENDATIONS FOR FUTURE ACTION

The issues most likely to affect the successful development of the multiuser sites program are siting, liability management, funding, and choice of institutional option. There is a need for an expanded evaluation of each of these issues to facilitate the development of the program. Development of a comprehensive siting process and a liability management plan may need to be addressed during the next phase of program development. In addition, funding methods should be explored in connection with the expanded study of siting. Finally, designation of the institutional management option is likely to be a threshold issue that will determine how siting, liability management, and funding efforts progress. It is likely that a consensus-building effort, similar to the one used to study viability and utility of the program, will also be required during the next phase. A description of the issues that may need to be prioritized is provided in the following sections.

Development of a Siting Process

The program study concludes that environmental, social, and economic advantages and disadvantages exist for all siting options and no particular site (i.e., aquatic, nearshore, or upland) can be distinguished as the most appropriate location for a disposal facility. In addition, the information indicates that it is technically possible to accommodate all program requirements for each siting option. During the next phase of the program study, a formal siting process may need to be developed and implemented to further examine the fit between a specific siting option and program objectives. Screening criteria may be developed and used to narrow the site options prior to the initiation of detailed technical studies.

A sophisticated public education and involvement plan will be an integral component of the siting process, during both screening and advanced evaluation of site options. The public education and involvement plan should evolve with the siting process so that concerns of all stakeholders and the general public are reviewed and accommodated (i.e., issues of concern may change as the siting process continues). Information provided as part of the public education and involvement plan should continue to be disseminated in a timely manner to all interested parties. In addition, a forum for reviewing comments may need to be established and could follow the citizen/proponent negotiation process discussed in the *Public Education and Involvement* section of this report.

As comments to siting proposals are received from stakeholders and the public, it is likely that specific options will be eliminated. At this point, in-depth evaluations and determinations should be performed of the technical studies required for the remaining site options. A periodic review of development costs for each site option may also be necessary during this phase.

Liability Management

In the event of a release of contaminated materials from a site, strict, joint and several liability is likely to be the standard imposed on all entities involved in program activities (i.e., ownership, use, development, operation, and management). However, accommodation of the inherent liability risks is possible. It is clear that the best way to avoid liability is to implement plans specifically designed to avoid site failure. This may be accomplished through the use of institutional and operational tools that ensure the fulfillment of program safety goals.

During the second phase of the program study, a liability management plan may be drafted according to the outline presented in this report. An appropriate initial step may be to survey the stakeholders to determine the level of protection that will be required by them before participation in the program can be assured. A consensus-building effort may be required to ensure that concerns and expectations of the stakeholders are both reasonable and capable of being accommodated.

The feasibility of pursuing legislatively prescribed releases from liability is also an early-stage activity and should be undertaken to help establish plan requirements (i.e., if legislative relief is not available, the plan must be developed accordingly). Legislative relief could take the form of liability ceilings for stakeholders and public policy-based exemptions for stakeholders who adopt more protective standards than those currently required by law. In addition, the preferred method of providing contingency funding (e.g., purchase of insurance and/or establishment of liability trust fund) can be determined early in this phase.

Investigation of legislative and funding options can proceed independent of other aspects of program development. However, the contents of the liability management plan will be dictated, to a large extent, on the results of the siting process. Safe operating standards are the cornerstone of liability management and will be very site-specific. Therefore, the siting process should be completed so that the results may be incorporated into the liability management plan. The relevance and scope of some of the other institutional tools described in the liability management plan outline (e.g., contracts and MOUs, public education and involvement plan) may also depend on the results of the siting process. A survey of methods used by other states to accommodate liability risks in similar projects may need to be performed.

Institutional Management and Responsibilities

Option 3 was recommended in the program study as providing the most protective and responsive institutional structure for implementation of the overall program. However, many of the decisions to be made during the second phase of this study (e.g., siting) depend on the existence of an identified agency that can authorize implementation of program development activities. Therefore, designation of the institutional option is a threshold question that needs to be addressed in the next phase of program development. Governmental authority to implement the program varies among the institutional options. Therefore, a consensus on the preferred option must be reached before a study of the requirements for implementation of the program can proceed. For example, MOUs cannot be executed until stakeholder roles and responsibilities are identified. The public education and involvement component of second phase activities may have a limited effect on the designation of an institutional option (unless an entirely inappropriate option is chosen); therefore, it may be possible to accomplish this task with a limited consensus-building effort.

If it is determined that Option 3 provides the best institutional management structure, the option should be developed to ensure that other major stakeholders (e.g., dredgers) have sufficient representation during appropriate phases of program development.

Funding Methods

Funding methods must necessarily be established prior to the implementation of significant portions of the program. Therefore, an expanded analysis of the options presented in this report may be undertaken during the next phase of the program study.

Sole or mixed sources of funding for a multiuser site can include user fees, taxes or assessments, and federal assistance. The program study concludes that private financing for all siting options is more expensive than tax-exempt revenue bonds. However, a funding alternative is not recommended in the study primarily because the alternatives will depend on the preferred institutional management structure. For example, taxes and assessments can be levied only if site ownership (and possibly operation and management) rests in the public sector.

Other factors exist that could affect the availability of private or public funds. The more important factors include the overall debt capacity and financial condition of the proposed owners and operators and the degree to which the provider of funds can participate in program decisions (e.g., the siting process, customer use, liability management). In addition, costs and availability of funds may increase or decrease substantially, depending on the manner in which program development proceeds as a whole. Funds will become increasingly available, and at better rates, as the risks of any program diminish. This consideration may dictate the completion of the other priority issues (siting, liability, and institutional designation) prior to a final decision regarding funding. However, these funding issues can be evaluated and used to narrow the options as other aspects of program development progress.

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