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Summary of Available Guidance and Best Practices for Determining Suitability of Dredged Material for Beneficial Uses

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Abstract: The Corps of Engineers has the responsibility to maintain navigation of waterways across the United States. The Corps dredges more than 300 million cubic yards of sediment annually. Subsequently, methods to evaluate and determine environmentally and economically sound management alternatives are needed. Technological advances in equipment, treatment, and handling technologies continue to increase the options for beneficial uses (BUs). Ten categories of BU are: 1) Habitat development, 2) Beach nourishment, 3) Aquaculture, 4) Parks and recreation, 5) Agriculture, forestry, and horticulture, 6) Strip mine reclamation and solid waste management, 7) Shoreline stabilization and erosion control, 8) Construction and industrial use, 9) Material transfer, and 10) Multiple purpose. BUs of dredged material have a productive history resulting in over 2,000 man-made islands, more than 100 marshes, and nearly 1,000 habitat development projects. Corps islands provide vital habitat for rare, threatened, or endangered species. It is estimated that 1,000,000 birds nest on dredged material islands each year. BUs of existing dredged material in confined disposal facilities (CDF) should be considered along with all the alternatives available for CDF management. This report compiles current guidance and best practices useful to evaluate dredged material from ongoing dredging projects or CDFs for BUs.

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Preface

This report summarizes guidance and best practices for determining the suitability of dredged material for beneficial uses. This project was funded by the Dredging Operations and Environmental Research Program Work Unit "Beneficial Uses Testing, Evaluation, and Database Guidance / Beneficial Uses of Dredged Material."

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This work was conducted under the general supervision of Dr. Robert P. Jones, Chief, ERAB, and Dr. Richard E. Price, Chief, EPED. At the time of publication of this report, Dr. Beth Fleming was Director of EL.

COL Richard B. Jenkins was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
cubic yards	0.7645549	cubic meters
hectares	1.0 E+04	square meters
miles (U.S. statute)	1,609.347	meters

1 Introduction

Background

The U.S. Army Corps of Engineers has the responsibility to maintain navigation in more than 11,930 miles of waterways across the United States. This task requires the dredging of more than 300 million cubic yards of sediment annually resulting in the need for methods to evaluate and determine environmentally and economically sound management alternatives. Management alternatives may include open-water, near shore, or upland placement, each having opportunities to provide a beneficial outcome in addition to maintaining navigation. Technological advances in equipment, treatment, and handling technologies continue to increase the options for beneficial uses (BUs). Most dredged material that is not suitable for open-water placement has historically been placed in confined disposal facilities (CDFs). Many existing CDFs have or are rapidly reaching design storage capacity, while some have increased capacity by raising dikes. Raising dikes is not a long-term solution to meet future dredging needs, however. New CDF construction is difficult to accomplish in many areas where high volume dredging occurs due to limited space along congested shorelines. In an effort to provide storage capacity for future dredging, dredged material currently disposed into CDFs is being evaluated for beneficial uses. Beneficial uses of existing dredged material in CDFs should be considered along with all the alternatives available for CDF management.

Engineer Manual (EM) 1110-2-5026 (Headquarters, U.S. Army Corps of Engineers 1986) discusses numerous BUs of dredged material in aquatic, wetland, and upland habitats. Ten categories of BUs are:

1. Habitat development (wetland, upland, island, aquatic including migratory and nesting use by waterbirds, shorebirds, and waterfowl)
2. Beach nourishment
3. Aquaculture
4. Parks and recreation
5. Agriculture, forestry, and horticulture
6. Strip mine reclamation and solid waste management
7. Shoreline stabilization and erosion control

8. Construction and industrial use (including port development, airports, urban, and residential)
9. Material transfer (fill, dikes, levees, parking lots, roads)
10. Multiple purpose

BUs of dredged material have been classified into three broad categories: engineered uses, agricultural and product uses, and environmental enhancements. Some BUs could be classified into multiple categories. For instance, beach nourishment could be categorized as engineered use or environmental enhancement. However, dredged material must be evaluated both for use suitability and for environmental acceptability prior to any decisions about potential BU. This report compiles current guidance and best practices useful to evaluate dredged material from ongoing dredging projects or CDFs for BU.

History of beneficial use

Historically, dredged material disposal in many cases resulted in BU of the material itself or the location on which it was placed. Until passage of Federal laws described below, decisions on disposal of dredged material was based primarily on cost effectiveness or local needs. Environmental or ecological impacts were generally not considered as the effects of contaminant and physical effects on wildlife and fishery habitats were not well understood. If the dredged material was considered physically suitable for any particular need, it was used as such. Many developed areas along coastlines, inland rivers, and lakes were constructed using dredged material.

Beneficial uses of dredged material have a productive history resulting in more than 2,000 man-made islands, 100 marshes, and nearly 1,000 habitat development projects. In many areas, Corps islands provide vital habitat for rare, threatened, or endangered species. It is estimated that 1,000,000 birds nest on dredged material islands each year (EM 1110-2-5026). These projects were completed with uncontaminated dredged material. Due to reduced storage capacities within CDFs and the reduced use of aquatic disposal alternatives, BUs of dredged material are being considered more extensively. While there are still sources of uncontaminated dredged material, there is also a need to evaluate BUs of dredged material with low to moderate contaminant concentrations.

Regulatory authority

The Water Resources Act of 1992, Section 204 – Beneficial Use of Dredged Material (Public Law (PL) 102-580) established USACE authority for implementing ecosystem restoration projects in connection with dredging. The regulation of dredged material disposal within waters of the United States is a shared responsibility of the U.S. Environmental Protection Agency (USEPA) and the U.S. Army Corps of Engineers (USACE). The primary Federal environmental statute governing discharge of dredged materials into inland and estuarine waters of the United States is the Federal Water Control Act Amendments of 1972 (i.e., the Clean Water Act (CWA)). All proposed dredged material activities regulated by the CWA must also comply with the applicable requirements of the National Environmental Policy Act (NEPA) and its implementing regulations. In addition to CWA and NEPA, a number of other Federal laws and Executive Orders must be considered in the evaluation of a dredging project. The geographical jurisdictions of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA) and CWA overlap within the territorial sea. Generally, the BU of dredged material placed within the territorial sea is evaluated under the CWA (USEPA/USACE 1998). The USEPA Office of Water has maintained that once dredged material is regulated under the CWA, it will always be regulated under the CWA. The CWA does not provide guidance for the protection of the environment after dredged material is placed in an upland environment (Childs et al. 2002). If biological testing indicates the material is suitable for open-water disposal, that material would likely be deemed suitable for a wide range of BU applications from a contamination standpoint. Most BUs involve open-water or confined placement. Therefore, the testing and assessment procedures as well as compliance with the 404 Guidelines must also be considered for BU (USACE/USEPA 1998).

2 Decision Process and Available Guidance

Guidance and practices

USACE/USEPA (2004) provides a framework for dredged material management, which includes the assessment of reasonable open-water, confined disposal, and BU alternatives. This document states, “Beneficial use options should be given full and equal consideration with other alternatives. It is USACE policy to fully consider all aspects of the dredging and disposal operations with a view toward maximizing public benefits.” Figure 1 presents a framework for BU determinations. This framework suggests evaluation of:

1. BU needs and opportunities
2. Physical suitability
3. Logistical considerations
4. Environmental suitability

The process for environmental suitability is somewhat vague. Winfield and Lee (1999) gives additional guidance on the implementation of the USACE/USEPA (2004) framework. Figure 2 shows a framework to evaluate environmental suitability for BUs. The steps include:

1. Evaluate physical and engineering suitability
2. Chemical evaluation
3. Biological evaluation
4. Retain or reject BU alternatives

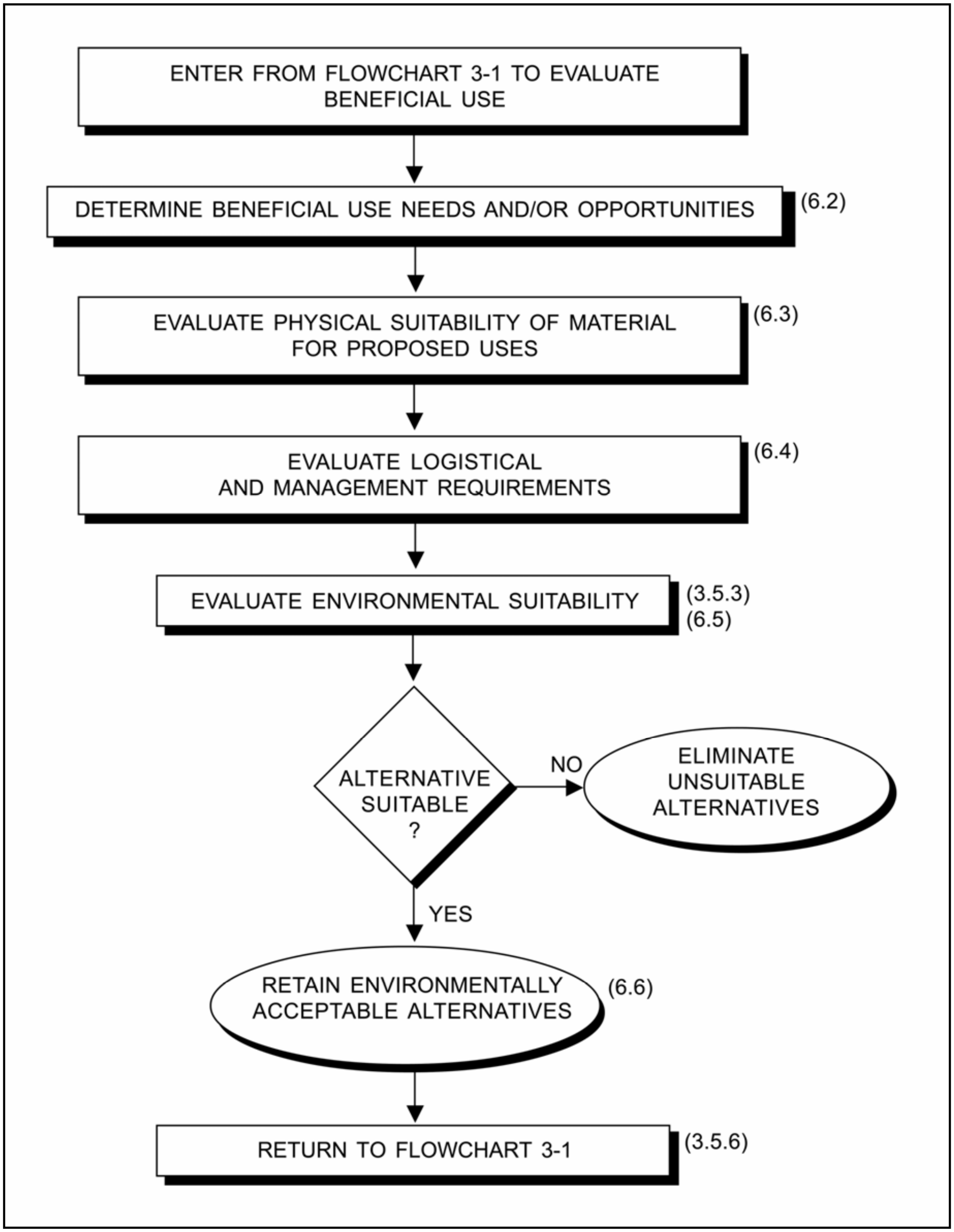

Figure 1. Framework for testing and evaluation for beneficial use applications from USACE/USEPA (2004).

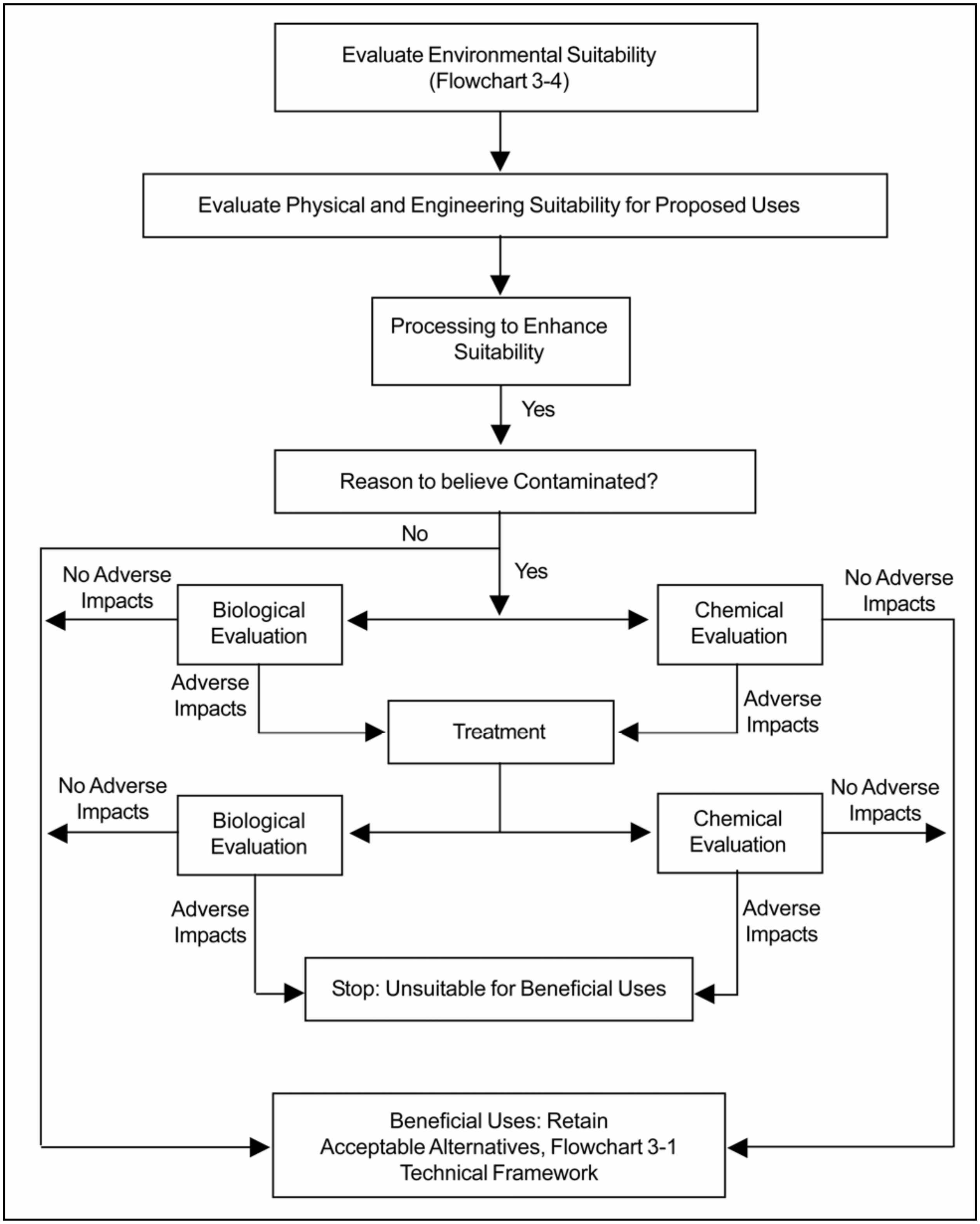

Figure 2. Framework for testing and evaluation of environmental suitability for beneficial uses (Winfield and Lee 1999).

This figure illustrates the underlying decision process used in characterization testing. Initially, characterization tests to determine the physical and engineering properties should be conducted (Figure 2). If there is reason to believe the dredged material is contaminated, the chemical and/or biological evaluations should be conducted. If the chemical/biological evaluation results indicate the potential for adverse impacts, the material is treated to manage the contaminants present, and then retested for adverse impacts. If adverse impacts are no longer indicated or if there is no reason to believe the dredged material is contaminated, then a BU alternative can be implemented. If adverse impacts are still indicated, the dredged material should not be used for beneficial purposes. USEPA/USACE (2002), a companion guide to the framework document, provides practical guidance for project sponsors and potential partners for identifying, planning, financing and implementing dredged material BU projects.

Currently, differences are vast between the BU guidance on the national, regional, and state levels. USEPA (2003) provides nine recommendations whose implementation should enhance the BU of dredged material substantially. These recommendations include:

1. The development of a national guidance document that presents a framework for identifying, planning, and financing BU projects and providing a summary of BU authorities and processes.
2. The development of a national guidance document that explains the role of the Federal Standard in implementing BUs of dredged material.
3. Encouraging and endorsing the implementation of Section 215 of the Water Resources Development Act of 2000 (PL 106-541), which allows the direct marketing of dredged material to public agencies and private entities.
4. Identifying factors needed to develop a system to track the volume of dredged material used beneficially.

The roles of a National Dredging Team (NDT), Regional Dredging Teams, and Local Planning/Project Groups are outlined (USEPA 1994e, 1998, 2003). Promoting the BU of dredged material is a specific objective of the NDT. The NDT should be instrumental in the development and implementation of a consistent national policy.

The development of regional guidance is one of the top priorities of the Great Lakes Dredging Team. The lack of adequate regulatory guidance was identified as an obstacle to BU of dredged material. Beneficial Use Upland Testing and Evaluation Project Management Team (2004a) brings together case studies, policy guidance, and regulations being used by Great Lakes states to make BU decisions. This framework offers a regional risk-based approach for testing and evaluating dredged material for upland BU.

San Francisco Bay Regional Water Quality Control Board (2000) summarizes the sediment screening and testing guidelines for beneficial reuse of dredged material in the San Francisco Bay. Figure 3 depicts the testing protocols for upland and wetland BU projects. The potential routes of exposure to non-human receptors considered were direct exposure to sediment, exposure to effluent from sediments during placement of material at reuse site, and exposure to leachate after material placement. This guidance is consistent with and is structured following the BU framework (Figure 2) and the selection testing described in the next section.

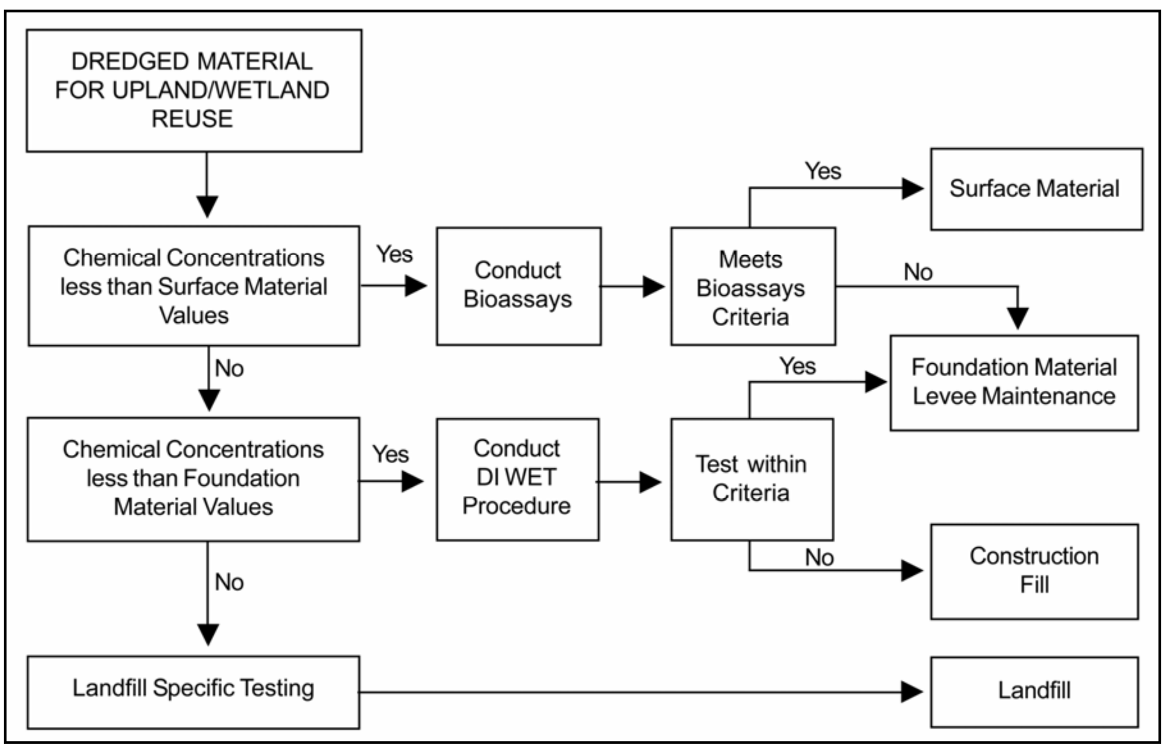

Figure 3. Recommended testing protocols for wetland/upland dredged material disposal in the San Francisco Bay Region (San Francisco Bay Regional Water Quality Control Board 2000).

The BU guidance on the state level is quite varied with some states even classifying dredged material as a solid waste. For instance, in Indiana dredged material deemed contaminated is regulated as a solid waste. Otherwise, it is not regulated as a solid waste (Great Lakes Commission 2001). However, Indiana has no regulatory definition for BUs of dredged material (327 Indiana Administrative Code). In New Jersey the Department of Environmental Protection officials concluded the NJ Solid Waste Management Act does not apply to dredged material (NJ Department of Environmental Protection Dredging Task Force 1997). In some states, dredged material never disposed of is regulated differently from dredged material removed from a CDF. The variability of state requirements for dredged material management can become increasingly complex when dredging projects cross state borders but can also be used advantageously to advance sound policy and change unsound policy. Figure 4 depicts the NY Checklist for Development and Beneficial Use Determination Petition.

Evaluate environmental suitability

The initial screening for contamination is the first step in the BU framework (Figure 2). Available information is used to determine if the material contains contaminants in forms and concentrations that are likely to cause unacceptable impacts to the environment. If contaminants are likely present, the sections on chemical evaluation and biological evaluation should be consulted. The presence of contaminants in dredged material invokes a more complex decision process that should be conducted in a phased approach (Lee 1999). If contaminants are not likely to cause unacceptable impacts to the environment, then BU alternatives are evaluated.

Two approaches can be used for BU characterization tests (i.e., BU suitability testing, BU selection testing). If a specific BU can be selected initially, then tests that provide information on the acceptability of the dredged material for that BU should be conducted (suitability testing). If no specific BU is selected initially, then more characterization tests should be conducted to determine the suitability of the dredged material for a wider range of BUs (selection testing) (Lee 1999). Lee uses several case studies to illustrate appropriate characterization tests when the BU was selected initially (suitability testing). Two examples describe the suitability testing used to evaluate dredged material in a CDF selected for landfill cover. Another example describes the suitability testing used to evaluate

BUD and/or RD&D PETITION COMPLETENESS CHECK

NAME OF FACILITY/APPLICANT:

COUNTY: TOWN:
FACILITY OWNER: PHONE:

PETITION SIGNED BY:

POSITION:

TYPE OF ACTION:

Part 360-	Guideline	YES	NO	N/A
For Beneficial Use Determinations only:				
1.1(b)	Have the procedures to be used to ensure that no hazardous waste will be accepted been provided?			
1.15(d)(1)	Does the petition show that the solid waste is being beneficially used in a manufacturing process to make a product or as an effective substitute for a commercial product?			
1.15(d)(1)(i)	Does the petition provide a description of the solid waste and its proposed use?			
1.15(d)(1)(ii)	Does the petition provide the chemical and physical characteristics of the solid waste and the type of proposed product?			
1.15(d)(1)(iii)	Does the petition provide a demonstration that there is a known or reasonably probable market for the intended use of the solid waste and the proposed product as specified in 1.15(d)(1)(iii)(a-d)?			
1.15(d)(1)(iv)	Does the petition provide a demonstration that the management of the solid waste under review will not adversely affect human health and safety, the environment and natural resources as specified in 1.15(d)(1)(iv)(a-b)?			
	Does the petition include a solid waste control plan?			
	Does the petition include a contingency plan?			
1.15(d)(2)(i)	Does the petition provide a demonstration that the essential nature of the proposed use of the material constitutes reuse rather than disposal?*			
1.15(d)(2)(ii)	Does the petition demonstrate that the project would be consistent with the solid waste management policy contained in section 27-0106 of the ECL?*			
1.15(d)(2)(iii)	Does the petition provide a demonstration that the material is intended to function or serve as an effective substitute for an analogous raw material?*			
1.15(d)(2)(iv)	Will the project provide a demonstration that the material need not be decontaminated prior to incorporation into a manufacturing process?*			
*These items will be evaluated by NYSDEC.				
For Research, Development and Demonstration Permits also include:				
1.7(a)(2)	Does the proposed project location comply with the siting prohibitions specified in 1.7(a)(2) (i-v)?			
1.11(i)	Does the application include a design capacity?			
1.14(b)(1)	Does the application include information, along with design provisions, describing how solid waste will be prevented from being deposited or entering surfacewaters and groundwater?			
1.14(b)(2)	Does the application include a facility design provide the necessary provisions to minimize the generation of leachate and prevent the migration of leachate into surface and ground waters?			
1.14(d)	Does the application and facility design provide assurance that access to the facility is strictly and continuously controlled by fencing, gates, signs, natural barriers or other suitable means?			
1.14(m)	Does the application address odor control?			
11.2(a)(3)(i)	Does the application include a description of the general operating plan for the proposed project, including the origin, composition, and expected weight or volume of all solid waste to be accepted, the maximum time any such waste will be stored, where all waste will be disposed of, and the proposed capacity,, and the expected life of the facility?			
11.2(a)(3)(ii)	Does the application include a description of all machinery and equipment, including the design capacity?			

Figure 4. NY checklist for Development and Beneficial Use Determination Petition.

11.3(a)(1)	Are the unloading areas adequate in size and design to facilitate efficient unloading from vehicles and the unobstructed movement of vehicles?			
11.3(a)(2)	Are the unloading and loading pavement areas constructed of concrete or asphalt paving material and equipped with adequate drainage structures?			
11.3(a)(3)	Are the processing and storage areas located within an enclosed building or covered area?			
11.3(a)(4)	Are there provisions for weighing or measuring all solid waste (processed dredged material) transferred to the facility?			
11.3(b)(1)	Are on-site roads designed to accommodate expected traffic flow in a safe and efficient manner?			
11.3(b)(3)	Are the road surface suitable for heavy vehicles, and the road capable of withstanding expected loads?			
11.4(f)	Will all floors be free from standing water? Does all drainage from cleaning areas discharged to sanitary sewers, authorized sanitary waste treatment facilities, or a corrosion-resistant holding tank? Is the disposal of leachate and drainage from cleaning areas and holding tanks must be in compliance with all applicable federal and State regulations?			
11.4(g)	Does the facility have adequate storage space for incoming solid waste?			
11.2(a)(2)(iii)	Does the site plan include all proposed structures and areas designated for unloading, processing and storage and the general process flow?			
1.9(h)	Will the project operations be covered under a contingency plan which meets the requirements of 1.9(h)(1)(i-iv)?			
11.2(a)(3)(vi)	Does the application provide for an alternate solid waste handling system for periods when not operating, or for delays in transporting solid waste due to undesirable conditions, such as delivery of unauthorized waste, fires, dust, odor, vectors, unusual traffic conditions, equipment breakdown or other emergencies?			
1.9(i)(1)	Is the application signed by an authorized person as specified in 1.9(i)(1)?			
1.14(i)(3)	Does the application provide for all records, including the entire permit application, to be maintained at the facility?			
1.14(j)	Does the application and facility design address the confinement of solid waste?			
1.14(k)	Does the application and facility design address dust control?			
11.4(b)	Is all solid waste passing through the facility ultimately treated or disposed of at a facility authorized by the department if in this State, or by the appropriate governmental agency or agencies if in other states, territories or nations?			
1.13(a)	Does the application show that the solid waste management facility is proposing to utilize an innovative and experimental solid waste management technology or process, including a beneficial use demonstration project?			
1.13(b)(1)	Does the RD&D permit application describe the proposed activity in detail?			
1.13(b)(2)	Does the RD&D permit application describe how the applicant intends to provide for the receipt and treatment or disposal by the proposed facility of only those types and quantities of solid waste necessary to determine the efficiency and performance capabilities of the technology or process and the effects of such technology or process on human health and the environment; and how the applicant intends to protect human health and the environment in the conduct of the project?			
1.13(b)(3)	Does the RD&D permit application state that the applicant will provide, on a timely basis, the department with any information obtained as a result of the activity undertaken under the permit. The information must be submitted in accordance with schedules identified in the permit?			
1.13(c)(1)	Does the RD&D permit application provide for the construction of facilities as necessary, and for the operation of the facility for not longer than one year (unless renewed as provided in subdivision (d) of this section)?			

Figure 4. Continued (NYSDEC 2001).

dredged material selected for manufactured soil. A final example describes the suitability testing used to evaluate sediment selected for manufactured soil and construction blocks. These materials contained low levels of heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and/or dioxins.

Evaluate physical and engineering suitability

An evaluation of physical and engineering suitability is the second step in the BU framework (Figure 2). Table 1 lists physical and engineering characterization tests needed to assess the properties of dredged material (Winfield and Lee 1999). This table includes references for the characterization tests listed. These references provide background information, method limitations, and additional guidance on the use of these characterization tests. Characterization is initiated by an evaluation of the physical properties including permeability, plasticity, and organic content. The engineering properties are used to estimate the compactability, consolidation, and shear strength of the dredged material. Winfield and Lee (1999) briefly discuss each test and its relevance to BU. This guidance does not identify the characterization tests required for specific BUs (suitability testing). Nor is there interpretative guidance to indicate when a dredged material would be acceptable for specific BUs.

In certain jurisdictions, physical and engineering characterization tests results determine the BU options. For Wisconsin projects involving beach nourishment, for example, material may be classified as suitable if the average percentage of silt plus clay (material passing through a #200 sieve) in the dredged material does not exceed the average percentage of silt plus clay in the existing beach by more than 15 percent (Wisconsin Administrative Code, Natural Resources Chapter 347). In Michigan, if the dredged materials are at least 95 percent sand, they are considered clean and suitable for beach nourishment (Beneficial Use Upland Testing and Evaluation Project Management Team 2004a). Table 2 shows particle size suitability of dredged material for various BUs.

PIANC (1992) summarizes the international perspective on the BU of dredged material. A distinction is made between the BU of dredged material and the BU of dredged material disposal. The recommended decision process focuses on the contaminant status and physical characterization. Dredged material is physically categorized as Rocks, Sand/Gravel, Consolidated Clay, Soft Clay/Silt, and Mixture. Distinct Engineered, Agricultural Product, and Engineered Enhancement BU are recommended for each physical category. For the physical category Consolidated Clay, for example, the recommended Engineered uses are Land creation, Land improvement, Offshore berms, Capping, and Shore protection. The recommended Environmental enhancements for this physical category are Wetland creation, Upland Habitat, and Fisheries improvement.

Table 1. Appropriate characterization tests for determining physical and engineering properties of dredged material to evaluation its suitability for beneficial uses.

Physical Analysis	Source
1. Grain Size	
Standard Sieve Test	ASTM D422-63; COE V; DOD 2-III, 2-V, 2-VI; CSSS 47.4
Hydrometer Test	ASTM D422-63; CSSS 47.3; COE V
Pipette Test	CSSS 47.2
2. Particle Shape/Texture	ASTM D2488, D4791-95, and D3398-93
3. Water Content/% Moisture	ASTM D2216-92; COE I-1; DOD 2-VII
4. Permeability	ASA: 41-3 and 41-4; ASTM D2434-68
5. Atterberg Limits (Plasticity)	ASTM D4318-9 5; COE III; DOD 2-VIII
6. Organic Content/Organic Matter	ASTM D2487-93
Engineering Properties	**Source**
7. Compaction Tests	
Proctors	COE VI
Standard Compaction Test	ASTM D698-91
Modified Compaction Test	ASTM D1557-91
15 Blow Compaction Test	ASTM D5080-93
California Bearing Ratio	DOD 2-IX
8. Consolidation Tests	COE VIII; ASTM D2435-90
9. Shear Strength	
UU (unconsolidated, undrained)	COE X-18
CU (consolidated, undrained)	COE X-29
CD (consolidated, drained)	COE IX-38

Notes:
ASTM = American Society for Testing and Materials (ASTM 1996).
ASA = American Society of Agronomy/Soil Science Society of America. Method of Soil Analysis, Part-1, 1965.
COE = EM 1110-2-1906 (Headquarters, U.S. Army Corps of Engineers 1986).
CSSS = Canadian Society of Soil Science (Carter 1993).
DOD = U.S. Department of the Army, Navy, and Air Force 1987.

Source: Winfield and Lee (1999).

Table 2. Suitability of dredged material for various BUs.

	Dredged Material Sediment Type				
Beneficial Use Options	Rock	Gravel & Sand	Consolidated Clay	Silt/Soft Clay	Mixture
Engineered Uses					
Land creation	X	X	X	X	X
Land improvement	X	X	X	X	X
Berm creation	X	X	X		X
Shore protection	X	X	X		
Replacement fill	X	X			X
Beach nourishment		X			
Capping		X	X		X
Agricultural/Product Uses					
Construction materials	X	X	X	X	X
Aquaculture			X	X	X
Topsoil				X	X
Environmental Enhancements					
Wildlife habitats	X	X	X	X	X
Fisheries improvement	X	X	X	X	X
Wetland restoration			X	X	X
Source: *http://el.erdc.usace.army.mil/dots/budm/types.html#mixture*.					

Chemical evaluation

Background

Chemical evaluation is the next step in the BU evaluation framework (Figure 2). Table 3 lists chemical characterization tests needed to assess the properties of dredged material. References provide background information and method limitations. Winfield and Lee (1999) do not identify the characterization tests required for specific BUs (suitability testing) or provide interpretative guidance for any of the characterization tests. This guidance (Winfield and Lee 1999) briefly discusses these tests and the dependencies between various properties. For instance, the Cation Exchange Capacity is pH dependent and directly proportional to the percent clay, organic matter content, and particle size distribution. An assessment of chemical properties can indicate the solubility, mobility and toxicity of contaminants. Myers et al. (1996) and Brannon et al. (1994) describe additional leachate quality tests.

Table 3. Appropriate characterization tests for chemical properties of dredged material to determine suitability for beneficial uses.

Analysis	Source
10. pH	ASA 1996: Ch 16; CSSS: 16.2.1
11. Calcium Carbonate Equivalents	ASA 1996: Ch 16; CSSS 14.2 and 44.6
12. Cation Exchange Capacity	ASA 1996: Ch 40; CSSS 19.4
13. Salinity	ASA 1996: Ch 14; CSSS: 18.2.2
14. Sodium	ASA 1996: Ch 19
15. Chloride	ASA 1996: Ch 31
16. Sodium Adsorption Ratio (SAR)	CSSS: 18.4.3
17. Electrical Conductivity	ASA 1996: Ch 14
18. Total Organic Carbon	ASTM D2974; D2974-87; ASA 1982: 29-4.2; CSSS 44.3
19. Carbon:Nitrogen Ratio	Analyses 19, 23, and 25 in this table
20. Total Kjeldahl Nitrogen	EPA-CRL-468
21. Ammonium Nitrogen	EPA-CRL-324
22. Nitrate-nitrogen	EPA-SW846-9200
23. Nitrite-nitrogen	EPA-SW846-9200
24. Total Phosphorus	EPA-CRL-435
25. Orthophosphorus	EPA-CRL-435
26. Potassium	ASA 1996: Ch 19
27. Sulfur	ASA 1996: Ch 33
28. Diethylene Triamine Pentaacetic Acid (DTPA) Metals)	ASA 1982: 19-3.3; CSSS: 1.3; Lee, Folsom, and Bates 1983
29. Total Metals*	EPA-SW846-200.9; ASA 1996: Ch 18-30
30. Pesticides (chlorinated)	EPA-SW846-8080
31. Polynuclear Aromatic Hydrocarbons (PAHs)	EPA-SW846-8270
32. Polychlorinated Biphenyls (PCBs) Congeners	EPA-CRL-8081
33. Dioxins	EPA-SW846-8290 and 1630
34. Leachate Quality Test	Myers and Brannon 1988
35. Surface Runoff Quality	Skogerboe et al. 1987

Notes: *Metals = arsenic, cadmium, chromium, copper, lead, mercury, silver, nickel, and zinc. Use EPA 1986 Method 245.6 for mercury determinations.
Methods:
ASA = American Society of Agronomy/Soil Science Society of America (Paige et al. 1982, 1996).
CSSS = Canadian Society of Soil Science (Carter 1993).
ASTM = American Society for Testing and Materials (ASTM 1996).
EPA = USEPA (1986).

Source: Winfield and Lee (1999).

USEPA/USACE (1995) provides:

1. Guidance on the development of quality assurance project plans for ensuring the reliability of data gathered to evaluate dredged material
2. Procedural outlines that should be followed when sampling and analyzing sediments, water, and tissues
3. Recommended target detection limits for chemicals of concern

USEPA has developed a two-tiered quality management structure that addresses quality assurance (QA) concerns. This structure includes QA management plans and QA project plans. A complete QA/quality control

(QC) effort for a dredged material testing program has two major components: a QA program implemented by the data user, and QC programs implemented by the data generators. The methods used in sample collection, transport, handling, storage, and manipulation of sediments and interstitial waters can influence the physicochemical properties and the resulting chemical, toxicity, and bioaccumulation analyses. USEPA (2001a) presents guidance for the collection, storage, and manipulation of sediments for chemical and toxicological analyses. This guidance includes a discussion of activities involved in sediment sampling, a list of important issues that need to be considered within each activity, and recommendations on how to best address the issues raised. The recommended procedures are more likely to maintain in situ conditions.

Screening levels

Peddicord et al. (1998) summarizes the use of sediment quality guidelines (SQGs) in dredged material management. SQGs are values used to determine sediment contaminant concentrations that differentiate sediments of little concern from those predicted to have an adverse impact. The technical limitations of SQGs restrict their usefulness to Tier 1 or Tier 2 screening of sediments that pose little concern under specific circumstances and to identifying situations in which higher tier effects-based testing is warranted. SQGs by themselves are technically unacceptable for making definitive determinations of adverse impacts of a material in a particular environment. If a dredged material requires further evaluation, the sections on Biological Evaluation and Treatment should be consulted. National, regional, and state contaminant concentration levels are presented with full acknowledgement of their limitations.

USEPA (2001b) provides guidance for developing soil screening levels (SSLs) for Superfund sites (Appendix A –Exhibit A-1). The National Oceanic and Atmospheric Administration (NOAA 1999) provides Screening Quick Reference Tables (Exhibit A-2). Threshold and probable effect levels for organic and inorganic contaminants from freshwater and marine sediments are provided. MacDonald and Ingersoll (2002a, 2002b, 2002c) provide threshold effects, lowest effects, probable effects, and severe effects levels for metals, PAHs, and organochlorine pesticides in freshwater ecosystems (Exhibits A-3 and A-4). Attachment D of USEPA (1996) provides metals, PAHs, and pesticide regulatory and human health benchmarks for SSLs (Exhibit A-5). Bulk sewage sludge or sewage sludge sold or given away shall not be applied to land if the concentration of any pollutant in the sewage sludge exceeds the pollutant's ceiling concentration (40 CFR 503). These metal ceiling concentrations have been proposed as screening levels for the BUs of dredged material in upland environments (Exhibit A-6).

Several regional screening levels have been developed. The Beneficial Use Upland Testing and Evaluation Project Management Team (2004a) presents Great Lakes regional contaminant levels for determining if a dredged material is suitable for certain BUs. The contaminant criteria for eight states are presented for eight BU scenarios (i.e., daily cover at municipal solid waste landfill, final cover at a municipal solid waste landfill, cover at Superfund or brownfield sites, beach nourishment, compost and topsoil manufacture, restricted fill, unrestricted fill, asphalt or cement aggregate). These criteria are given in Appendix A – Exhibits A-7 through A-18. At least one Great Lakes state lacked the established criteria for each of the scenarios considered. Appendix A – Exhibit A-9 shows the criteria for the unrestricted use of topsoil. As an example of the variation between states, arsenic concentrations from various Great Lakes states range from 0.042 to 41.0 mg/kg. It should be noted that this is only one example of at least three orders of magnitude difference in regional guidance.

San Francisco Bay Regional Water Quality Control Board (2000) lists sediment chemistry guidelines for beneficial reuse of dredged material (Exhibit A-19) and biological effects-based concentrations of analytes in sediments (Exhibit A-20). The referenced document is for planning uses and the general suitability of dredged material for upland and wetland BU projects. Compliance with the screening values does not by itself indicate that any particular dredged material will be found suitable for reuse.

Appendix A contains state screening levels from Florida, Indiana, Louisiana, New Jersey, New York, Oregon, Pennsylvania, Washington, and Wisconsin (Appendix A – Exhibits A-21 through A-32) to evaluate dredged material for BU. These screening levels can be used to assess whether additional chemical and biological testing is warranted. They can also be grouped to gain a regional perspective.

Florida sediment quality guidelines

Florida sediment quality guidelines provide Total and Permissible Exposure Limits for metals, PCBs, PAHs, pesticides, chlorinated organic substances, and phthalates (Exhibit A-21). These values were derived from an effects data set (Florida Department of Environmental Protection 1994). MacDonald and Ingersoll (2002c) provide interpretative guidance for freshwater sediment quality investigations. Exhibit A-3 lists sediment threshold effect concentrations (TECs). Harmful effects are unlikely to occur at concentrations below the TECs. Exhibit A-4 lists sediment probable effect concentrations (PECs). Harmful effects are likely to occur at concentrations above the PECs. The arsenic TEC and PEC are 5.9 and 17.0 mg/kg, respectively. The Florida arsenic threshold effect and probable effect levels are 7.24 and 41.60 mg/kg, respectively (Exhibit A-21). This is another example of the disparity between screening level resources.

Indiana Risk Integration System of Closure (RISC)

Indiana Department of Environmental Management (2002) includes tables of risked-based standards. Exhibit A-22 shows RISC levels for residential and commercial/industrial closures. Closure values are provided for metals, pesticides, and PAHs. These values could be appropriately compared to dredged material concentrations for upland BU projects. Indiana has no regulatory definition for BUs of dredged material (327 Indiana Administrative Code).

Louisiana screening levels

The Louisiana Department of Environmental Quality has developed a Risk Evaluation/Corrective Action Program (RECAP) to address risks to human health and the environment posed by the release of chemical constituents to the environment. RECAP consists of a tiered framework comprising a Screening Option and three Management Options. This tiered approach allows site evaluation and corrective action efforts to be tailored to site conditions and risks. Louisiana Screening Option table (Appendix A – Exhibit A-23; *http://www.aehs.com/surveys/soil/03/LA.HTM*) can be used to determine if additional evaluation and/or corrective action is warranted. Industrial, non-industrial, and groundwater soil screening values are provided.

New Jersey screening levels

In New Jersey the Department of Environmental Protection officials concluded the NJ Solid Waste Management Act does not apply to dredged material. NJ Department of Environmental Protection Dredging Task Force (1997) establishes clear and comprehensive policies and procedures for reviewing dredging activities and dredged material management. The Acceptable Use Determination (AUD) shall be issued for dredged materials that are non-hazardous waste and do not contain PCBs. Dredged material will be considered for an AUD if the material and each admixture are used directly as a substitute for a product or as a substitute for an admixture that is incorporated into a product. The dredged-material-based product must meet the specifications and standards for a generally accepted and similarly manufactured product or raw material. The application process will include a contaminant profile in relation to current soil guidance levels and other evaluation requirements. The Direct Contact Soil Cleanup Criteria (DCSCC) (Appendix A – Exhibit A-24) includes an Unrestricted or Residential DCSCC and a Restricted or Non-residential DCSCC (NJ Department of Environmental Protection Dredging Task Force 1997). NJ AUD is somewhat similar to USACE selection testing.

New York screening levels

The New York State Department of Environmental Conservation (NYSDEC) produced a draft dredged material beneficial use handbook (NYSDEC 2001). Currently only excerpts from this document are released to the public (i.e., checklist for development and review of BU petition (Figure 4)). NYSDEC (1994a, 1994b) provide contaminant concentrations for sediment evaluation and cleanup (Exhibits A-25 and A-26, respectively). The SSLs are provided for restricted use and unrestricted use of dredged material. The contaminants include metals, PCBs, PAHs, and dioxin. NYSDEC (1994b) has been rescinded and will soon be replaced by NYSDEC Division of Water "TOGS 5.1.9: In-Water and Riparian Dredged Material Management Guidance." Executive approval is pending. (Kathleen McCue, NYSDEC Division of Solid and Hazardous Materials, personal communication, 7 September 2004).

Oregon Level II screening levels

Oregon Department of Environmental Quality (2001) provides Level II screening level values to be used during ecological risk assessments. These exposure concentrations are deemed to be acceptable for ecological receptors. Exhibit A-27 provides screening level values for plants, invertebrates, and wildlife exposed to soil and surface water. Exhibit A-28 provides screening level values for freshwater and marine sediments. The contaminants include metals, PCBs, PAHs, and pesticides.

Pennsylvania general permit for dredged material in road applications

Bureau of Land Recycling and Waste Management (Number WMGR072) describes a general use permit for the beneficial use of dredged material in roadway construction. The dredged material shall not be placed directly into the environment if any of the total or leachable levels are exceeded in the analysis of the material. Exhibit A-29 lists some of the compounds included in the permit. The compounds include metals, PAHs, and pesticides.

Washington "No Adverse" and "Minor Adverse" effect levels

Washington Administrative Code Chapter 173-204 Sediment Management Standards provides two levels of effects specific to the contamination of marine sediments: "No Adverse Level" (Exhibit A-30) and "Minor Adverse Effects" (Exhibit A-31). These levels are defined as the Sediment Quality Standard and the Cleanup Screening Level, respectively. The Sediment Quality Standard represents the goal for all sediments. The Cleanup Screening Level represents the upper limit of chemical contamination (Vining et al. 1998). The compounds include metals, PAHs, and PCBs.

Wisconsin wildlife screening levels

The Wisconsin Department of Natural Resources established a wildlife soil criterion to protect wildlife from adverse effects resulting from the ingestion of soils and terrestrial organisms taken from soils (Wisconsin Department of Natural Resources 2001). The soil values assumed to be protective was the geometric mean of the values calculated for three mammalian species and for four different avian species, respectively. The wildlife soil criterion for PCBs was determined by the lower of the geometric mean of the mammalian protection soil values (1.9 µg PCBs/kg soil) or the avian protection soil values (71.3 µg PCBs/kg soil) is 1.9 µg PCBs/kg soil

(Exhibit A-32). The approach used to calculate the soil criterion is an adaptation of USEPA's Great Lakes Water Quality Initiative (GLI) Methodology for the Development of Wildlife Criteria (40 CFR Part 132, Appendix D).

Biological evaluation

Biological evaluation is the next step in the BU evaluation framework (Figure 2). Table 4 lists biological characterization tests needed to assess the properties of dredged material (Winfield and Lee 1999). This guidance does not identify the characterization tests required for suitability testing, selection testing, or provide interpretative guidance for any of the characterization tests. National and regional documents provide biological characterization guidance for upland, wetland, and aquatic environments (USEPA/USACE 1998; USACE 2003; USEPA/GLNPO/USACE 1998; Vining et al. 1998; USEPA 2001a, 1994d; Beneficial Use Upland Testing and Evaluation Project Management Team 2004a). USEPA (1993) utilized Elutriate Toxicity Tests, Whole Sediment Toxicity Tests, Benthic Community Structure, Mutagenicity Assays, and Genotoxicity Assays to assess Indiana Harbor, Buffalo River, and Saginaw River sediment samples. This collection of documents lacks the comprehensive interpretative guidance necessary to definitively incorporate test results into a dredged material management decision. Beneficial Use Upland Testing and Evaluation Project Management Team (2004b) includes many additional references that will be useful in evaluating upland BUs of dredged material.

Table 4. Appropriate tests for biological properties of dredged material to determine suitability for beneficial uses.

Analysis	Methods
36. Manufactured Soil Test	Sturgis et al. (1999)
37. Plant Bioassay	Folsom, Lee, and Preston 1981
38. Animal Bioassay	ASTM 1998, Standard Guide E 1676-97
39. Elutriate Bioassay	EPA 1991 (Method: 11.1.4) (USACE/USEPA 1991)
40. Pathogens (coliforms)	Standard Methods: 9221 E (Greensberg et al. 1992)

Source: Winfield and Lee (1999).

MacDonald and Ingersoll (2002a, 2002b, 2002c) provide a freshwater ecosystem-based framework for assessing and managing contaminated sediments; sediment quality investigation design and implementation guidance, and results interpretation guidance. The framework has five major steps (MacDonald and Ingersoll 2002a):

- Collate the existing ecosystem base and identify and assess the issues.
- Develop and articulate ecosystem health goals and objectives.
- Select ecosystem health indicators.
- Conduct direct research and monitoring.
- Make informed decisions on the assessment, conservation, protection, and restoration of natural resources.

For instance, sediment toxicity may be selected as an indicator of ecosystem health. Ecosystem health indicators need to be accompanied by appropriate metrics and quantitative targets. A metric is any measurable characteristic of an ecosystem health indicator (e.g., survival of an amphipod in a 28-day toxicity test). A target defines the desirable range of a specific metric (e.g., not statistically different from the reference response). MacDonald and Ingersoll (2002a) presents a methodology for evaluating ecosystem health indicators. MacDonald and Ingersoll (2002c) discusses the advantages, disadvantages, uncertainty, and data interpretation of sediment chemistry, toxicity testing, benthic invertebrate community assessment, bioaccumulation assessment, and fish health and fish community assessments.

Treatment

Treatment is the next step in the BU evaluation framework (Figure 2). Lee (2000) provides implementation guidance for selected options for reclamation and the BUs of contaminated dredged material. The process of incorporating characterization test results into the implementation plan is described. The fact that dredged material contaminant concentrations exceed applicable screening levels does not automatically exclude the dredged material from BU. A number of technologies are available to reduce both metal and organic compounds in dredged material. Effectiveness of technologies varies but generally rate and effectiveness of removal increases with increasing cost of treatment. The cost of treatment must be carefully evaluated based on specific site needs and other available options. Many treatment technologies are new and being advertised by commercial vendors as effective in dredged material despite the lack of product testing in such material. This is especially true for biological treatment technologies that are being rapidly patented and marketed by a growing number of environmental remediation companies. While it has been impossible to evaluate all of the emerging remedial technologies on the market, certain concepts have been evaluated and some guidance for selecting the most appropriate approaches is provided.

Clesceri et al. (2000) discusses bench-scale tests used to estimate removal efficiencies of nine technologies. The Water Resource Development Act treatment train provides a rationale for deciding which treatment options to pursue (Figure 5). Additional information can be found at *http://www.bnl.gov/wrdacobridge/product.biblio.jsp?osti_id=759042*.

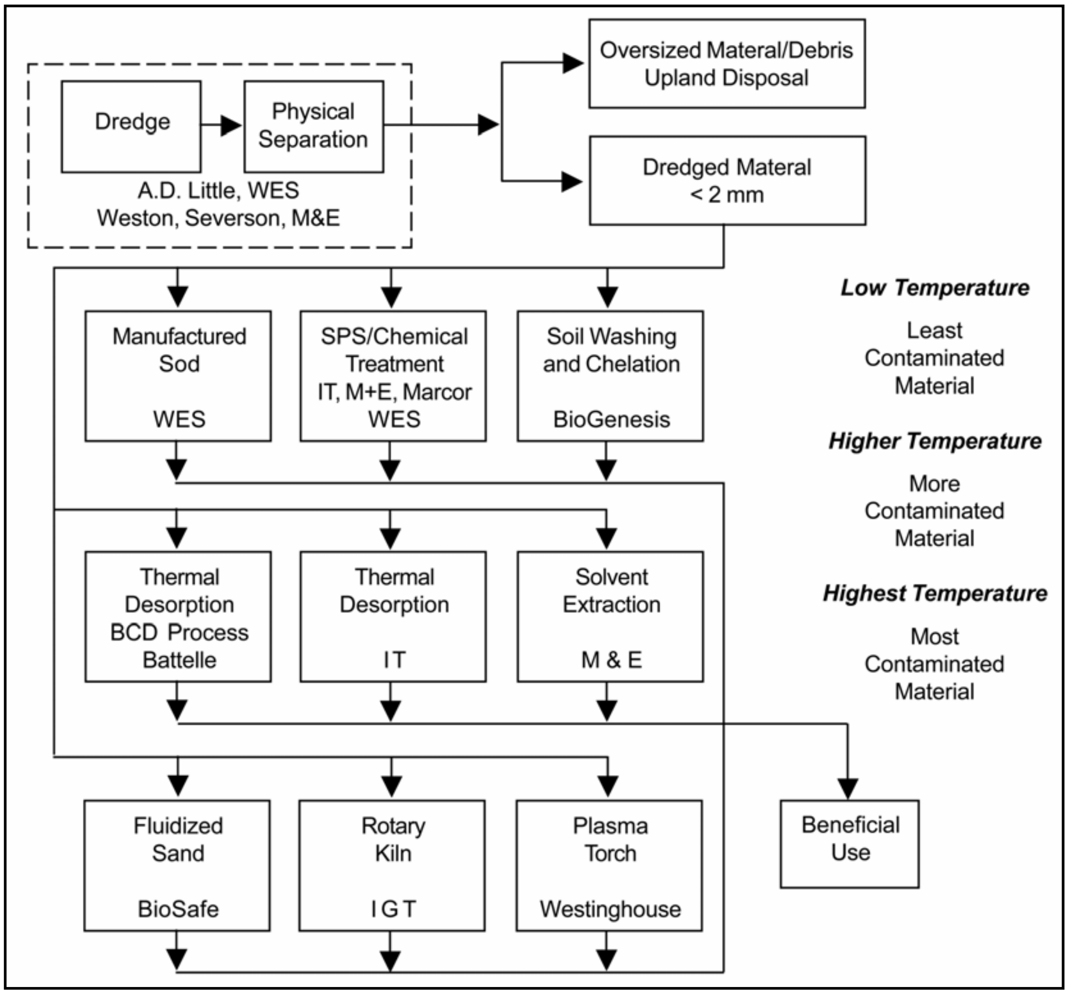

Figure 5. Water Resource Development Act treatment train (Clasceri et al. 2000).

Chemoreclamation

Averett et al. (1990) reviewed technologies involving the removal of contaminated sediment with subsequent transport, treatment, containment, or disposal, and those for non-removal alternatives, such as in situ treatment or containment of the contaminated sediment. USEPA (1994c) evaluated grain size separation, magnetic separation, gravity separation, attrition scrubbing, and froth flotation for their effectiveness in concentrating contaminants from sediment samples. The mineral processing technology concept showed promise in assisting remediation and involves using size separation to separate a contaminant-laden portion from the bulk of the sediment. This reduces the size and cost of the final treatment or disposal effort. Other potential benefits include improved effectiveness of any treatment process and possible beneficial use of cleaner sediment fractions. Report results show that grain size separation applied to coarse-grained sediment such as that from the Saginaw River has the potential to concentrate metallic and organic contaminants in approximately 20 percent of the sediment mass. Potential applications of magnetic separation at Indiana Harbor, and froth flotation at Saginaw River, showed limited application.

Francingues and Thompson (2000) reviewed innovative dredged sediment decontamination and treatment technologies. The technologies were categorized as: (1) contaminant destruction using thermal processes, (2) contaminant containment or removal processes. USEPA (1994a) provides an evaluation of SoilTech's Anaerobic Thermal Process (ATP) technology. This technology was tested using sediment samples from the Buffalo and Grand Calumet Rivers. PCB removal from the Grand Calumet River was 72 percent. PAH removal from both sediments was 99 percent. The data indicate that metal removal was significant for the Grand Calumet River sediment. USEPA (1994b) includes a bench-scale evaluation of ReTeC's Thermal Desorption Technology on Ashtabula River sediments. The specific objectives were to: (1) determine process extraction efficiencies for PCBs and PAHs, (2) conduct a mass balance for solids, water, oil, PCBs, and PAHs, and (3) examine process effects on metals, oil and grease, and several other parameters. The PCB and PAH removals were >96 and >60 percent, respectively.

Phytoreclamation

Price and Lee (1999) describe an approach to evaluating the phytoreclamation alternative for dredged material treatment. This approach falls under the treatment block for testing and evaluation of dredged material. The framework is expanded to include a phased approach to determine the suitability of a contaminated dredged material for plant-mediated reclamation. The three basic assessments include sediment physical and chemical characteristics, plant exposure effects, and contaminant reduction effectiveness. The advantages and disadvantages of various phytoreclamation approaches for metals are stated. Once a phytoreclamation approach has been determined, implementation and management strategies must be developed to ensure success. Marinucci and Bartha (1979) and McHale and McHale (1994) describe methods which effectively remove metals from waste and groundwater. These authors indicated that practical biotreatments for metal-contaminated soils and sediments are still in the developmental stage. Price et al. (1999) summarized the discussion and conclusions of a phytoreclamation work group. Specific recommendations were made for the phytoreclamation of heavy metal, petroleum hydrocarbon, PCB, pesticide, and dioxin-contaminated dredged material. Lee and Price (2003) review the phytoreclamation and management of lead contaminated dredged material. Seidel et al. (2004) investigates the conditioning of dredged sludge by plants and the solid-bed leaching of heavy metals using microbially produced sulfuric acid. Within 21 days, zinc, cadmium, manganese, and nickel were removed by 61–81 percent while chromium and lead were nearly immobile. A cost-benefit assessment of this remediation process indicates it to be a suitable treatment for restoring contaminated sediments for BUs (Seidel et al. 2004).

Bioreclamation

Fredrickson et al. (1999) provides guidance on how to determine the suitability of organic contaminated dredged material for bioreclamation. This guidance was designed to serve as the second phase in a two-phased biotreatability management decision guide. For successful bioreclamation, the dredged material must support microbal communities and their metabolism. Norris et al. (1994) provides methods to estimate the number of microorganisms present and their potential metabolic activity. Myers and Bowman (1999) describes the use of a relatively passive biotechnology to reduce polycyclic aromatic hydrocarbons concentrations. Myers et al. (2003) discusses the feasibility of bioremediating dredged material contaminated with PAHs and PCBs using composting methods. After undergoing chemical, thermal, phytoreclamation, or bioreclamation treatment, dredged material would be subjected to the appropriate suitability or selection testing.

Upland confined disposal facilities

Although dredged material is perpetually managed in accordance with the CWA, the Act does not provide guidance for the protection of the environment after dredged material is placed in an upland environment (Childs et al. 2002). A CDF is designed to contain dredged material that is unsuitable for aquatic placement. Placement of dredged material into a CDF implies contaminant levels are sufficient to prevent its use in the aquatic environment. However, many CDFs contain dredged material that would be suitable for aquatic placement or is otherwise not contaminated. USACE (2003) describes techniques used to evaluate contaminated dredged material proposed for disposal at a CDF. The purpose of the evaluation is to determine potential pathways of contaminant migration outside of a CDF. Once a contaminant pathway is identified, a control can be engineered to prevent contaminant mobility. A significant portion of the dredged material available for BU projects resides within CDFs. Removal and BU of dredged material from CDFs requires a thorough assessment of potential impacts from its use. USACE (2003) was not developed to evaluate the suitability of dredged material for BU and other resources may need to be consulted before a BU determination is made.

Volume of dredged material

Much of the dredged material in upland CDFs is already dewatered and readily useable for beneficial purposes. Olin-Estes and Palermo (2000a, 2000b) and Olin-Estes (2000) give guidance for evaluating dredged material recovery potential for BU (i.e., soil separation concepts, site characterization: prescriptive approach, site characterization: statistical approach). These documents provide physical separation concepts and sampling methods for estimating the volume of recoverable material meeting BU requirements. The approaches vary based on the amount of data available to the user. Spaine et al. (2001) gives guidance in evaluating dredged material recovery potential when debris and trash removal is required. Myers and Adrian (2000) discusses the types, features, and logistics of equipment that can be deployed to remove debris and trash from dredged material. Determining the volume of dredged material is appropriate for BU selection and suitability testing. These documents were developed to assist in determining when dredged material recovery is technically and economically feasible.

Olin-Estes et al. (2002a) develops an approach for screening-level economic analysis of separation alternatives. Scenarios are developed for one-time and long-term dredging projects to illustrate the relative importance of the different variables. Olin-Estes et al. (2002b) summarizes a mobile treatment plant soil separation demonstration at a CDF. The demonstration utilized a portable hydrocyclone unit suitable for conducting soil separation feasibility evaluations. The silt/clay separation is expected to be an important factor in maximizing dredged material recovery from CDFs in which the silt fraction is substantially less contaminated than the clay fraction. In at least one state (i.e., Wisconsin), removing dredged material from a CDF would invoke mining regulations. After removal, the dredged material can be subjected to the suitability or selection testing previously discussed.

Upland CDF treatments

Myers and Williford (2000) discusses applications of bioremediation techniques to manage organic contaminants in CDFs. Several design concepts and bioremediation technologies have shown promise for practical application to recalcitrant organic contaminants (i.e., polychlorinated dibenzo-p-dioxins/furans, PCBs, PAHs). The reviewed technologies of windrow composting, biopile composting, landfarming, and land treatment are logistically fully developed. Additional research is required to investigate process unknowns including time requirements for treatment (rate and extent of reaction); optimal use of nutrients, bioaugmentation, air, and water; and the specifics of anaerobic to aerobic transition in CDFs. The goal is to transform diked structures designed to retain dredged material solids from disposal to treatment facilities. Myers and Horner (2003) presents results from a pilot-scale study designed to evaluate the technical feasibility of using land treatment technology to remediate dredged material contaminated with hydrophobic organic chemicals. The authors conclude that PCBs in dredged material is amenable to land treatment in CDFs but PCDDs and PCDFs are resistant.

Lee (2001a) provides implementation guidance for the control of undesirable CDF vegetation. Undesirable vegetation has interfered with CDF operations and degraded the quality of dredged material for BU products. Cooperative research and development agreements (CRDAs) were established between the U.S. Army Engineer Research and Development Center (ERDC) and several entities. In accordance with the CRDAs, specific innovative technologies developed and demonstrated the application of these technologies to the reclamation and reuse of dredged material from existing CDFs (Lee et al. 2007).

Upland CDF issues

Several issues related to dredged material removed from CDFs need to be resolved. One issue relates to ownership. Another issue relates to liability associated with future uses of the material. Some states with CDFs on state property require compensation for dredged material removed from these CDFs. Dredged material can be documented as of no economic value (e.g., Black Warrior and Tombigbee Rivers CDFs in the Mobile District). This declaration will allow entities to acquire the dredged material without compensating the State of Alabama. Alabama requires a mining permit for the excavation of dredged material from a CDF. Other states may have similar requirements. Another issue is potential lawsuits from companies claiming to have patents on certain technology (e.g., manufactured top soil using dredged material).

3 Beneficial Use Implementation

Engineered options

After suitability or selection testing is completed, all acceptable alternatives are retained. Additional guidance is available to further evaluate many of the alternatives. Montgomery et al. (1979) lists the guidelines for disposal area reuse. Walsh and Malkasian (1978) provides guidance for planning and implementing productive land use areas. Spaine et al. (1978) published guidance for land improvement using dredged material.

Strip mine reclamation and solid waste management

Lee (2001b) describes the use of dredged material in manufacturing topsoil for restoration of brownfields and abandoned acid minelands. Perrier et al. (1980) describes strip mine reclamation using dredged material. Harrison and Luik (1980) discusses the suitability of dredged material for the reclamation of surface-mined land.

Near shore berm

McLellan et al. (1990) provides interim guidance for nearshore berm construction. This guidance includes an overview of considerations for siting and design of nearshore berms, simple quantitative techniques for berm siting and design using one east coast site and one west coast site as illustrations. Williams and Prickett (1998) addresses primary considerations for planning and managing nearshore placement of mixed sediment from dredging projects.

Capping

Capping contaminated sediments with dredged material is a BU. Palermo et al. (1998) gives guidance for subaqueous dredged material capping. This comprehensive approach includes:

1. Design requirements and a design sequence of capping.
2. Documented placement techniques for contaminated dredged material and capping material placement.
3. Defined capping project site selection considerations.

4. Guidelines for cap monitoring.

This guidance is applicable to capping projects in inland and near-coastal waters. Winter (2002) discusses subaqueous capping and natural recovery from the hydrogeologic perspective. Clarke et al. (2001) evaluates the long-term stability of the subaqueous cap. Guidance is provided on estimating the bioturbation profiles, depths, and process rates in relation to the subaqueous cap design. Fredette et al. (2002) presents contaminated sediments pilot study capping results.

Construction and industrial

Dalton et al. (2004) evaluates the use of dredged material as a feedstock in the conventional manufacture of Portland cement. The efficacy of the process at the bench and pilot scales was demonstrated. A batch rotary kiln was used for a pilot-scale manufacture. X-ray diffraction analysis and American Society for Testing and Materials (ASTM) tests for strength, soundness, and setting time suggested that with optimized burn conditions, dredged material can be successfully incorporated into full-scale manufacture.

Agricultural and product uses

Aquaculture

Aquaculture is a promising BU because aquaculture ponds and dredged material containment areas have similar design characteristics (e.g., perimeter levees, construction on impervious soils, control structures for water discharge and drainage). Both types of facilities include locations adjacent to waterways in coastal areas. The recommended sediment types are consolidated clay and silt/soft clay (Figure 4). Tatem (1990) offers guidance in determining the chemical suitability of a dredged material containment area for aquaculture.

Agriculture, forestry, and horticulture

Sturgis and Lee (1999) describes a process for creating topsoil using dredged material as a major component of blended materials. Screening tests to determine the most productive blend ratios of dredged material and other materials (e.g., yardwastes, biosolids and industrial byproducts) are described. These tests require less than 5 gallons of each test material and can be conducted in most any greenhouse or growth chamber facility with the plant species indicated or with site-specific plant species. Selection of a suitable blend is based on an acceptable plant response within an economically feasible ratio of dredged material and other materials. The manufacturing of a productive soil product from dredged material should include a two-phased approach. Phase 1 should include the physical and chemical characterization, and bench-scale screening for seed germination and plant growth. If the screening tests show the dredged material can potentially be used to manufacture a soil product, then phase 2 involves either a demonstration project using the blends identified in phase 1 or commercialization of the process. The use of dredged material for topsoil production is currently site specific. The maximum limits for metals in agricultural soils amended with biosolids derived from sewage sludge were used to put a perspective on dredged material amended with yardwaste and biosolids. Sturgis et al. (2001, 2002) discuss the application of manufactured soil technology to dredged material in Toledo Harbor and a CDF in Mobile, AL, respectively.

Parks and recreation

USEPA (2000) presents 11 guiding principles for constructed treatment wetlands. One principle is to create opportunities for the beneficial use of dredged material. Guidelines are provided for siting, design, construction, operation, maintenance, and monitoring of constructed treatment wetlands. Lee et al. (2007) discusses a partnership between ERDC and AMD&ART (*http://www.amdandart.org*) to restore an abandoned acid mine drainage (AMD) site into a recreational park and passive remediation facility. Dredged material was blended with waste paper fiber and processed cow manure to produce a substrate used in the constructed wetland as a final polishing treatment for AMD. The treatment system includes six neutralization ponds and seven acres of constructed wetland. The dredged material used in this demonstration was shown to be very effective in the construction of wetlands on abandoned AMD.

Comoss et al. (2002) illustrates the use of dredged material to implement a low cost and innovative erosion protection project. Riprap was placed off the shoreline, and downed trees were anchored in the riprap to function as timber groins. Dredged material was placed between the shoreline and riprap, and vegetation was transplanted into the newly created area. Geotextile and wattles were used to aid in vegetative rooting. The project resulted in an aesthetic alternative to conventional shoreline erosion, several additional hectares of stabilized vegetation, and a valuable example to other parks.

Environmental enhancement

Habitat development

Coastal Zone Resources Division (1978) suggests approaches to terrestrial wildlife habitat development on dredged material. Terrestrial habitats on dredged material areas support highly diverse wildlife populations (e.g., birds, mammals, reptiles, and amphibians). A synopsis of plant species (e.g., trees, shrubs, vines, herbs, and grasses) of value for terrestrial wildlife habitat development is provided. Determining a wildlife habitat for a proposed upland area consists of deciding what species of wildlife inhabit the area, determining the habitat requirements for those particular wildlife species, and deciding on the level of effort or intensity of the management effort.

Osburn et al. (1999) discusses interagency coordination on a 240-acre LA barrier reef restoration project. Twelve federal and state entities formed the Inter-agency Coordination Team (ICT). The ICT planned the Houston-Galveston Navigation Channel project and established habitat resource conservation priorities. More than 78 million cubic yards of dredged material will be moved and disposed. Five million cubic yards will have to be dredged annually to maintain the channel (Wagner 2000). Over the 50-year project life, 3,889 acres of marsh, upland, and colonial water bird habitat will be restored using dredged material (Jefts 2002). Additionally, docking and unloading areas will be constructed on CDFs. Dredged material will be used to construct an offshore berm. This berm will provide the channel inlet with storm surge suppression (Wagner 2000).

Islands

Landin (1986) describes the environmental considerations and techniques that have been developed and tested for building, developing, and managing dredged material islands for use by birds for nesting and other life requirements. The Corps of Engineers, state agencies, and private enterprises have created over 2,000 man-made islands throughout the United States. Location, timing, and design are the primary considerations for building dredged material islands for bird habitat. Allen and Shirley (1988) describes successful techniques for developing marsh on dredged material in moderate to high wave-energy environments for habitat creation and substrate stabilization. Sandbag, floating tire, and tire pole breakwaters and transplanted sprigs were used to establish marsh in moderate to high wave-energy environments.

Aquatic habitats

Miller (1988a) provides information on techniques, materials, and equipment necessary to construct submerged aquatic habitats in large waterways using coarse-grained sediments. The site selection criteria include appropriate water depth and velocity. These habitats can be considered to offset potential adverse effects of maintenance dredging or water resource development projects. Miller (1988b) provides information on the construction of a shallow-water gravel bar habitat in small to medium-sized rivers using coarse-grained sediments. Payne and Tippet (1989) investigates the value of gravel disposal mounds in river side channels for freshwater mussels. Basic guidelines are suggested to guide site selection. A comparison between the number of mussels colonizing gravel mounds and the number found in the reference location indicate that gravel disposal enhanced the value of these areas for mussels.

Wetlands

Wade et al. (2002) discusses the environmental and engineering effects of dredging and placing Appomattox River sediments in the proposed Puddledock site. The testing and analysis of upland disposal is documented. The Puddledock site will be flooded and then allowed to maintain natural ponded elevation. The potential contaminant releases from disposal in the Puddledock site pose small environmental impacts that should be acceptable with proper management. Welp et al. (2004) describes the use of the flexible-discharge dustpan dredge to restore wetlands. The dustpan configuration used was most efficient where continuous thick shoals were present and minimal movement of the hard point was required.

Beach nourishment

NOAA (2000) discusses the use of dredged material to nourish beaches. Twelve states actually recommend the use of dredged material for beach nourishment in policy language. Finding large quantities of suitable sand is one of the major obstacles in performing beach nourishment operations.

Francingues et al. (2000) examines innovations in dredging technology: equipment, operations, and management. The equipment innovations include silt/sand separation, the reclamation of contaminated sediments, and near shore placement for beach nourishment. Nelson and Pullen (1990) lists environmental considerations in using dredged material as beach nourishment.

Multiple purposes

A park and recreation complex built over an existing solid waste landfill using a dredged material cap is one example of a multipurpose project. The Vintondale, PA, AMD site, transformed into a recreational park and passive remediation facility, is another multipurpose project. Material from the CDF at Donora, PA, was removed and used in a constructed wetland (Lee et al. 2007).

Beneficial uses: Retain acceptable alternatives

Retaining all acceptable alternatives is the final step in the testing and evaluation for BU framework (Figure 2). After selection testing is completed, an objective method is needed to select an alternative. USEPA/USACE (2002) provides generic criteria (Table 5) and customized criteria (Table 6) for evaluating BU alternatives. When the number of alternatives considered is small, a qualitative evaluation may be appropriate. In complex cases, the Simple Multiattribute Rating Technique (SMART) is recommended to systematically evaluate alternatives. SMART is an application of multiattribute utility theory. These criteria were developed in the context of comprehensive watershed planning.

Table 5. General criteria to evaluate BU alternatives.

Criterion	Examples
Human Benefits	Recreation Flood Protection Economic Development
Ecological Benefits	Improved Hydrologic Functions Habitat Enhancement Improved Water Quality
Compatibility with Estuary or Watershed-Wide Plans/Goals	Habitat Restoration Enhanced Public Access to Estuary
Feasibility	Technical Logistical Institutional (Decision Process/Infrastructure)
Cost	Of Dredging Of Transportation Of Maintenance Of Monitoring
Availability of Funding Mechanisms	USACE EPA State Agencies Local Governments Public/Private Partnerships Private Lenders
Environmental Impacts	Of Construction Of Project After Construction
Legal Authority	Positive Authority to Take Action Regulatory Requirements
Public Support	Decision Leaders Regulators Neighbors Advocacy Groups Other Interested Publics General Public
Risk	Financial Environmental Human Health Schedule of Project
Source: USEPA/USACE (2002).	

Table 6. Customized criteria to evaluate BU alternatives.

Step 1	Seek the early involvement of pertinent multiple shareholders in identifying and structuring criteria.
Step 2	Elicit criteria from stakeholder representatives.
Step 3	Combine each stakeholder's criteria into an objectives hierarchy, which is akin to an organization chart.
Step 4	Combine the stakeholder hierarchies into a single comprehensive hierarchy.
Step 5	Hold a review meeting with the stakeholders.
Source: USEPA/USACE (2002).	

Bonnevie et al. (2002) proposed a framework for evaluating beneficial uses of dredged material in NY/NJ harbor. The dredged material management plan defined and provided a preference ranking for numerous dredged material management options. A single, systematic framework that evaluates and compares various BU options was developed. This framework incorporates economic, environmental, and policy related information that would be supplemental to a standard benefit/cost analysis. The "weight of evidence" approach was used to balance and integrate multiple lines of evidence. The framework includes four steps:

1. Identification of assessment and measurement endpoints.
2. Determination of measurement endpoint weights.
3. Determining, finding, and magnitude for each measurement endpoint.
4. Weight of evidence results.

This process would be useful in determining the best BU for a dredged material undergoing selection testing.

4 Summary and Recommendations

Summary

Beneficial uses of dredged material have a productive history resulting in thousands of man-made islands, marshes, and habitat development projects. In many areas, Corps islands provide vital habitat for rare, threatened, or endangered species. Traditionally, projects were completed with uncontaminated dredged material. Due to reduced storage capacities within CDFs and the reduced use of aquatic disposal alternatives, BUs of dredged material are being considered more extensively. While sources of uncontaminated dredged material are still available, there is also a need to evaluate BU of dredged material with low to moderate contaminant concentrations.

The USEPA and USACE share the regulatory responsibility of dredged material disposal within waters of the United States. CWA is the primary Federal environmental statute governing BU projects. The USEPA Office of Water has maintained that, once dredged material is regulated under the CWA, it will always be regulated under the CWA. However, the CWA does not provide guidance for the protection of the environment after dredged material is placed in an upland environment (Childs et al. 2002). Figure 2 provides a framework for testing and evaluation for BU projects. The testing and evaluation consider Physical, Environmental, and Engineering Suitability, Chemical and Biological Evaluations, and BU Alternatives. If there is reason to believe the dredged material is contaminated, chemical and/or biological evaluations are conducted. If the chemical/biological evaluation results indicate the potential for adverse impacts, the material is treated to manage the contaminants present, then retested for adverse impacts. If adverse impacts are no longer indicated or if there is no reason to believe the dredged material is contaminated, then a BU alternative can be implemented. If adverse impacts are still indicated, the dredged material should not be used for BU purposes.

Barriers to the optimal utilization of BUs of dredged material are numerous. Comprehensive national guidance is needed. There seems to be an inconsistency between the technical limits of screening levels (Peddicord et al. 1998) and the way they are applied (Exhibits A-1 through

A-31). The characterization tests provided in Tables 1, 3, and 4 are not subdivided into the proper selection or suitability testing required for BU. No interpretative guidance is provided for these characterization tests (Tables 1, 3, and 4). Many of the current guidance documents are draft or interim (e.g., USEPA/USACE 2002) and need to be finalized. The lack of proven technologies to treat dredged material is another barrier to BU. Many of the referenced technologies have been used on a pilot scale. The lack of commercial applications of these technologies makes it difficult to accurately evaluate their effectiveness and estimate cost. The Corps' initiative to select the least cost disposal alternative is also a hindrance to some BU projects. Issues of property ownership and compensation are barriers to BU implementations. Agencies' liability for future uses of dredged material (i.e., potting soil, building blocks, figurines) must be clearly delineated before dredged material can be fully utilized beneficially.

Recommendations

USEPA (2003) provides nine recommendations whose implementation should enhance the BU of dredged material substantially. These recommendations need to be fully implemented. The roles of an NDT, Regional Dredging Teams, and Local Planning/Project Groups are outlined (USEPA 1994e, 1998, 2003). Implementing these recommendations at the national, regional and local levels will greatly enhance BUs of dredged material. The NDT should be instrumental in the development and implementation of consistent national guidance. This guidance should improve the selection and suitability testing guidance. Interpretative guidance is needed for all tests listed in Tables 1, 2, and 3. The inconsistency between the technical limitations of screening levels (Peddicord et al. 1998) and their use by states needs to be resolved. Promoting the BU of dredged material is a specific objective of the NDT, and it needs to address the Federal standard that requires USACE to use the least costly acceptable method for dredging and disposal. This standard is an impediment to the BU of dredged material. The NDT should address issues related to the removal of dredged material from CDFs (i.e., ownership, compensation, liability). All Regional Dredging Teams and Local Planning/Project Groups should be operational. Some teams are currently functioning effectively. For example, the Beneficial Use Upland Testing and Evaluation Project Management Team (2004a) represents a cohesive regional BU effort. Pebbles and Thorp (2001) summarizes BU in the Great Lakes.

Additional research that clearly delineates the practical limits of treatment technologies described in the Treatment section of Chapter 2 should be conducted. Thermal, chemical, phytoremediation, and bioremediation treatment research is warranted to provide interpretative guidance for contaminated sediment management. Current research has shown moderate success with contaminants or groups of contaminants. The NY/NJ Harbor Sediment Decontamination project developed through the Water Resource Development Act (*http://www.bnl.gov/wrdadcon/*) is an example of the type of research suggested. The risk associated with using these technologies must be communicated to decision makers. After a dredged material has been selected for BU, agencies should utilize automated procedures to objectively determine the best BU. USEPA/USACE (2002) provided generic and customized criteria to evaluate BU alternatives in a comprehensive watershed planning context. Bonnevie et al. (2002) also provided a framework for comparing potential BUs. USEPA/USACE (2002) and Bonnevie et al. (2002) describe methodologies that should be incorporated into BU guidance documents. Comprehensive guidance and adequate decision support tools for decision makers would greatly enhance the BU of dredged material.

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Appendix A: Contaminant Screening Levels

Exhibit A-1. Generic SSLs for Residential Scenario*

Compound	CAS No.	Ingestion-Dermal (mg/kg)	Inhalation of Volatiles (mg/kg)	Inhalation of Fugitive Particulates (mg/kg)	Migration to Ground Water	
Organics					DAF=20 (mg/kg)	DAF=1 (mg/kg)
Acenaphthene	83-32-9	3,400 [b]	--- [c]	---	570 [b]	29 [b]
Acetone (2-Propanone)	67-64-1	7,800 [b,c]	--- [c]	---	16 [b]	0.8 [b]
Aldrin	309-00-2	0.04 [c,e]	3 [e]	---	0.5 [e]	0.02 [e]
Anthracene	120-12-7	17,000 [b]	--- [c]	---	12,000 [b]	590 [b]
Benz(a)anthracene	56-55-3	0.6 [e]	--- [c]	---	2 [e]	0.08 [e,f]
Benzene	71-43-2	12 [c,e]	0.8 [e]	---	0.03	0.002 [f]
Benzo(b)fluoranthene	205-99-2	0.6 [e]	--- [c]	---	5 [e]	0.2 [e,f]
Benzo(k)fluoranthene	207-08-9	6 [e]	--- [c]	---	49 [e]	2 [e]
Benzoic acid	65-85-0	310,000 [b,c]	--- [c]	---	400 [b,i]	20 [b,i]
Benzo(a)pyrene	50-32-8	0.06 [e,f]	--- [c]	---	8	0.4
Bis(2-chloroethyl)ether	111-44-4	0.4 [e]	0.2 [e,f]	---	0.0004 [e,f]	0.00002 [e,f]
Bis(2-ethylhexyl)phthalate	117-81-7	35 [e]	--- [c]	---	3,600	180
Bromodichloromethane	75-27-4	10 [c,e]	--- [c]	---	0.6	0.03
Bromoform (tribromomethane)	75-25-2	81 [c,e]	52 [e]	---	0.8	0.04
Butanol	71-36-3	7,800 [b,c]	--- [c]	---	17 [b]	0.9 [b]
Butyl benzyl phthalate	85-68-7	12,000 [b]	--- [c]	---	930 [d]	810 [b]
Carbazole	86-74-8	24 [e]	--- [c]	---	0.6 [e]	0.03 [e,f]
Carbon disulfide	75-15-0	7,800 [b,c]	720 [d]	---	32 [b]	2 [b]
Carbon tetrachloride	56-23-5	5 [c,e]	0.3 [e]	---	0.07	0.003 [f]
Chlordane	57-74-9	2 [e]	72 [e]	---	10	0.5
p-Chloroaniline	106-47-8	240 [b]	--- [c]	---	0.7 [b]	0.03 [b,f]
Chlorobenzene	108-90-7	1,600 [b,c]	130 [b]	---	1	0.07
Chlorodibromomethane	124-48-1	8 [c,e]	--- [c]	---	0.4	0.02
Chloroform	67-66-3	100 [c,e]	0.3 [e]	---	0.6	0.03
2-Chlorophenol	95-57-8	310 [b]	--- [c]	---	4 [b,i]	0.2 [b,f,i]
Chrysene	218-01-9	62 [e]	--- [c]	---	160 [e]	8 [e]

Exhibit A-1 (continued)

Compound *Organics (continued)*	CAS No.	Ingestion-Dermal (mg/kg)	Inhalation of Volatiles (mg/kg)	Inhalation of Fugitive Particulates (mg/kg)	Migration to Ground Water DAF=20 (mg/kg)	Migration to Ground Water DAF=1 (mg/kg)
1,2-Dichloropropane	78-87-5	9 [c,e]	15 [b]	---	0.03	0.001 [f]
1,3-Dichloropropene	542-75-6	6 [c,e]	1 [e]	---	0.004 [e]	0.0002 [e]
Dieldrin	60-57-1	0.04 [c,e]	1 [e]	---	0.004 [e]	0.0002 [e,f]
Diethylphthalate	84-66-2	49,000 [b]	--- [c]	---	470 [b]	23 [b]
2,4-Dimethylphenol	105-67-9	1,200 [b]	--- [c]	---	9 [b]	0.4 [b]
2,4-Dinitrophenol	51-28-5	120 [b]	--- [c]	---	0.2 [b,f,i]	0.008 [b,f,i]
2,4-Dinitrotoluene	121-14-2	0.7 [e]	--- [c]	---	0.0008 [e,f]	0.00004 [e,f]
2,6-Dinitrotoluene	606-20-2	0.7 [e]	--- [c]	---	0.0007 [e,f]	0.00003 [e,f]
Di-n-octyl phthalate	117-84-0	1,200 [b]	--- [c]	---	10,000 [d]	10,000 [d]
Endosulfan	115-29-7	470 [b,c]	--- [c]	---	18 [b]	0.9 [b]
Endrin	72-20-8	23 [b,c]	--- [c]	---	1	0.05
Ethylbenzene	100-41-4	7,800 [b,c]	400 [d]	---	13	0.7
Fluoranthene	206-44-0	2,300 [b]	--- [c]	---	4,300 [b]	210 [b]
Fluorene	86-73-7	2,300 [b]	--- [c]	---	560 [b]	28 [b]
Heptachlor	76-44-8	0.1 [c,e]	4 [e]	---	23	1
Heptachlor Epoxide	1024-57-3	0.07 [c,e]	5 [e]	---	0.7	0.03
Hexachlorobenzene	118-74-1	0.3 [e]	1 [e]	---	2	0.1 [f]
Hexachloro-1,3-butadiene	87-68-3	6 [e]	8 [e]	---	2	0.1 [f]
• -HCH (• -BHC)	319-84-6	0.1 [c,e]	0.7 [e]	---	0.0005 [e,f]	0.00003 [e,f]
•-HCH(•-BHC)	319-85-7	0.4 [c,e]	6 [e]	---	0.003 [e]	0.0001 [e,f]
•-HCH(Lindane)	58-89-9	0.4 [e]	--- [c]	---	0.009	0.0005 [f]
Hexachlorocyclopentadiene	77-47-4	430 [b]	10 [b]	---	400	20
Hexachloroethane	67-72-1	35 [e]	54 [e]	---	0.5 [e]	0.02 [e,f]
Indeno(1,2,3-cd)pyrene	193-39-5	0.6 [e]	--- [c]	---	14 [e]	0.7 [e]
Isophorone	78-59-1	510 [e]	--- [c]	---	0.5 [e]	0.03 [e,f]
Methoxychlor	72-43-5	390 [b,c]	--- [c]	---	160	8
Methyl bromide	74-83-9	110 [b,c]	9 [b]	---	0.2 [b]	0.01 [b,f]

Exhibit A-1 (continued)

Compound	CAS No.	Ingestion-Dermal (mg/kg)	Inhalation of Volatiles (mg/kg)	Inhalation of Fugitive Particulates (mg/kg)	Migration to Ground Water DAF=20 (mg/kg)	Migration to Ground Water DAF=1 (mg/kg)
Organics (continued)						
1,1,2-Trichloroethane	79-00-5	11 [c,e]	1 [e]	---	0.02	0.0009 [f]
Trichloroethylene	79-01-6	58 [c,e]	5 [e]	---	0.06	0.003 [f]
2,4,5-Trichlorophenol	95-95-4	6,100 [b]	--- [c]	---	270 [b,i]	14 [b,i]
2,4,6-Trichlorophenol	88-06-2	44 [e]	200 [e]	---	0.2 [e,f,i]	0.008 [e,f,i]
Vinyl acetate	108-05-4	--- [c]	980 [b]	---	170 [b]	8 [b]
Vinyl chloride (chloroethene)	75-01-4	0.9 [c,e]	0.6 [e]	---	0.01 [f,i]	0.0007 [f]
m-Xylene	108-38-3	160,000 [b,c]	--- [c]	---	210	10
o-Xylene	95-47-6	160,000 [b,c]	--- [c]	---	190	9
p-Xylene	106-42-3	160,000 [b,c]	--- [c]	---	200	10
Inorganics						
Antimony	7440-36-0	31 [b,c]	---	--- [c]	5	0.3
Arsenic	7440-38-2	0.4 [e]	---	770 [e]	29 [i]	1 [i]
Barium	7440-39-3	5,500 [b,c]	---	710,000 [b]	1,600 [i]	82 [i]
Beryllium	7440-41-7	160 [c,e]	---	1,400 [e]	63 [i]	3 [i]
Cadmium	7440-43-9	70 [b,h]	---	1,800 [e]	8 [i]	0.4 [i]
Chromium (total)	7440-47-3	230 [b,c]	---	280 [e]	38 [i]	2 [i]
Chromium (III)	16065-83-1	120,000 [b,c]	---	--- [c]	--- [g]	--- [g]
Chromium (VI)	18540-29-9	230 [b,c]	---	280 [e]	38 [i]	2 [i]
Cyanide (amenable)	57-12-5	1,600 [b,c]	---	--- [c]	40	2
Lead	7439-92-1	400 [j]	---	--- [j]	--- [j]	--- [j]
Mercury	7439-97-6	23 [b,c,k]	10 [b,i]	---	2 [i]	0.1 [i]
Nickel	7440-02-0	1,600 [b,c]	---	14,000 [e]	130 [i]	7 [i]
Selenium	7782-49-2	390 [b,c]	---	--- [c]	5 [i]	0.3 [i]
Silver	7440-22-4	390 [b,c]	---	--- [c]	34 [b,i]	2 [b,i]
Thallium	7440-28-0	6 [b,c,l]	---	--- [c]	0.7 [i]	0.04 [i]
Vanadium	7440-62-2	550 [b,c]	---	--- [c]	6,000 [b]	300 [b]
Zinc	7440-66-6	23,000 [b,c]	---	--- [c]	12,000 [b,i]	620 [b,i]

DAF = Dilution Attenuation Factor

- [a] Screening level based on human health criteria only
- [b] Calculated values correspond to a noncancer hazard quotient of 1
- [c] Ingestion-Dermal pathway: no dermal absorption data available; calculated based on ingestion data only. Inhalation of volatiles pathway: no toxicity criteria available
- [d] Soil Saturation Limit (Csat)
- [e] Calculated values correspond to a cancer risk of 1 in 1,000,000
- [f] Level is at or below Contract Laboratory Program required quantification limit for Regular Analytical Services (RAS)
- [g] Chemical-specific properties are such that this pathway is not of concern at any soil contaminant concentration
- [h] SSL is based on dietary RfD
- [i] SSL for pH of 6.8
- [j] A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA, 1994)
- [k] SSL is based on RfD for mercuric chloride (CAS No. 007847-94-7)
- [l] SSL is based on Rfd for thallium chloride (CAS No. 7791-12-0)

(Source: USEPA 2001b)

Exhibit A-2. Screening Quick Reference Table for Inorganics in Solids.

(values in ppb dry weight)	FRESHWATER SEDIMENT					MARINE SEDIMENT					SOIL	
COMPOUND	"Background" [1]	Lowest ARCs H. azteca TEL	Threshold Effects Level (TEL)	Probable Effects Level (PEL)	Upper [2] Effects Threshold (UET)	Threshold Effects Level (TEL)	Effects Range-Low (ERL)	Probable Effects Level (PEL)	Effects Range Median (ERM)	Apparent [3] Effects Threshold (AET)	Background: Geometric Mean	Background: Range
Predicted Toxicity Gradient:		Increasing →				Increasing →						
ALUMINUM (Al) (%)	0.26%	2.55%								1.8% N	4.7%	0.5- >10%
ANTIMONY (Sb)	160				3,000 M					9,300 E	480	bd-8,800
ARSENIC (As)	1,100	10,798	5,900	17,000	17,000 I	7,240	8,200	41,600	70,000	35,000 B	5,200	bd-97,000
BARIUM (Ba)	700									48,000 A	440,000	10,000-0.5%
CADMIUM (Cd)	100-300	583	596	3,530	3,000 I	676	1,200	4,210	9,600	3,000 N		
CHROMIUM (Cr)	7,000-13,000	36,286	37,300	90,000	95,000 H	52,300	81,000	160,400	370,000	62,000 N	37,000	1000-0.2%
COBALT (Co)	10,000									10,000 N	6,700	bd-70,000
COPPER (Cu)	10,000-25,000	28,012	35,700	197,000	86,000 I	18,700	34,000	108,200	270,000	390,000 MO	17,000	bd-700,000
IRON (Fe) (%)	0.99-1.8 %	18.84%			4% I					22% N	1.8%	0.01- >10%
LEAD (Pb)	4,000-17,000	37,000	35,000	91,300	127,000 H	30,240	46,700	112,180	218,000	400,000 B	16,000	bd-700,000
MANGANESE (Mn)	400,000	630,000			1,100,000 I					260,000 N	330,000	bd-0.7%
MERCURY (Hg)	4-51		174	486	560 M	130	150	696	710	410 M	58	bd-4,600
NICKEL (Ni)	9,900	19,514	18,000	35,900	43,000 H	15,900	20,900	42,800	51,600	110,000 EL	13,000	bd-700,000
SELENIUM (Se)	290									1,000 A	260	bd-4,300
SILVER (Ag)	<500				4,500 H	730	1,000	1,770	3,700	3,100 B		
STRONTIUM (Sr)	49,000										120,000	bd-0.3%
TIN (Sn)	5,000									> 3,400 N as TBT	890	bd-10,000
VANADIUM (V)	50,000									57,000 N	58,000	bd-500,000
ZINC (Zn)	7,000-38,000	98,000	123,100	315,000	520,000 M	124,000	150,000	271,000	410,000	410,000 I	48,000	bd-0.29%
SULFIDES					130,000 M					4,500 MO		

1 "Background" values are derived from a compilation of sources, but come primarily from Int. Joint Comm. Sediment Subcommittee (1988).
2 Entry is lowest, reliable value among a compilation of AET levels: I - Infaunal community impacts; H - *Hyalella azteca* bioassay; M - Microtox bioassay
3 Entry is lowest value among AET levels: I - Infaunal community impacts; A-Amphipod; B-Bivalve; M-Microtox; O-Oyster larvae; E-Echinoderm larvae; L-Larval$_{max}$; or , N-*Neanthes* bioassays

(all sediment and soil values in ppb dry weight, except as noted)		WATER					SEDIMENT: Freshwater Sediment				Marine Sediment					SOIL	
CHEMICAL	CAS No.	Maximum Contaminent Level	Ambient Water Quality Criteria [1]: Freshwater CMC	Freshwater CCC	Marine CMC	Marine CCC	Lowest ARCs H. azteca TEL	Threshold Effects Level (TEL)	Probable Effects Level (PEL)	Upper [2] Effects Threshold (UET)	Threshold Effects Level (TEL)	Effects Range-Low (ERL)	Effects Range-Median (ERM)	Probable Effects Level (PEL)	Apparent [3] Effects Threshold (AET)	Agri- [4] cultural Target	Urban [4] park / Residential Target
CHLORINATED DIOXINS & PCBS																	
TCDD 2,3,7,8-	1746016	0.00003	<0.01*	<0.00001*						0.0088†H					0.0036 N	0.01	1
POLYCHLORINATED BIPHENYLS	1336363	0.5	2	0.014	10	0.03	31.62	34.1	277	26 M	21.55	22.7	180	188.79	130 M	500	5000
SEMIVOLATILES																	
BENZIDINE	92875		2500*														
BENZOIC ACID	65850														65 O		
BENZYL ALCOHOL	100516														52 B		
CHLOROANILINE 4-	106478		250*C	50*C	160*C	129*C											
DIBENZOFURAN	132649									5100 H					110 E		
DIPHENYLHYDRAZINE 1,2-	122667		270*														
ISOPHORONE	78591		117000*		12900*												
SEMIVOLATILE, NITROAROMATICS																	
DINITROTOLUENE 2,4-	121142		330*	230*	590* S	370*S											
NITROBENZENE	98953		27000*		6680*										21 N		
N-NITROSODIPHENYLAMINE	86306		5850C*		3300000*C										28 I		
SEMIVOLATILE, ORGANOCHLORINES																	
ALDRIN	309002		1.5 ❷		0.65 ❷					40 I					9.5 AE		
CHLORDANE	57749	2	1.2 ❷	0.00215 ❷	0.045 ❷	0.002 ❷		4.5	8.9	30 I	2.26	0.5	6	4.79	2.8 A		
CHLORONAPHTHALENE 2-	91587		1600* C		7.5* C												
p,p-DDD (TDE)	72548		0.6*		3.6*			3.54	8.51	60 I	1.22	2	20	7.81	16 I		
p,p-DDE	72559		1050*		14*			1.42	6.75	50 I	2.07	2.2	27	374.17	9 I		
p,p-DDT	50293		0.55 ❷	0.0005 ❷	0.065 ❷	0.0005 ❷				< 50 I	1.19	1	7	4.77	12 E		
DDT, total								6.98	4450	50 I	3.89	1.58	46.1	51.7	11 B		
DIELDRIN ‡	60571		0.24	0.056	0.355 ❷	0.00095 ❷		2.85	6.67	300 I	0.715	0.02	8	4.3	1.9 E		
ENDOSULFAN (α + β)	115297		0.11 ❷	0.028 ❷	0.017 ❷	0.00435 ❷											
ENDRIN ‡	72208	2	0.086	0.036	0.0185 ❷	0.00115 ❷		2.67	62.4	500 I							
HEPTACHLOR	76448	0.4	0.26 ❷	0.0019 ❷	0.0265 ❷	0.0018 ❷				10 I					0.3 B		
HEPTACHLOR EPOXIDE	1024573	0.2	0.26 ❷	0.0019 ❷	0.0265 ❷	0.0018 ❷		0.6	2.74	30 I							
HEXACHLOROBENZENE	118741	1	6 p	3.68 p	160*C	129*C				100 I					6 B	50	2000
HEXACHLOROBUTADIENE	87683		90*	9.3*	32*										1.3 E		
HEXACHLOROCYCLOHEXANE (BHC)	608731		100*		0.34*					100 I						50	2000

‡ — EPA Proposed Criteria, based on Equilibrium Partitioning, for Dieldrin are 11,000 and 20,000, and for Endrin are 4,200 and 760 µg/kg O.C. in freshwater and marine sediment, respectively.

1 p - proposed; * - Lowest Observable Effect Level; C - value for chemical class; S - value for summation of isomers; ❷ - CMC has been halved to be comparable to criteria derived by 1985 Guidelines.
2 Entry is lowest, reliable value among AET tests, on 1% TOC basis: I - Infaunal community impacts; M - Microtox bioassay; H - *Hyalella azteca* bioassay: † - value on dry weight basis.
3 Entry is lowest value among AET tests: I - Infaunal community impacts; A-Amphipod; B-Bivalve; M-Microtox; O-Oyster larvae; E-Echinoderm larvae; L-Larval$_{max}$; or , N-*Neanthes* bioassays.
4 Residues greater than target require remediation to levels below target for applicable land use in British Columbia: 'A' denotes a soil value intended to protect adjacent, aquatic habitat.

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Exhibit A-2 (concluded)

CHEMICAL (all sediment and soil values in ppb dry weight, except as noted)	CAS No.	WATER: Maximum Contam-inent Level	WATER: Ambient Water Quality Criteria [1] Freshwater CMC	Freshwater CCC	Marine CMC	Marine CCC	SEDIMENT – Freshwater Sediment: Lowest ARCs H. azteca TEL	Threshold Effects Level (TEL)	Probable Effects Level (PEL)	Upper [2] Effects Threshold (UET)	SEDIMENT – Marine Sediment: Threshold Effects Level (TEL)	Effects Range-Low (ERL)	Effects Range-Median (ERM)	Probable Effects Level (PEL)	Apparent [3] Effects Threshold (AET)	SOIL: Agri- [4] cultural Target	Urban [4] park / Residential Target
SEMIVOLATILE, PAHs																	
ACENAPHTHENE	83329		1700*	520*	970*	710*				290 M	6.71	16	500	88.9	130 E		
ACENAPHTHYLENE	208968				300*C					160 M	5.87	44	640	127.87	71 E		
ANTHRACENE	120127				300*C		10			260 M	46.85	85.3	1100	245	280 E		
BENZO[K]FLUORANTHENE	207089				300*C		27.2			13,400B					1800 EI	100	1000
BENZO[A]PYRENE	50328	0.2			300*C		32.4	31.9	782	700 I	88.81	430	1600	763.22	1100 E	100	1000
BENZO[B]FLUORANTHENE	205992				300*C										1800 EI	100	1000
BENZO[GHI]PERYLENE	191242				300*C					300 M					670 M		
BENZ[A]ANTHRACENE	56553				300*C		15.72	31.7	385	500 I	74.83	261	1600	692.53	960 E	100	1000
CHRYSENE	218019				300*C		26.83	57.1	862	800 I	107.77	384	2800	845.98	950 E		
DIBENZ[A,H]ANTHRACENE	53703				300*C		10			100 M	6.22	63.4	260	134.61	230 OM	100	1000
FLUORANTHENE	206440		3980*		40*	16 *	31.46	111	2355	1,500 M	112.82	600	5100	1493.54	1300 E		
FLUORENE	86737				300*C		10			300 M	21.17	19	540	144.35	120 E		
INDENO[1,2,3-CD]PYRENE	193395				300*C		17.32			330 M					600 M	100	1000
METHYLNAPHTHALENE, 2-	91576				300*C						20.21	70	670	201.28	64 E		
NAPHTHALENE	91203		2300*	620*	2350*		14.65			600 I	34.57	160	2100	390.64	230 E	100	5000
PHENANTHRENE	85018		30 p	6.3 p	7.7 p	4.6 p	18.73	41.9	515	800 I	86.68	240	1500	543.53	660 E	100	5000
PYRENE	129000				300*C		44.27	53	875	1,000 I	152.66	665	2600	1397.6	2400 E	100	10000
LMW PAHs					300*C		76.42			5,300 M	311.7	552	3160	1442.00	1200 E		
HMW PAHs					300*C		192.95			6,500 M	655.34	1700	9600	6676.14	7900 E		
Total PAHs					300*C		264.05			12,000M	1684.06	4022	44792	16770.4			
VOLATILE, AROMATIC & HALOGENATED																	
BENZENE	71432	5	5300*		5100*	700*										8 A	8 A
BIS[2-CHLOROETHOXY]METHANE	111911		11000*C		12000*C	6400*C											
CARBON TETRACHLORIDE	56235	5	35200*		50000*											100	5000
CHLOROBENZENE	108907	100	250*C	50*C	160*C	129*C										100	1000
CHLORODIBROMOMETHANE	124481	100C	11000*C		12000*C	6400*C											
CHLOROFORM	67663	5	28900*	1240*												100	5000
DIBROMOMETHANE	74953	0.05	11000*C		12000*C	6400*C											
DICHLOROBENZENE 1,2-	95501	600	1120*S	763*S	1970*S	129*C									13 N	100	1000
DICHLOROBENZENE 1,4-	106467	75	1120*S	763*S	1970*S	129*C									110 I M	100	1000
DICHLOROBROMOMETHANE	75274	100C	11000*C		12000*C	6400*C											
DICHLORODIFLUOROMETHANE	75718		11000*C		12000*C	6400*C											

1 p - proposed; * - Lowest Observable Effect Level; C - value for chemical class; S - value for summation of isomers; ❷ - CMC has been halved to be comparable to criteria derived by 1985 Guidelines.
2 Entry is lowest, reliable value among AET tests, on 1% TOC basis: I - Infaunal community impacts; M - Microtox bioassay; H - *Hyalella azteca* bioassay; † - value on dry weight basis.
3 Entry is lowest value among AET tests: I - Infaunal community impacts; A-Amphipod; B-Bivalve; M-Microtox; O-Oyster larvae; E-Echinoderm larvae; L-Larval $_{max}$; or, N-*Neanthes* bioassays.
4 Residues greater than target require remediation to levels below target for applicable land use in British Columbia: 'A' denotes a soil value intended to protect adjacent, aquatic habitat.

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Source: NOAA (1999). *http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.pdf*

Exhibit A-3. Sediment quality guidelines that reflect threshold effect concentrations (TECs)

Substance	*Threshold Effect Concentrations*						
	TEL	LEL	MET	ERL	TEL-HA28	SQAL	Consensus-Based TEC
Metals (in mg/kg DW)							
Arsenic	5.9	6	7	33	11	NG	9.79
Cadmium	0.596	0.6	0.9	5	0.58	NG	0.99
Chromium	37.3	26	55	80	36	NG	43.4
Copper	35.7	16	28	70	28	NG	31.6
Lead	35	31	42	35	37	NG	35.8
Mercury	0.174	0.2	0.2	0.15	NG	NG	0.18
Nickel	18	16	35	30	20	NG	22.7
Zinc	123	120	150	120	98	NG	121
Polycyclic Aromatic Hydrocarbons (PAHs; in µg/kg DW)							
Anthracene	NG	220	NG	85	10	NG	57.2
Fluorene	NG	190	NG	35	10	540	77.4
Naphthalene	NG	NG	400	340	15	470	176
Phenanthrene	41.9	560	400	225	19	1800	204
Benz[a]anthracene	31.7	320	400	230	16	NG	108
Benzo(a)pyrene	31.9	370	500	400	32	NG	150
Chrysene	57.1	340	600	400	27	NG	166
Dibenz[a,h]anthracene	NG	60	NG	60	10	NG	33.0
Fluoranthene	111	750	600	600	31	6200	423
Pyrene	53	490	700	350	44	NG	195
Total PAHs	NG	4000	NG	4000	260	NG	1610

Substance	*Threshold Effect Concentrations*						
	TEL	LEL	MET	ERL	TEL-HA28	SQAL	Consensus-Based TEC
Polychlorinated Biphenyls (PCBs; in µg/kg DW)							
Total PCBs	34.1	70	200	50	32	NG	59.8
Organochlorine Pesticides (in µg/kg DW)							
Chlordane	4.5	7	7	0.5	NG	NG	3.24
Dieldrin	2.85	2	2	0.02	NG	110	1.90
Sum DDD	3.54	8	10	2	NG	NG	4.88
Sum DDE	1.42	5	7	2	NG	NG	3.16
Sum DDT	NG	8	9	1	NG	NG	4.16
Total DDTs	7	7	NG	3	NG	NG	5.28
Endrin	2.67	3	8	0.02	NG	42	2.22
Heptachlor epoxide	0.6	5	5	NG	NG	NG	2.47
Lindane (gamma-BHC)	0.94	3	3	NG	NG	3.7	2.37

TEC = Threshold effect concentration (from MacDonald *et al.* 2000a).
TEL = Threshold effect level; dry weight (Smith *et al.* 1996).
LEL = Lowest effect level, dry weight (Persaud *et al.* 1993).
MET = Minimal effect threshold; dry weight (EC & MENVIQ 1992).
ERL = Effects range low; dry weight (Long and Morgan 1991).
TEL-HA28 = Threshold effect level for *Hyalella azteca*; 28 day test; dry weight (USEPA 1996).
SQAL = Sediment quality advisory levels; dry weight at 1% OC (USEPA 1997).
NG = No guideline; DW = dry weight.

Note: It is unlikely that concentrations below the TECs will produce harmful effects.
Source: Table 1, MacDonald and Ingersoll (2002c).

Exhibit A-4. Sediment quality guidelines that reflect probable effect concentrations (PECs).

Substance	Probable Effect Concentrations					
	PEL	SEL	TET	ERM	PEL-HA28	Consensus-Based PEC
Metals (in mg/kg DW)						
Arsenic	17	33	17	85	48	33.0
Cadmium	3.53	10	3	9	3.2	4.98
Chromium	90	110	100	145	120	111
Copper	197	110	86	390	100	149
Lead	91.3	250	170	110	82	128
Mercury	0.486	2	1	1.3	NG	1.06
Nickel	36	75	61	50	33	48.6
Zinc	315	820	540	270	540	459
Polycyclic Aromatic Hydrocarbons (PAHs; in µg/kg DW)						
Anthracene	NG	3700	NG	960	170	845
Fluorene	NG	1600	NG	640	150	536
Naphthalene	NG	NG	600	2100	140	561
Phenanthrene	515	9500	800	1380	410	1170
Benz[a]anthracene	385	14800	500	1600	280	1050
Benzo(a)pyrene	782	14400	700	2500	320	1450
Chrysene	862	4600	800	2800	410	1290
Fluoranthene	2355	10200	2000	3600	320	2230
Pyrene	875	8500	1000	2200	490	1520
Total PAHs	NG	100000	NG	35000	3400	22800
Polychlorinated Biphenyls (PCBs; in µg/kg DW)						
Total PCBs	277	5300	1000	400	240	676

Substance	Probable Effect Concentrations					
	PEL	SEL	TET	ERM	PEL-HA28	Consensus-Based PEC
Organochlorine Pesticides (in µg/kg DW)						
Chlordane	8.9	60	30	6	NG	17.6
Dieldrin	6.67	910	300	8	NG	61.8
Sum DDD	8.51	60	60	20	NG	28.0
Sum DDE	6.75	190	50	15	NG	31.3
Sum DDT	NG	710	50	7	NG	62.9
Total DDTs	4450	120	NG	350	NG	572
Endrin	62.4	1300	500	45	NG	207
Heptachlor Epoxide	2.74	50	30	NG	NG	16.0
Lindane (gamma-BHC)	1.38	10	9	NG	NG	4.99

PECs = probable effect concentrations (from MacDonald *et al.* 2000a)
PEL = Probable effect level; dry weight (Smith *et al.* 1996).
SEL = Severe effect level, dry weight (Persaud *et al.* 1993).
TET = Toxic effect threshold; dry weight (EC & MENVIQ 1992).
ERM = Effects range median; dry weight (Long and Morgan 1991).
PEL-HA28 = Probable effect level for *Hyalella azteca*; 28-day test; dry weight (USEPA 1996a).
NG = No guideline; DW = dry weight.

Note: It is likely that concentrations above the PECs will produce harmful effects.
Source: Table 2, MacDonald and Ingersoll (2002c).

Exhibit A-5. Soil screening guidance.
(Regulatory and human health benchmarks used for SSL development.)

		Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
CAS Number	Chemical Name	MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
83-32-9	Acenaphthene					2E+00	RfD							6.0E-02	1		
67-64-1	Acetone (2-Propanone)					4E+00	RfD	D			D			1.0E-01	1		
309-00-2	Aldrin					5E-06	SF_o	B2	1.7E+01	1	B2	4.9E-03	1	3.0E-05	1		
120-12-7	Anthracene					1E+01	RfD	D			D			3.0E-01	1		
7440-36-0	Antimony	6.0E-03	3	6.0E-03	3									4.0E-04	1		
7440-38-2	Arsenic			5.0E-02	3			A	1.5E+00	1	A	4.3E-03	1	3.0E-04	1		
7440-39-3	Barium	2.0E+00	3	2.0E+00	3									7.0E-02	1	5.0E-04	2
56-55-3	Benz(*a*)anthracene					1E-04	SF_o	B2	7.3E-01	4	B2						
71-43-2	Benzene			5.0E-03	3			A	2.9E-02	1	A	8.3E-06	1				
205-99-2	Benzo(*b*)fluoranthene					1E-04	SF_o	B2	7.3E-01	4	B2						
207-08-9	Benzo(*k*)fluoranthene					1E-03	SF_o	B2	7.3E-02	4	B2						
65-85-0	Benzoic acid					1E+02	RfD							4.0E+00	1		
50-32-8	Benzo(*a*)pyrene			2.0E-04	3			B2	7.3E+00	1	B2						
7440-41-7	Beryllium	4.0E-03	3	4.0E-03	3			B2	4.3E+00	1	B2	2.4E-03	1	5.0E-03	1		
111-44-4	Bis(2-chloroethyl)ether					8E-05	SF_o	B2	1.1E+00	1	B2	3.3E-04	1				
117-81-7	Bis(2-ethylhexyl)phthalate			6.0E-03	3			B2	1.4E-02	1	B2			2.0E-02	1		
75-27-4	Bromodichloromethane			1.0E-01 *	3			B2	6.2E-02	1	B2			2.0E-02	1		
75-25-2	Bromoform (tribromomethane)			1.0E-01 *	3			B2	7.9E-03	1	B2	1.1E-06	1	2.0E-02	1		
71-36-3	Butanol					4E+00	RfD	D			D			1.0E-01	1		
85-68-7	Butyl benzyl phthalate					7E+00	RfD	C			C			2.0E-01	1		
7440-43-9	Cadmium	5.0E-03	3	5.0E-03	3						B1	1.8E-03	1	1.0E-03**	1		
86-74-8	Carbazole					4E-03	SF_o	B2	2.0E-02	2							
75-15-0	Carbon disulfide					4E+00	RfD							1.0E-01	1	7.0E-01	1
56-23-5	Carbon tetrachloride			5.0E-03	3			B2	1.3E-01	1	B2	1.5E-05	1	7.0E-04	1		
57-74-9	Chlordane			2.0E-03	3			B2	1.3E+00	1	B2	3.7E-04	1	6.0E-05	1		
106-47-8	*p* -Chloroaniline					1E-01	RfD							4.0E-03	1		
108-90-7	Chlorobenzene	1.0E-01	3	1.0E-01	3			D			D			2.0E-02	1	2.0E-02	2
124-48-1	Chlorodibromomethane	6.0E-02	3	1.0E-01 *	3			C	8.4E-02	1	C			2.0E-02	1		
67-66-3	Chloroform			1.0E-01 *	3			B2	6.1E-03	1	B2	2.3E-05	1	1.0E-02	1		
95-57-8	2-Chlorophenol					2E-01	RfD							5.0E-03	1		

* Proposed MCL = 0.08 mg/L, *Drinking Water Regulations and Health Advisories* , U.S. EPA (1995).

** Cadmium RfD is based on dietary exposure.

Exhibit A-5. (continued)

		Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
CAS Number	Chemical Name	MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
7440-47-3	Chromium	1.0E-01	3	1.0E-01	3			A			A	1.2E-02	1	5.0E-03	1		
16065-83-1	Chromium (III)					4E+01	RfD							1.0E+00	1		
18540-29-9	Chromium (VI)			1.0E-01	3 *			A			A	1.2E-02	1	5.0E-03	1		
218-01-9	Chrysene					1E-02	SF_o	B2	7.3E-03	4							
57-12-5	Cyanide (amenable)	(2.0E-01)	3	(2.0E-01)	3			D			D			2.0E-02	1		
72-54-8	DDD					4E-04	SF_o	B2	2.4E-01	1	B2						
72-55-9	DDE					3E-04	SF_o	B2	3.4E-01	1	B2						
50-29-3	DDT					3E-04	SF_o	B2	3.4E-01	1	B2	9.7E-05	1	5.0E-04	1		
53-70-3	Dibenz(*a,h*)anthracene					1E-05	SF_o	B2	7.3E+00	4	B2						
84-74-2	Di-*n* -butyl phthalate					4E+00	RfD	D			D			1.0E-01	1		
95-50-1	1,2-Dichlorobenzene	6.0E-01	3	6.0E-01	3			D			D			9.0E-02	1	2.0E-01	2
106-46-7	1,4-Dichlorobenzene	7.5E-02	3	7.5E-02	3			B2	2.4E-02	2	B2					8.0E-01	1
91-94-1	3,3-Dichlorobenzidine					2E-04	SF_o	B2	4.5E-01	1	B2						
75-34-3	1,1-Dichloroethane					4E+00	RfD	C			C			1.0E-01	7	5.0E-01	2
107-06-2	1,2-Dichloroethane			5.0E-03	3			B2	9.1E-02	1	B2	2.6E-05	1				
75-35-4	1,1-Dichloroethylene	7.0E-03	3	7.0E-03	3			C	6.0E-01	1	C	5.0E-05	1	9.0E-03	1		
156-59-2	*cis* -1,2-Dichloroethylene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	2		
156-60-5	*trans* -1,2-Dichloroethylene	1.0E-01	3	1.0E-01	3									2.0E-02	1		
120-83-2	2,4-Dichlorophenol					1E-01	RfD							3.0E-03	1		
78-87-5	1,2-Dichloropropane			5.0E-03	3			B2	6.8E-02	2	B2					4.0E-03	1
542-75-6	1,3-Dichloropropene					5E-04	SF_o	B2	1.8E-01	2	B2	3.7E-05	2	3.0E-04	1	2.0E-02	1
60-57-1	Dieldrin					5E-06	SF_o	B2	1.6E+01	1	B2	4.6E-03	1	5.0E-05	1		
84-66-2	Diethylphthalate					3E+01	RfD	D			D			8.0E-01	1		
105-67-9	2,4-Dimethylphenol					7E-01	RfD							2.0E-02	1		
51-28-5	2,4-Dinitrophenol					4E-02	RfD							2.0E-03	1		
121-14-2	2,4-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				2.0E-03	1		
606-20-2	2,6-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				1.0E-03	2		
117-84-0	Di-*n* -octyl phthalate					7E-01	RfD							2.0E-02	2		
115-29-7	Endosulfan					2E-01	RfD							6.0E-03	2		
72-20-8	Endrin	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	1		

* MCL for total chromium is based on Cr (VI) toxicity.

** Cancer Slope Factor is for 2,4-, 2,6-Dinitrotoluene mixture.

Exhibit A-5. (continued)

		Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor (mg/kg-d)$^{-1}$			Unit Risk Factor (µg/m^3)$^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
CAS Number	Chemical Name	MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
100-41-4	Ethylbenzene	7.0E-01	3	7.0E-01	3			D			D			1.0E-01	1	1.0E+00	1
206-44-0	Fluoranthene					1E+00	RfD	D			D			4.0E-02	1		
86-73-7	Fluorene					1E+00	RfD	D						4.0E-02	1		
76-44-8	Heptachlor			4.0E-04	3			B2	4.5E+00	1	B2	1.3E-03	1	5.0E-04	1		
1024-57-3	Heptachlor epoxide			2.0E-04	3			B2	9.1E+00	1	B2	2.6E-03	1	1.3E-05	1		
118-74-1	Hexachlorobenzene			1.0E-03	3			B2	1.6E+00	1	B2	4.6E-04	1	8.0E-04	1		
87-68-3	Hexachloro-1,3-butadiene	1.0E-03	3			1E-03	SF_o	C	7.8E-02	1	C	2.2E-05	1	2.0E-04	2		
319-84-6	α-HCH (α-BHC)					1E-05	SF_o	B2	6.3E+00	1	B2	1.8E-03	1				
319-85-7	β-HCH (β-BHC)					5E-05	SF_o	C	1.8E+00	1	C	5.3E-04	1				
58-89-9	γ-HCH (Lindane)	2.0E-04	3	2.0E-04	3			B2	1.3E+00	2	C			3.0E-04	1		
77-47-4	Hexachlorocyclopentadiene	5.0E-02	3	5.0E-02	3			D			D			7.0E-03	1	7.0E-05	2
67-72-1	Hexachloroethane					6E-03	SF_o	C	1.4E-02	1	C	4.0E-06	1	1.0E-03	1		
193-39-5	Indeno(1,2,3-*cd*)pyrene					1E-04	SF_o	B2	7.3E-01	4	B2						
78-59-1	Isophorone					9E-02	SF_o	C	9.5E-04	1	C			2.0E-01	1		
7439-97-6	Mercury	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	2	3.0E-04	2
72-43-5	Methoxychlor	4.0E-02	3	4.0E-02	3			D			D			5.0E-03	1		
74-83-9	Methyl bromide					5E-02	RfD	D			D			1.4E-03	1	5.0E-03	1
75-09-2	Methylene chloride			5.0E-03	3			B2	7.5E-03	1	B2	4.7E-07	1	6.0E-02	1	3.0E+00	2
95-48-7	2-Methylphenol (*o* -cresol)					2E+00	RfD	C			C			5.0E-02	1		
91-20-3	Naphthalene					1E+00	RfD	D			D			4.0E-02	6		
7440-02-0	Nickel					1E-01	HA *	A			A	2.4E-04	1	2.0E-02	1		
98-95-3	Nitrobenzene					2E-02	RfD	D			D			5.0E-04	1	2.0E-03	2
86-30-6	*N* -Nitrosodiphenylamine					2E-02	SF_o	B2	4.9E-03	1	B2						
621-64-7	*N* -Nitrosodi-*n* -propylamine					1E-05	SF_o	B2	7.0E+00	1	B2						
87-86-5	Pentachlorophenol			1.0E-03	3			B2	1.2E-01	1	B2			3.0E-02	1		
108-95-2	Phenol					2E+01	RfD	D			D			6.0E-01	1		
129-00-0	Pyrene					1E+00	RfD	D			D			3.0E-02	1		
7782-49-2	Selenium	5.0E-02	3	5.0E-02	3			D			D			5.0E-03	1		
7440-22-4	Silver					2E-01	RfD	D			D			5.0E-03	1		
100-42-5	Styrene	1.0E-01	3	1.0E-01	3									2.0E-01	1	1.0E+00	1
79-34-5	1,1,2,2-Tetrachloroethane					4E-04	SF_o	C	2.0E-01	1	C	5.8E-05	1				

* Health advisory for nickel (MCL is currently remanded); EPA Office of Science and Technology, 7/10/95.

Exhibit A-5. (concluded)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L): MCLG (PMCLG)	Ref. [a]	Maximum Contaminant Level (mg/L): MCL (PMCL)	Ref. [a]	Water Health Based Limits (mg/L): HBL [b]	Basis	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$: Carc. Class [c]	SF_o	Ref. [a]	Unit Risk Factor $(\mu g/m^3)^{-1}$: Carc. Class [c]	URF	Ref. [a]	Reference Dose (mg/kg-d): RfD	Ref. [a]	Reference Concentration (mg/m^3): RfC	Ref. [a]
127-18-4	Tetrachloroethylene			5.0E-03	3				5.2E-02	5		5.8E-07	5	1.0E-02	1		
7440-28-0	Thallium	5.0E-04	3	2.0E-03	3												
108-88-3	Toluene	1.0E+00	3	1.0E+00	3			D			D			2.0E-01	1	4.0E-01	1
8001-35-2	Toxaphene			3.0E-03	3			B2	1.1E+00	1	B2	3.2E-04	1				
120-82-1	1,2,4-Trichlorobenzene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	1	2.0E-01	2
71-55-6	1,1,1-Trichloroethane	2.0E-01	3	2.0E-01	3			D			D					1.0E+00	5
79-00-5	1,1,2-Trichloroethane	3.0E-03	3	5.0E-03	3			C	5.7E-02	1	C	1.6E-05	1	4.0E-03	1		
79-01-6	Trichloroethylene	zero	3	5.0E-03	3				1.1E-02	5		1.7E-06	5				
95-95-4	2,4,5-Trichlorophenol					4E+00	RfD							1.0E-01	1		
88-06-2	2,4,6-Trichlorophenol					8E-03	SF_o	B2	1.1E-02	1	B2	3.1E-06	1				
7440-62-2	Vanadium					3E-01	RfD							7.0E-03	2		
108-05-4	Vinyl acetate					4E+01	RfD							1.0E+00	1	2.0E-01	1
75-01-4	Vinyl chloride (chloroethene)			2.0E-03	3			A	1.9E+00	2	A	8.4E-05	2				
108-38-3	*m* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
95-47-6	*o* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
106-42-3	*p* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	1 **		
7440-66-6	Zinc					1E+01	RfD	D			D			3.0E-01	1		

* MCL for total xylenes [1330-20-7] is 10 mg/L.

** RfD for total xylenes is 2 mg/kg-day.

[a] References:
1 = IRIS, U.S. EPA (1995)
2 = HEAST, U.S. EPA (1995)
3 = U.S. EPA (1995)
4 = OHEA, U.S. EPA (1993)
5 = Interim toxicity criteria provided by Superfund Health Risk Techincal Support Center, Environmental Criteria Assessment Office (ECAO), Cincinnati, OH (1994)
6 = ECAO, U.S. EPA (1994i)
7 = ECAO, U.S. EPA (1994h)

[b] Health Based Limits calculated for 30-year exposure duration, 10^{-6} risk or hazard quotient = 1.

[c] Categorization of overall weight of evidence for human carcinogenicity:
Group A: human carcinogen
Group B: probable human carcinogen
B1: limited evidence from epidemiologic studies
B2: "sufficient" evidence from animal studies and "inadequate" evidence or "no data" from epidemiologic studies
Group C: possible human carcinogen
Group D: not classifiable as to health carcinogenicity
Group E: evidence of noncarcinogenicity for humans

Source: Attachment D, USEPA (1996).

Exhibit A-6. Sewage sludge ceiling concentrations.

Pollutant	Ceiling concentration (milligrams per kilogram) [1]
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7500

[1] Dry weight basis.

Source: Table 1 of §503.13 (40 CFR 503).

Exhibit A-7. Daily cover at MSW landfill.

Contaminant	IL[a]	IN[b]	MI[c]	MN[d]	NY[e]	OH[f]	PA[g]	WI[h]
Arsenic	*0.05**	*20*	5.8	*25*	41	*12*	--	--
Lead	*0.0075**	*230*	3,333	*700*	4	*600*	--	--
Zinc	*7,500*	*10000*	466667	*70000*	n/a	*360*	--	--
PCBs	*1*	*5.3*	16	*8*	n/a	*33*	50	50
Benzo(a)pyrene	*0.8*	*1.5*	n/a	*4*	n/a	*0.7*	--	--
Benzene	*0.03*	*0.67*	0.102	*4*	n/a	*5*	--	--
Criteria Source	Cleanup – Industrial	Cleanup – Industrial	Use-specific regulations	Cleanup – Industrial	Reuse – Specific	Soil Quality – Industrial	Non-TSCA	Non-TSCA

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 industrial tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for an industrial soil.[74]

c: Michigan criteria are based on sample values from Operational Memo 115-10.[184]

d: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]

e: New York criteria are based on the Suggested Metal Limits for General Reuse Options.[97]

f: Ohio values are adapted from the Canadian Environmental Quality Guidelines for soil at an industrial location.[246]

g: Pennsylvania requires that dredged material be dewatered enough to pass the paint filter test. It must also be shown to not fail the TCLP (cannot be a hazardous waste) nor be a TSCA waste. The state would prefer nondetect for regulated organics like VOCs, PCBs, dioxin/furan, or PAHs.

h: For Wisconsin, the material cannot be a hazardous waste as defined in NR 600.03(98). Additionally, it must pass the paint filter test and TCLP tests and be less than 15 percent silt and clay (P200). The requirement of 50 ppm PCBs is based on the definition of TSCA wastes, which are prohibited. The WDNR can set criteria on a case-by-case basis and would prefer non-detect levels for regulated organics like VOCs, PCBs, dioxin/furan, or PAHs.

Exhibit A-8. Beach nourishment.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH	PA	WI[e]
Arsenic	0.05*	3.9	Must be >95% sand	12	7.5			Grain size and color requirements
Lead	0.0075*	81		400	Background			
Zinc	7,500	10,000		1,242**	20			
PCBs	1	1.8		1.2**	1			
Benzo(a)pyrene	0.09	0.5		1.0**	0.061			
Benzene	0.03	0.034		0.034**	0.06			
Criteria Source	Cleanup - Residential	Cleanup - Residential	Use-specific regulation	Cleanup - Recreational	Cleanup - General			Use-specific regulation

All units are in milligrams per kilogram (mg/kg) of material except * in milligrams per liter (mg/L) of leachate.

a. Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b. Indiana values are based on the RISC tables for a residential soil.[74]

c. Minnesota criteria are based on SRV Tier 2 chronic recreational standards,[96] except for **, which are from SLV Tier 1 standards (Minnesota Pollution Control Agency 1996).[194]

d. New York criteria are based on Department of Environmental Remediation Technical and Administrative Guidance Memorandum 4046: Determination of Soil Cleanup Objectives and Cleanup Levels.[98]

e. The Wisconsin code lists only two explicit criteria, grain size and color. Risk to beach users is addressed qualitatively by limits placed on the source of beach nourishment material. Grain size is limited by requiring the P200 fraction to be no more than 15% of the average fines content (silt and clay, or P200 fraction) of the native beach material. Color is required to be a close match to existing beach soil color.

Exhibit A-9. Compost or topsoil, unrestricted use.

Contaminant	IL[a]	IN[b]	MI[c]	MN[d]	NY[e]	OH[f]	PA	WI[g]
Arsenic	*0.05**	*3.9*	7.6	*10*	7.5	*41*		*0.042*
Lead	*0.0075**	*81*	400	*400*	Background	*300*		*50*
Zinc	*7,500*	*10000*	65	*1,242***	Background	*2,800*		*4,700*
PCBs	*1*	*1.8*	1.2	*1.2*	*1.0*	--		--
Benzo(a)pyrene	*0.09*	*0.5*	2	*1.0***	*0.061*	--		*0.0088*
Benzene	*0.03*	*0.034*	0.1	*0.034***	*0.06*	--		--
Criteria Source	Cleanup – Residential	Cleanup – Residential	Use-specific regulation	Cleanup – Residential	Specific reuse and general cleanup	Sludge rules		Reuse – General

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for a residential soil.[74]

c: Michigan compost criteria are based on draft rules[183] for Part 115.[13]

d: Minnesota criteria are based on SRV Tier 2 chronic residential standards,[96] except for **, which are from SLV Tier 1 standards[194].

e: New York criteria are based on DER TAGM.[98] Background can be a site or regional background, as appropriate. Compost values in 6 NYCRR Part 360-5[16] may apply if the dredged material is used as a limited component.

f: Ohio values are based on monthly average limits contained in Ohio's sewage sludge rules[22]. There are additional limits for a single application and a total lifetime loading limit.

g: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as Category 1, allowing its application in nearly all beneficial uses.

Exhibit A-10. Compost or topsoil, bagged use.

Contaminant	IL[a]	IN[b]	MI[c]	MN[d]	NY[e]	OH[f]	PA	WI[g]
Arsenic	*0.05**	*3.9*	7.6	*10*	7.5	*41*		*0.042*
Lead	*0.0075**	*81*	400	*400*	Background	*300*		*50*
Zinc	*7,500*	*10000*	170000	*1,242***	Background	*2,800*		*4,700*
PCBs	*1*	*1.8*	1.2	*1.2*	*1.0*	--		--
Benzo(a)pyrene	*0.09*	*0.5*	2	*1.0***	*0.061*	--		*0.0088*
Benzene	*0.03*	*0.034*	180	*0.034***	*0.06*	--		--
Criteria Source	Cleanup – residential	Cleanup – residential	Use-specific regulation	Cleanup – recreational	Specific reuse and general cleanup	Sludge rules		General reuse

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for a residential soil.[74]

c: Michigan compost criteria are based on draft rules[183] for Part 115.[13]

d: Minnesota criteria are based on SRV Tier 2 chronic recreational standards,[96] except for **, which are from SLV Tier 1 standards.[194]

e: New York criteria are based on DER TAGM.[98] Background can be a site or regional background, as appropriate. Compost values in 6 NYCRR Part 360-5[16] may apply if the dredged material is used as a limited component.

f: Ohio values are based on monthly average limits contained in Ohio's Sewage Sludge Rules.[22] There are additional limits for a single application and a total lifetime loading limit.

g: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as category 1, allowing its application in nearly all beneficial uses.

Exhibit A-11. Compost or topsoil, restricted use.

Contaminant	IL[a]	IN[b]	MI[c]	MN[d]	NY[e]	OH[f]	PA	WI[g]
Arsenic	*0.05**	*3.9*	7.6	*25*	7.5	*41*		*0.042*
Lead	*0.0075**	*81*	400	*700*	Background	*300*		*50*
Zinc	*7,500*	*10000*	227	*70000*	Background	*2,800*		*4,700*
PCBs	*1*	*1.8*	1.2	*8*	*1.0*	--		--
Benzo(a)pyrene	*0.09*	*0.5*	2	*4*	*0.061*	--		*0.0088*
Benzene	*0.03*	*0.034*	1	*4*	*0.06*	--		--
Criteria Source	Cleanup – residential	Cleanup – residential	Use-specific regulations	Cleanup – industrial	Specific reuse and general cleanup	Sludge rules		General reuse

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for a residential soil.[74]

c: Michigan compost criteria are based on draft rules[183] for Part 115.[13]

d: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]

e: New York criteria are based on DER TAGM.[98] Background can be a site or regional background, as appropriate. Compost values in 6 NYCRR part 360-5[16] may apply if the dredged material is used as a limited component.

f: Ohio values are based on monthly average limits contained in Ohio's Sewage Sludge Rules.[22] There are additional limits for a single application and a total lifetime loading limit.

g: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as category 1, allowing its application in nearly all beneficial uses. Less restrictive criteria may be applicable following evaluation by the WDNR.

Exhibit A-12. Final cover at a MSW landfill.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH[e]	PA	WI[f]
Arsenic	*0.05**	*20*		*25*	Varies	*41*		*21*
Lead	*0.0075**	*230*		*700*		*300*		--
Zinc	*7,500*	*10000*		*70000*		*2,800*		--
PCBs	*1*	*5.3*		*8*		--		--
Benzo(a)pyrene	*0.8*	*1.5*		*4*		--		*4.4*
Benzene	*0.03*	*0.67*		*4*		--		--
Criteria Source	Cleanup – Industrial	Cleanup – Industrial		Cleanup – Industrial		Sludge rules		Reuse – specific

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 industrial tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for an industrial soil.[74]

c: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]

d: Criteria applied to dredged material used under an impermeable barrier, such as a flexible membrane, will be less stringent than material used above the barrier, which may be required to meet criteria similar to unrestricted fill (Scenario 6)

e: Ohio values are based on monthly average limits contained in Ohio's sewage sludge rules.[22] There are additional limits for a single application and a total lifetime loading limit.

f: Wisconsin criteria are based on Table 2B in NR 538 Appendix A, qualifying the material as Category 3 and appropriate for use in many geotechnical applications. If barriers are present, Category 4 material, having less stringent standards may be applicable. Criteria for pollutants that are not represented in the table may be enforced by the WDNR.

Exhibit A-13. Cover to meet residential use.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH[e]	PA	WI[f]
Arsenic	*0.05**	*3.9*		*10*	Use prohibited	*12*		*0.042*
Lead	*0.0075**	*81*		*400*		*140*		*50*
Zinc	*7,500*	*10000*		*1,242***		*200*		*4,700*
PCBs	*1*	*1.8*		*1.2*		*1.3*		--
Benzo(a)pyrene	*0.09*	*0.5*		*1.0***		*0.7*		*0.0088*
Benzene	*0.03*	*0.034*		*0.034***		*0.5*		--
Criteria Source	Cleanup – residential	Cleanup – residential		Cleanup – residential and general	Use-specific regulation	Soil quality – residential		Reuse – general

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for a residential soil.[74]

c: Minnesota criteria are based on SRV Tier 2 chronic residential standards,[96] except for **, which are from SLV Tier 1 standards.[194]

d: This use is explicitly precluded in Suggested Metals Limits for General Reuse Options[97] for contaminated soils.

e: Ohio values are adapted from the Canadian Environmental Quality Guidelines for soil at a residential location[246].

f: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as category 1, allowing its application in nearly all beneficial uses.

Exhibit A-14. Cover to meet industrial use.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH[e]	PA	WI[f]
Arsenic	*0.05**	*20*		*25*	14.5	*41*		*0.042*
Lead	*0.0075**	*230*		*700*	150	*300*		*50*
Zinc	*7,500*	*10000*		*70000*	2,480	*2,800*		*4,700*
PCBs	*1*	*5.3*		*8*	10	--		--
Benzo(a)pyrene	*0.8*	*1.5*		*4*	0.061	--		*0.0088*
Benzene	*0.03*	*0.67*		*4*	0.06	--		--
Criteria Source	Cleanup – industrial	Cleanup – Industrial		Cleanup – Industrial	Reuse – Specific	Sludge rules		Reuse – general

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 industrial tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for an industrial soil.[74]

c: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]

d: New York metal criteria are based on Suggested Metals Limits for General Reuse Options,[97] category A; surficial use of contaminated material prohibited. Organic criteria based on DER TAGM 4046.[98]

e: Ohio values are based on monthly average limits contained in Ohio's sewage sludge rules.[22] There are additional limits for a single application and a total lifetime loading limit.

f: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as Category 1, allowing its application in nearly all beneficial uses. Less restrictive criteria may be applicable following evaluation by the WDNR.

Exhibit A-15. Cover to meet commercial use.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH[e]	PA	WI[f]
Arsenic	*0.05**	*20*		*25*	14.5	*41*		*0.042*
Lead	*0.0075**	*230*		*700*	150	*300*		*50*
Zinc	*7500*	*10000*		*70000*	2480	*2800*		*4700*
PCBs	*1*	*5.3*		*8*	10	--		--
Benzo(a)pyrene	*0.8*	*1.5*		*4*	0.061	--		*0.0088*
Benzene	*0.03*	*0.67*		*4*	0.06	--		--
Criteria Source	Cleanup – industrial	Cleanup – industrial		Cleanup – industrial	Reuse – specific	Sludge rules		Reuse – general

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 industrial tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for an industrial soil.[74]

c: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]

d: New York metal criteria are based on Suggested Metals Limits for General Reuse Options,[97] category A; surficial use of contaminated material prohibited. Organic criteria based on DER TAGM 4046.[98]

e: Ohio values are based on monthly average limits contained in Ohio's sewage sludge rules.[22] There are additional limits for a single application and a total lifetime loading limit.

f: Wisconsin criteria are based on NR 538, Appendix 1, Table 1B. These criteria qualify the material as category 1, allowing its application in nearly all beneficial uses. Less restrictive criteria may be applicable following evaluation by the WDNR.

Exhibit A-16. Unrestricted fill.

Contaminant	IL[a]	IN[b]	MI[c]	MN[d]	NY[e]	OH[f]	PA[g]	WI
Arsenic	*0.05**	*3.9*	*5.8*	*10*	7.5	*12*	41	
Lead	*0.0075**	*81*	*400*	*400*	Background	*70*	450	
Zinc	*7,500*	*10000*	*65*	*1,242***	Background	*200*	12,000	
PCBs	*1*	*1.8*	*1*	*1.2*	1	*0.5*	Various	
Benzo(a)pyrene	*0.09*	*0.5*	*0.33*	*1.0***	0.061	*0.1*	2.5	
Benzene	*0.03*	*0.034*	*1*	*0.034***	0.06	*0.05*	0.13	
Criteria Source	Cleanup – residential	Cleanup – residential	Cleanup	Cleanup – general	Use-specific regulation	Soil quality	Use-specific regulation	

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.

a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b: Indiana values are based on the RISC tables for a residential soil.[74]

c: Michigan criteria are based on Act 307 Type B Cleanup Criteria for Groundwater and Soil.[182]

d: Minnesota criteria are based on SRV Tier 1 standards,[96] except for **, which are from SLV Tier 1 standards.[194]

e: Preclusion of uses for contaminated dredged material as a fill in residential and several other applications are contained in the Suggested Metal Limits for General Reuse Options,[97] but where appropriate, comparison to DER TAGM 4046[98] criteria may indicate minimal contaminant levels which may pose no adverse impact if material is used in an unrestricted manner (further case-specific review will be necessary).

f: Ohio values are adapted from the Canadian Environmental Quality Guidelines for soil based on the most stringent value.[246]

g: Pennsylvania criteria are for the regulated fill rules[218] for residential use. PCB criteria are given separately for 7 congeners.

Exhibit A-17 Restricted fill.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH[e]	PA[f]	WI[g]
Arsenic	*0.05**	*20*		*25*	Case-by-case determination	*41*	53	21
Lead	*0.0075**	*230*		*700*		*300*	450	--
Zinc	*7,500*	*10000*		*70000*		*2,800*	12,000	--
PCBs	*1*	*5.3*		*8*		--	various	--
Benzo(a)pyrene	*0.8*	*1.5*		*4*		--	11	4.4
Benzene	*0.03*	*0.67*		*4*		--	0.13	--
Criteria Source	Cleanup – industrial	Cleanup – industrial		Cleanup – industrial	Reuse – general	Sludge rules	Use-specific regulation	Reuse – specific

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.
a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 industrial tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.
b: Indiana values are based on the RISC tables for an industrial soil.[74]
c: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]
d: New York criteria will be determined on a case-by-case basis.
e: Ohio values are based on monthly average limits contained in Ohio's sewage sludge rules.[22] There are additional limits for a single application and a total lifetime loading limit.
f: Pennsylvania criteria are for the proposed regulated fill rules[218] for nonresidential use. PCB criteria are given separately for 7 congeners.
g: Wisconsin criteria are based on Table 2B in NR 538 Appendix A, qualifying the material as Category 3 and appropriate for use in many geotechnical and transportation-based applications. If barriers are present, Category 4 material, having less stringent standard may be applicable. Criteria for pollutants that are not represented in the table may be enforced by the WDNR.

Exhibit A-18. Aggregate.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH	PA[e]	WI[f]
Arsenic	*0.05**	*20*		*25*	41		41	--
Lead	*0.0075**	*230*		*700*	4		200	--
Zinc	*7,500*	*10000*		*70000*	--		1,000	--
PCBs	*1*	*5.3*		*8*	--		5	--
Benzo(a)pyrene	*0.8*	*1.5*		*4*	--		0.6	--
Benzene	*0.03*	*0.67*		*4*	--		0.8	--
Criteria Source	Cleanup – industrial	Cleanup – Industrial		Cleanup – Industrial	Reuse – specific		Use-specific regulation	Non-haz. waste

All units are in milligrams per kilogram (mg/Kg) of material except * in milligrams per liter (mg/L) of leachate.
a: Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 industrial tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.
b: Indiana values are based on the RISC tables for an industrial soil.[74]
c: Minnesota criteria are based on SRV Tier 2 chronic industrial standards.[96]
d: New York criteria are based on the *Suggested Metal Limits for General Reuse Options*[97] Category B. Organic limits will be determined on a case-by-case basis.
e: Pennsylvania values are based on General Permit No. WMGR072.
f: For Wisconsin, the material cannot be a hazardous waste as defined in WAC NR 600.03(98).

Exhibits A-7 through A-18 were taken from Tables A.2 through A.13, Beneficial Use Upland Testing and Evaluation Project Management Team (2004a), (*http://www.glc.org/upland/download/UplandFrameworkGLC.pdf*). Beneficial Use Upland Testing and Evaluation Project Management Team (2004b) lists the numerical references used in these exhibits.

Exhibit A-19. Recommended sediment chemistry guidelines for beneficial reuse of dredged material.

ANALYTE	Wetland Surface Material		Wetland Foundation Material	
	Concentration	Decision Basis	Concentration	Decision Basis
METALS (mg/kg)				
Arsenic	15.3	Ambient Values	70	ER-M
Cadmium	0.33	Ambient Values	9.6	ER-M
Chromium	112	Ambient Values	370	ER-M
Copper	68.1	Ambient Values	270	ER-M
Lead	43.2	Ambient Values	218	ER-M
Mercury	0.43	Ambient Values	0.7	ER-M
Nickel	112	Ambient Values	120	ER-M
Selenium	0.64	Ambient Values		
Silver	0.58	Ambient Values	3.7	ER-M
Zinc	158	Ambient Values	410	ER-M
ORGANOCHLORINE PESTICIDES/PCBS (µg/kg)				
DDTS, sum	7.0	Ambient Values	46.1	ER-M
Chlordanes, sum	2.3	TEL	4.8	PEL
Dieldrin	0.72	TEL	4.3	PEL
Hexachlorocyclohexane, sum	0.78	Ambient Values		
Hexachlorobenzene	0.485	Ambient Values		
PCBs, sum	22.7	ER-L	180	ER-M
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)				
PAHs, total	3,390	Ambient Values	44,792	ER-M
Low molecular weight PAHs, sum	434	Ambient Values	3,160	ER-M
High molecular weight PAHs, sum	3,060	Ambient Values	9,600	ER-M
1-Methylnaphthalene	12.1	Ambient Values		
1-Methylphenanthrene	31.7	Ambient Values		
2,3,5-Trimethylnaphthalene	9.8	Ambient Values		
2,6-Dimethylnaphthalene	12.1	Ambient Values		
2-Methylnaphthalene	19.4	Ambient Values	670	ER-M
2-Methylphenanthrene		Ambient Values		
3-Methylphenanthrene		Ambient Values		
Acenaphthene	26.0	Ambient Values	500	ER-M
Acenaphthylene	88.0	Ambient Values	640	ER-M
Anthracene	88.0	Ambient Values	1,100	ER-M
Benz(a)anthracene	412	Ambient Values	1,600	ER-M
Benzo(a)pyrene	371	Ambient Values	1,600	ER-M
Benzo(e)pyrene	294	Ambient Values		
Benzo(b)fluoranthene	371	Ambient Values		
Benzo(g,h,i)perylene	310	Ambient Values		
Benzo(k)fluoranthene	258	Ambient Values		
Biphenyl	12.9	Ambient Values		
Chrysene	289	Ambient Values	2,800	ER-M
Dibenz(a,h)anthracene	32.7	Ambient Values	260	ER-M
Fluoranthene	514	Ambient Values	5,100	ER-M
Fluorene	25.3	Ambient Values	540	ER-M
Indeno(1,2,3-c,d)pyrene	382	Ambient Values		
Naphthalene	55.8	Ambient Values	2,100	ER-M
Perylene	145	Ambient Values		
Phenanthrene	237	Ambient Values	1,500	ER-M
Pyrene	665	Ambient Values	2,600	ER-M

Source: Table 4, San Francisco Bay Regional Water Quality Control Board (2000).

Exhibit A-20. Selected biological effects-based concentrations of analytes in sediments.

ANALYTE	ER-L 1995	ER-M 1995	TEL	PEL
METALS (mg/kg)				
Arsenic	8.2	70	7.24	41.6
Cadmium	1.2	9.60	0.676	4.21
Chromium, total	81	370	52.3	160
Copper	34	270	18.7	108
Lead	46.7	218	30.2	112
Mercury	0.15	0.71	0.13	0.696
Nickel	20.9	51.6	15.9	42.8
Selenium				
Silver	1	3.7	0.733	1.77
Zinc	150	410	124	271
PESTICIDES AND PCBs (µg/kg)				
Aldrin				
Chlordane			2.26	4.79
Chlordanes, total				
Dieldrin			0.715	4.3
Endrin				
Heptachlor				
Hexachlorocyclohexane-delta				
Hexachlorocyclohexane-gamma (Lindane)			0.32	0.99
HCB, total				
Methoxychlor				
Mirex				
Toxaphene				
p,p'-DDD (or DDD ?)			1.22	7.81
p,p'-DDE (or DDE ?)	2.20	27	2.07	374
p,p'-DDT (or DDT ?)			1.19	4.77
DDTS, total of 6 isomers	1.58	46.1	3.89	51.7
PCBs, total	22.7	180	21.6	189
PCBs, total (SFEI 40 list)				

Exhibit A-20. (concluded)

ANALYTE	ER-L 1995	ER-M 1995	TEL	PEL
ACID/BASE NEUTRALS (µg/kg)				
Bis(2-ethylhexyl) phthalate			182	2,647
Dibenzofuran				
Di-n-butyl phthalate				
Hexachlorobenzene (HCB)				
Phthalates, total				
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)				
PAHs, total	4,022	44,792	1,684	16,770
High molecular weight PAHs, total	1,700	9,600	655	6,676
Low molecular weight PAHs, total	552	3,160	312	1,442
1-Methylnaphthalene				
1-Methylphenanthrene				
2,3,5-Trimethylnaphthalene				
2,6-Dimethylnaphthalene				
2-Methylnaphthalene	70	670	20.2	201
2-Methylphenanthrene				
3-Methylphenanthrene				
Acenaphthene	16	500	6.71	88.9
Acenaphthylene	44	640	5.87	128
Anthracene	85.3	1,100	46.90	245
Benz(a)anthracene	261	1,600	74.8	693
Benzo(a)pyrene	430	1,600	88.8	763
Benzo(b)fluoranthene				
Benzo(g,h,i)perylene				
Benzo(k)fluoranthene				
Biphenyl				
Chrysene	384	2,800	107.8	846
Dibenz(a,h)anthracene	63.4	260	6.22	135
Fluoranthene	600	5,100	113	1494
Fluorene	19	540	21.2	144
Indeno(1,2,3-c,d)pyrene				
Naphthalene	160	2,100	34.6	391
Perylene				
Phenanthrene	240	1,500	86.7	543.5
Pyrene	665	2,600	153	1,398

Source: San Francisco Bay Regional Water Quality Control Board (2000).

Exhibit A-21. Florida sediment quality guidelines.

Substance	Total Number of Records	Number of Entries in the EDS	Number of Entries in the NEDS	Sediment Quality Assessment Guidelines TEL	PEL
Metals (SQAGs in mg/kg)					
Arsenic	295	39	256	7.24	41.6
Cadmium	433	107	326	0.676	4.21
Chromium	354	53	301	52.3	160
Copper	440	105	335	18.7	108
Lead	402	95	307	30.2	112
Mercury	331	66	265	0.13	0.696
Nickel	355	23	332	15.9	42.8
Silver	190	35	155	0.733	1.77
Tributyltin	72	6	66	ID	ID
Zinc	411	96	315	124	271
Polychlorinated Biphenyls (PCBs; SQAGs in µg/kg)					
Total PCBs	199	65	134	21.6	189
Polycyclic Aromatic Hydrocarbons (PAHs; SQAGs in µg/kg)					
Acenaphthene	240	62	178	6.71	88.9
Acenaphthylene	209	36	173	5.87	128
Anthracene	259	70	189	46.9	245
Fluorene	263	73	190	21.2	144
2-methylnaphthalene	189	40	149	20.2	201
Naphthalene	256	57	199	34.6	391
Phenanthrene	268	74	194	86.7	544
Sum LMW-PAHs	274	69	205	312	1442
Polycyclic Aromatic Hydrocarbons (PAHs; SQAGs in µg/kg)					
Benz(a)anthracene	249	63	186	74.8	693
Benzo(a)pyrene	259	68	191	88.8	763
Chrysene	258	68	190	108	846
Dibenzo(a,h)anthracene	246	54	192	6.22	135
Fluoranthene	279	85	194	113	1494
Pyrene	263	70	193	153	1398
Sum HMW-PAHs	274	64	210	655	6676
Total PAHs	250	58	192	1684	16770
Pesticides (SQAGs in µg/kg)					
Aldrin	180	15	165	ID	ID
Azinphos-methyl (Guthion)	0	0	0	ID	ID
Chlordane	203	25	178	2.26	4.79
Chlorthalonil	0	0	0	ID	ID
Chlorpyrifos	1	1	0	ID	ID
p,p'-DDD	173	22	151	1.22	7.81
p,p'-DDE	211	37	174	2.07	374
p,p'-DDT	175	26	149	1.19	4.77
Total DDT	89	37	52	3.89	51.7
Dieldrin	181	25	156	0.715	4.3
Disulfoton	0	0	0	ID	ID
Endosulfan	6	4	2	ID	ID
Endrin	146	14	132	ID	ID

Exhibit A-21. (concluded)

Substance	Total Number of Records	Number of Entries in the EDS	Number of Entries in the NEDS	Sediment Quality Assessment Guidelines	
				TEL	PEL
Pesticides (SQAGs in µg/kg)					
Heptachlor	168	14	154	ID	ID
Heptachlor epoxide	137	9	128	ID	ID
Lindane (gamma-BHC)	181	21	160	0.32	0.99
Mirex	120	3	117	ID	ID
Phorate	0	0	0	ID	ID
Quintozene (PCNB)	0	0	0	ID	ID
Toxaphene (alpha-BHC)	133	4	129	ID	ID
Trifluralin	0	0	0	ID	ID
Chlorinated Organic Substances (SQAGs in µg/kg)					
2,3,7,8-Tetrachlorodibenzo-p-dioxin	18	2	16	ID	ID
2,3,7,8-Tetrachlorodibenzofuran	17	1	16	ID	ID
Pentachlorophenol	82	7	75	ID	ID
Phthalates (SQAGs in µg/kg)					
Bis(2-ethylhexyl)phthalate	131	31	100	182	2647
Dimethyl phthalate	86	10	76	ID	ID
Di-n-butyl phthalate	79	7	72	ID	ID

Total Number of Records = Number of data records in the expanded biological effects database for sediments.
All of the sediment quality assessment guidelines are expressed on a dry weight basis, as potential normalizers (e.g., Al, TOC, AVS) were rarely reported.
EDS = Effects data set; NEDS = No effects data set; TEL = Toxic effect level; PEL = Probable effect level.
ID = insufficient data to derive sediment quality assessment guidelines.
SQAG = Sediment quality assessment guidelines

Source: Florida Department of Environmental Protection (1994).
http://www.dep.state.fl.us/waste/quick_topics/publications/documents/sediment/volume1/chapter6.pdf

Exhibit A-22. Indiana risk integrated system residential closure levels.

Table A	Default	Closure	Residential										January 1, 2004		
Constituent	CAS	SOIL									GROUNDWATER				
		Soil Attenuation Capacity	Soil Saturation (Csat)	Construction		Soil Direct		Migration to GW		Default Closure Level	Groundwater Solubility	MCL	Residential		Default Closure Level
		(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)	(mg/l)	(mg/l)	(mg/l)		(mg/l)
Acenaphthene	83-32-9	6000/2000		50,000	NC	9,500	NC	130	NC	130	4.2		0.46	NC	0.46
Acenaphthylene	208-96-8	6000/2000		5,900	NC	1,100	NC	18	NC	18	3.9		0.071	NC	0.071
Acetone (2-Propanone)	67-64-1	6000/2000	200,000	34,000	NC	4,800	NC	3.8	NC	3.8	1,000,000		0.95	NC	0.95
Acrolein [5]	107-02-8	6000/2000	50,000	3.5	NC	0.5	NC	0.00027	NC	0.00027	210,000		0.000055	NC	0.000055
Aldrin	309-00-2	6000/2000		27	NC	0.25	C	4.9	C	0.25	0.18		0.00005	C	0.00005
Anthracene	120-12-7	6000/2000		250,000	NC	47,000	NC	51	NC	51	0.043		2.3	NC	0.043
Antimony and compounds [6]	7440-36-0	10,000		460	NC	140	NC	5.4	NC	5.4		0.006	0.015	NC	0.006
Arsenic [3,6]	7440-38-2	10,000		320	NC	3.9		29	C	3.9		0.05	0.00057	C	0.05
Barium [6]	7440-39-3	10,000		79,000	NC	23,000	NC	1,600	NC	1,600		2	2.6	NC	2
Benzene	71-43-2	6000/2000	590	560	NC	7.8	C	0.034	C	0.034	1,800	0.005	0.0052	C	0.005
Benzo(a)anthracene	56-55-3	6000/2000		790	C	5	C	19	C	5	0.0094		0.0012	C	0.0012
Benzo(a)pyrene	50-32-8	6000/2000		79	C	0.5	C	8.2	C	0.5	0.0016	0.0002	0.00012	C	0.0002
Benzo(b)fluoranthene	205-99-2	6000/2000		790	C	5	C	57	C	5	0.0015		0.0012	C	0.0012
Benzo(g,h,i)perylene [14]	191-24-2	6000/2000		7,900	C	50	C	16	C	16	0.00026		0.012	C	0.00026
Benzo(k)fluoranthene [14]	207-08-9	6000/2000		7,900	C	50	C	39	C	39	0.0008		0.012	C	0.0008
Benzoic acid [6]	65-85-0	6000/2000		1,000,000	NC	730,000	NC	590	NC	590	3,500		150	NC	150
Benzyl Alcohol	100-51-6	6000/2000	8,800	270,000	NC	55,000	NC	48	NC	48	40,000		11	NC	11
Beryllium and compunds [6]	7440-41-7	10,000		2,300	NC	680	NC	63	C	63		0.004	0.073	NC	0.004
Bis(2-chloro-1-methylethyl) ether	108-60-1	6000/2000	550	5,200	C	30	C	0.027	C	0.027	1,700		0.0042	C	0.0042
Bis(2-Chloroethyl)ether [5]	111-44-4	6000/2000	4,000	280	C	1.6	C	0.0007	C	0.0007	17,000		0.00015	C	0.00015
Bis(2-chloroisopropyl)ether	39638-32-9	6000/2000	550	5,200	C	30	C	0.027	C	0.027	1,700		0.0042	C	0.0042
Bis(2-ethylhexyl)phthalate	117-81-7	6000/2000	10,000	18,000	NC	300	C	3,600	C	300	0.34	0.006	0.061	C	0.006
Bromodichloromethane [7]	75-27-4	6000/2000	2,100	2,100	C	10	C	0.51	C	0.51	6,700	0.08	0.0029	C	0.08
Bromoform(tribromomethane) [7]	75-25-2	6000/2000	1,200	7,700	NC	280	C	0.6	C	0.6	3,100	0.08	0.11	C	0.08
n-Butanol	71-36-3	6000/2000	16,000	2,700	NC	380	NC	16	NC	16	74,000		3.7	NC	3.7
Butylbenzylphthalate [2,14]	85-68-7	6000/2000	310	180,000	NC	37,000	NC	6,200	NC	310	2.7		7.3	NC	2.7
Cadmium [3,6]	7440-43-9	10,000		590	NC	12		7.5	C	7.5		0.005	0.018	NC	0.005
Carbazole	86-74-8	6000/2000		31,000	C	210	C	5.9	C	5.9	7.5		0.043	C	0.043
Carbon disulfide	75-15-0	6000/2000	480	6,200	NC	900	NC	10	NC	10	1,200		1.3	NC	1.3
Carbon tetrachloride	56-23-5	6000/2000	520	31	NC	3.3	C	0.066	C	0.066	790	0.005	0.0026	C	0.005
Chlordane	12789-03-6	6000/2000		510	NC	17	C	9.6	C	9.6	0.056	0.002	0.0024	C	0.002
p-Chloroaniline [6]	106-47-8	6000/2000		3,600	NC	730	NC	0.97	NC	0.97	5,300		0.15	NC	0.15
Chlorobenzene	108-90-7	6000/2000	310	2,600	NC	380	NC	1.3	NC	1.3	470	0.1	0.13	NC	0.1
Chloroethane	75-00-3	6000/2000	3,000	16,000	C	80	C	0.65	C	0.65	5,700		0.062	C	0.062
Chloroform [7,10]	67-66-3	6000/2000	2,300	6.4	NC	0.91	NC	0.47	C	0.47	7,900	0.08	0.00084	NC	0.08
2-Chloronapthalene	91-58-7	6000/2000		71,000	NC	15,000	NC	42	NC	42	12		0.61	NC	0.61
2-Chlorophenol [6]	95-57-8	6000/2000	22,000	2,200	NC	360	NC	0.75	NC	0.75	22,000		0.038	NC	0.038
Chromium III [6]	16065-83-1	10,000		1,000,000	NC	520,000	NC	1,000,000	NC	10,000		0.1	55	NC	0.1
Chromium VI [6,12]	18540-29-9	10,000		3,400	NC	430	C	38	C	38		0.1	0.11	NC	0.1
Chrysene [14]	218-01-9	6000/2000		79,000	C	500	C	25	C	25	0.0016		0.12	C	0.0016
Copper [6]	7440-50-8	10,000		42,000	NC	13,000	NC	920	NC	920		1.3	1.4	NC	1.3
Cyanide, Free [13]	57-12-5	6000/2000	0	23,000	NC	6,900	NC	0.94	NC	0.94	1,000,000	0.2	0.73	NC	0.2
Cyclohexane [2]	110-82-7	6000/2000	69	51,000	NC	7,200	NC	330	NC	69	55		13	NC	13

Exhibit A-22. (continued)

Table A	Default	Closure	Residential										January 1, 2004		
Constituent	CAS	SOIL									GROUNDWATER				
		Soil Attenuation Capacity	Soil Saturation (Csat)	Construction		Soil Direct		Migration to GW		Default Closure Level	Groundwater Solubility	MCL	Residential		Default Closure Level
		(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)	(mg/l)	(mg/l)	(mg/l)		(mg/l)
Dibenzofuran	132-64-9	6000/2000		1,800	NC	370	NC	4.9	NC	4.9	3.1		0.015	NC	0.015
1,2-Dichlorobenzene	95-50-1	6000/2000	220	18,000	NC	2,800	NC	17	NC	17	160	0.6	0.48	NC	0.6
1,3-Dichlorobenzene	541-73-1	6000/2000	230	250	NC	40	NC	0.2	NC	0.2	160		0.0069	NC	0.0069
1,4-Dichlorobenzene	106-46-7	6000/2000		8,000	C	42	C	2.2	C	2.2	74	0.075	0.008	C	0.075
3,3-Dichlorobenzidine	91-94-1	6000/2000		1,400	C	9.5	C	0.062	C	0.062	3.1		0.0019	C	0.0019
1,1-Dichloroethane	75-34-3	6000/2000	1,400	8,600	NC	1,300	NC	5.6	NC	5.6	5,100		0.99	NC	0.99
1,2-Dichloroethane	107-06-2	6000/2000	2,000	150	NC	3.7	C	0.024	C	0.024	8,500	0.005	0.002	C	0.005
1,1-Dichloroethylene	75-35-4	6000/2000	930	2,200	NC	310	NC	0.058	NC	0.058	2,300	0.007	0.43	NC	0.007
cis-1,2-Dichloroethylene	156-59-2	6000/2000	1,000	750	NC	110	NC	0.4	NC	0.4	3,500	0.07	0.077	NC	0.07
trans-1,2-Dichloroethylene	156-60-5	6000/2000	2,100	1,200	NC	180	NC	0.68	NC	0.68	6,300	0.1	0.15	NC	0.1
2,4-Dichlorophenol [6]	120-83-2	6000/2000		2,700	NC	550	NC	1.1	NC	1.1	4,500		0.11	NC	0.11
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	6000/2000		9,100	NC	2,000	NC	0.35	NC	0.35	680	0.07	0.37	NC	0.07
1,2-Dichloropropane	78-87-5	6000/2000	830	100	NC	4.5	C	0.03	C	0.03	2,800	0.005	0.0026	C	0.005
1,3-Dichloropropene	542-75-6	6000/2000	1,000	290	NC	9.5	C	0.04	C	0.04	2,800		0.0056	C	0.0056
Dieldrin	60-57-1	6000/2000		39	C	0.27	C	0.046	C	0.046	0.2		0.000053	C	0.000053
Diethylphthalate	84-66-2	6000/2000	840	710,000	NC	150,000	NC	450	NC	450	1,100		29	NC	29
2,4-Dimethylphenol [6]	105-67-9	6000/2000		18,000	NC	3,700	NC	9	NC	9	7,900		0.73	NC	0.73
Dimethylphthalate [2]	131-11-3	6000/2000	1,100	1,000,000	NC	1,000,000	NC	2,000	NC	1,100	4,000		370	NC	370
Di-n-butyl phthalate [2]	84-74-2	6000/2000	760	89,000	NC	18,000	NC	5,000	NC	760	11		3.7	NC	3.7
2,4-Dinitrophenol [6]	51-28-5	6000/2000		1,800	NC	370	NC	0.29	NC	0.29	2,800		0.073	NC	0.073
Dinitrotoluene mixture	25321-14-6	6000/2000		890	NC	6.3	C	0.0091	C	0.0091	230		0.0013	C	0.0013
Di-n-octyl phthalate [14]	117-84-0	6000/2000	3,300	18,000	NC	3,700	NC	67,000	NC	2,000	0.02		0.73	NC	0.02
Endosulfan	115-29-7	6000/2000		5,300	NC	1,100	NC	20	NC	20	0.51		0.22	NC	0.22
Endrin	72-20-8	6000/2000		270	NC	55	NC	0.99	NC	0.99	0.25	0.002	0.011	NC	0.002
Ethylbenzene	100-41-4	6000/2000	160	29,000	NC	4,600	NC	13	NC	13	170	0.7	1.6	NC	0.7
Fluoranthene [14]	206-44-0	6000/2000		33,000	NC	6,300	NC	880	NC	880	0.21		1.5	NC	0.21
Fluorene	86-73-7	6000/2000		33,000	NC	6,300	NC	170	NC	170	2		0.31	NC	0.31
alpha-HCH(alpha-BHC)	319-84-6	6000/2000		120	C	0.99	C	0.0072	C	0.0072	2		0.00014	C	0.00014
beta-HCH(beta-BHC)	319-85-7	6000/2000		410	C	3.5	C	0.026	C	0.026	0.24		0.00047	C	0.00047
gamma-HCH(Lindane)	58-89-9	6000/2000		310	NC	4.8	C	0.0094	C	0.0094	6.8	0.0002	0.00066	C	0.0002
Heptachlor	76-44-8	6000/2000		140	C	0.93	C	23	C	0.93	0.18	0.0004	0.00019	C	0.0004
Heptachlor epoxide	1024-57-3	6000/2000		12	NC	0.47	C	0.67	C	0.47	0.2	0.0002	0.000094	C	0.0002
Hexachloro-1,3-butadiene	87-68-3	6000/2000	350	180	NC	37	NC	16	C	16	3.2		0.0073	NC	0.0073
Hexachlorobenzene	118-74-1	6000/2000		390	C	2.7	C	2.2	C	2.2	6.2	0.001	0.00053	C	0.001
Hexachlorocyclopentadiene	77-47-4	6000/2000	720	5,300	NC	1,100	NC	400	NC	400	1.8	0.05	0.22	NC	0.05
Hexachloroethane	67-72-1	6000/2000		660	NC	120	NC	2.8	C	2.8	50		0.037	NC	0.037
n-Hexane	110-54-3	6000/2000	100	1,200	NC	170	NC	97	NC	97	9.5		0.44	NC	0.44
Indeno(1,2,3-cd)pyrene [14]	193-39-5	6000/2000		790	C	5	C	3.1	C	3.1	0.000022		0.0012	C	0.000022
Iodomethane	74-88-4	6000/2000	3,600	620	C	4.3	C	0.0044	C	0.0044	14,000		0.00085	C	0.00085
Isophorone	78-59-1	6000/2000	3,500	180,000	NC	4,500	C	5.3	C	5.3	12,000		0.9	C	0.9
Lead [8]	7439-92-1	10,000		970	NC	400	NC	81	NC	81		0.015	.015	NC	0.015
Mercury and compounds [9]	7439-97-6	10,000		340	NC	100	NC	2.1	NC	2.1	69,000	0.002	0.011	NC	0.002
Methoxychlor [14]	72-43-5	6000/2000		4,400	NC	910	NC	160	NC	160	0.045	0.04	0.18	NC	0.04

Exhibit A-22. (continued)

Table A	**Default**	**Closure**	**Residential**										**January 1, 2004**		
Constituent	CAS	SOIL									GROUNDWATER				
		Soil Attenuation Capacity	Soil Saturation (Csat)	Construction		Soil Direct		Migration to GW		Default Closure Level	Groundwater Solubility	MCL	Residential		Default Closure Level
		(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)	(mg/l)	(mg/l)	(mg/l)		(mg/l)
Methylene chloride	75-09-2	6000/2000	3,000	22,000	C	120	C	0.023	C	0.023	13,000	0.005	0.063	C	0.005
2-Methylnaphthalene	91-57-6	6000/2000		17,000	NC	3,200	NC	16	NC	16	25		0.15	NC	0.15
3-Methylphenol (m-cresol) [6]	108-39-4	6000/2000	6,100	44,000	NC	9,100	NC	9.8	NC	9.8	23,000		1.8	NC	1.8
4-Methylphenol (p-cresol) [6]	106-44-5	6000/2000		4,400	NC	910	NC	1.1	NC	1.1	22,000		0.18	NC	0.18
2-Methylphenol(o-cresol) [6]	95-48-7	6000/2000		39,000	NC	7,500	NC	14	NC	14	26,000		1.8	NC	1.8
Naphthalene	91-20-3	6000/2000		17,000	NC	3,200	NC	0.7	NC	0.7	31		0.0083	NC	0.0083
Nickel, soluble salts [6]	various	10,000		23,000	NC	6,900	NC	950	C	950			0.73	NC	0.73
2-Nitroaniline	88-74-4	6000/2000		51	NC	10	NC	0.013	NC	0.013	1,500		0.0021	NC	0.0021
Nitrobenzene	98-95-3	6000/2000	690	440	NC	91	NC	0.028	NC	0.028	2,100		0.0043	NC	0.0043
N-Nitrosodi-n-propylamine [5,6]	621-64-7	6000/2000	2,500	89	C	0.61	C	0.0006	C	0.0006	9,900		0.00012	C	0.00012
N-Nitrosodiphenylamine [6]	86-30-6	6000/2000		130,000	C	870	C	9.7	C	9.7	35		0.17	C	0.17
PCBs (polychorinated biphenyls) [11]	1336-36-3	6000/2000		16	NC	1.8	C	6.2	C	1.8	0.7	0.0005	0.00043	C	0.0005
Pentachlorophenol [6]	87-86-5	6000/2000		3,800	C	20	C	0.028	C	0.028	2,000	0.001	0.0071	C	0.001
Phenanthrene	85-01-8	6000/2000		2,500	NC	470	NC	13	NC	13	1.2		0.023	NC	0.023
Phenol [6]	108-95-2	6000/2000		230,000	NC	44,000	NC	56	NC	56	83,000		11	NC	11
Pyrene [14]	129-00-0	6000/2000		25,000	NC	4,700	NC	570	NC	570	0.14		1.1	NC	0.14
Selenium [6]	7782-49-2	10,000		5,700	NC	1,700	NC	5.2	NC	5.2		0.05	0.18	NC	0.05
Silver [6]	7440-22-4	10,000		5,700	NC	1,700	NC	31	NC	31			0.18	NC	0.18
Styrene	100-42-5	6000/2000	550	68,000	NC	11,000	NC	3.5	NC	3.5	310	0.1	2	NC	0.1
1,1,1,2-Tetrachloroethane	630-20-6	6000/2000	1,200	7,400	C	39	C	0.053	C	0.053	3,000		0.0069	C	0.0069
1,1,2,2-Tetrachloroethane	79-34-5	6000/2000	1,200	960	C	5	C	0.007	C	0.007	3,000		0.0009	C	0.0009
Tetrachloroethylene (PCE)	127-18-4	6000/2000	120	720	NC	16	C	0.058	C	0.058	200	0.005	0.0088	C	0.005
Thallium (and compounds) [6]	7440-28-0	10,000		80	NC	24	NC	2.8	NC	2.8		0.002	0.0026	NC	0.002
Toluene	108-88-3	6000/2000	310	11,000	NC	1,700	NC	12	NC	12	530	1	0.93	NC	1
Toxaphene	8001-35-2	6000/2000		560	C	3.9	C	31	C	3.9	0.74	0.003	0.00077	C	0.003
1,2,4-Trichlorobenzene	120-82-1	6000/2000	1,100	8,900	NC	1,800	NC	5.3	NC	5.3	300	0.07	0.22	NC	0.07
1,1,1-Trichloroethane	71-55-6	6000/2000	640	34,000	NC	5,000	NC	1.9	NC	1.9	1,300	0.2	3.8	NC	0.2
1,1,2-Trichloroethane	79-00-5	6000/2000	1,300	600	NC	9.4	C	0.03	C	0.03	4,400	0.005	0.0032	C	0.005
Trichloroethylene (TCE)	79-01-6	6000/2000	630	150	C	0.71	C	0.057	C	0.057	1,100	0.005	0.00045	C	0.005
2,4,5-Trichlorophenol [6]	95-95-4	6000/2000		89,000	NC	18,000	NC	250	NC	250	1,200		3.7	NC	3.7
2,4,6-Trichlorophenol [6]	88-06-2	6000/2000		89	NC	18	NC	0.07	C	0.07	800		0.0037	NC	0.0037
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5	6000/2000		8,900	NC	1,800	NC	2.2	NC	2.2	270		0.37	NC	0.37
1,2,4-Trimethylbenzene	95-63-6	6000/2000	430	920	NC	130	NC	2.5	NC	2.5	57		0.016	NC	0.016
1,3,5-Trimethylbenzene	108-67-8	6000/2000	90	380	NC	54	NC	0.61	NC	0.61	48		0.016	NC	0.016
Vinyl acetate	108-05-4	6000/2000	4,200	7,600	NC	1,100	NC	2.3	NC	2.3	20,000		0.55	NC	0.55
Vinyl chloride (chloroethene) [15]	75-01-4	6000/2000	930	250	C	1.5	C	0.013	C	0.013	2,800	0.002	0.00053	C	0.002
Xylene mixed (total)	1330-20-7	6000/2000	170	4,800	NC	690	NC	210	NC	170	160	10	0.27	NC	10
Zinc [6]	7440-66-6	10,000		340,000	NC	100,000	NC	14,000	NC	10,000			11	NC	11

Exhibit A-22. (continued)

Table A	Default	Closure	Industrial										January 1, 2004		
Constituent	CAS	SOIL									GROUNDWATER				
		Soil Attenuation Capacity	Soil Saturation (Csat)	Construction		Soil Direct		Migration to GW		Default Closure Level	Groundwater Solubility	MCL	Industrial		Default Closure Level
		(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)	(mg/l)	(mg/l)	(mg/l)		(mg/l)
Acenaphthene [14]	83-32-9	6000/2000		50,000	NC	24,000	NC	1,200	NC	1,200	4.2		6.1	NC	4.2
Acenaphthylene	208-96-8	6000/2000		5,900	NC	2,800	NC	180	NC	180	3.9		0.73	NC	0.73
Acetone (2-Propanone)	67-64-1	6000/2000	200,000	34,000	NC	6,300	NC	370	NC	370	1,000,000		92	NC	92
Acrolein [5]	107-02-8	6000/2000	50,000	3.5	NC	0.64	NC	0.25	NC	0.25	210,000		0.051	NC	0.051
Aldrin	309-00-2	6000/2000		27	NC	0.8	C	16	C	0.8	0.18		0.00017	C	0.00017
Anthracene [14]	120-12-7	6000/2000		250,000	NC	120,000	NC	51	NC	51	0.043		31	NC	0.043
Antimony and compounds [6]	7440-36-0	10,000		460	NC	620	NC	37	NC	37		0.006	0.041	NC	0.041
Arsenic [6]	7440-38-2	10,000		320	NC	20	C	29	C	20		0.05	0.0019	C	0.05
Barium [6]	7440-39-3	10,000		79,000	NC	98,000	NC	5,900	NC	5,900		2	7.2	NC	7.2
Benzene	71-43-2	6000/2000	590	560	NC	13	C	0.35	C	0.35	1,800	0.005	0.052	C	0.052
Benzo(a)anthracene	56-55-3	6000/2000		790	C	15	C	62	C	15	0.0094		0.0039	C	0.0039
Benzo(a)pyrene	50-32-8	6000/2000		79	C	1.5	C	16	C	1.5	0.0016	0.0002	0.00039	C	0.00039
Benzo(b)fluoranthene [14]	205-99-2	6000/2000		790	C	15	C	74	C	15	0.0015		0.0039	C	0.0015
Benzo(g,h,i)perylene [14]	191-24-2	6000/2000		7,900	C	150	C	16	C	16	0.00026		0.039	C	0.00026
Benzo(k)fluoranthene [14]	207-08-9	6000/2000		7,900	C	150	C	39	C	39	0.0008		0.039	C	0.0008
Benzoic acid [6]	65-85-0	6000/2000		1,000,000	NC	1,000,000	NC	1,600	NC	1,600	3,500		410	NC	410
Benzyl Alcohol	100-51-6	6000/2000	8,800	270,000	NC	150,000	NC	140	NC	140	40,000		31	NC	31
Beryllium and compunds [9]	7440-41-7	10,000		2,300	NC	2,900	NC	3,200	C	2,300		0.004	0.2	NC	0.2
Bis(2-chloro-1-methylethyl) ether	108-60-1	6000/2000	550	5,200	C	61	C	0.26	C	0.26	1,700		0.041	C	0.041
Bis(2-Chloroethyl)ether [5]	111-44-4	6000/2000	4,000	280	C	3	C	0.012	C	0.012	17,000		0.0026	C	0.0026
Bis(2-chloroisopropyl)ether	39638-32-9	6000/2000	550	5,200	C	61	C	0.26	C	0.26	1,700		0.041	C	0.041
Bis(2-ethylhexyl)phthalate	117-81-7	6000/2000	10,000	18,000	NC	980	C	120,000	C	980	0.34	0.006	0.2	C	0.2
Bromodichloromethane [7]	75-27-4	6000/2000	2,100	2,100	C	17	C	0.51	C	0.51	6,700	0.08	0.046	C	0.08
Bromoform(tribromomethane) [7]	75-25-2	6000/2000	1,200	7,700	NC	580	C	2.7	C	2.7	3,100	0.08	0.36	C	0.36
n-Butanol	71-36-3	6000/2000	16,000	2,700	NC	490	NC	44	NC	44	74,000		10	NC	10
Butylbenzylphthalate [2,14]	85-68-7	6000/2000	310	180,000	NC	98,000	NC	6,200	NC	310	2.7		20	NC	2.7
Cadmium [6]	7440-43-9	10,000		590	NC	990	NC	77	C	77		0.005	0.051	NC	0.051
Carbazole	86-74-8	6000/2000		31,000	C	690	C	20	C	20	7.5		0.14	C	0.14
Carbon disulfide	75-15-0	6000/2000	480	6,200	NC	1,200	NC	82	NC	82	1,200		10	NC	10
Carbon tetrachloride	56-23-5	6000/2000	520	31	NC	5.2	C	0.29	C	0.29	790	0.005	0.022	C	0.022
Chlordane	12789-03-6	6000/2000		510	NC	68	C	39	C	39	0.056	0.002	0.0082	C	0.0082
p-Chloroaniline [6]	106-47-8	6000/2000		3,600	NC	2,000	NC	2.7	NC	2.7	5,300		0.41	NC	0.41
Chlorobenzene	108-90-7	6000/2000	310	2,600	NC	510	NC	27	NC	27	470	0.1	2	NC	2
Chloroethane	75-00-3	6000/2000	3,000	16,000	C	120	C	10	C	10	5,700		0.99	C	0.99
Chloroform [7,10]	67-66-3	6000/2000	2,300	6.4	NC	1.2	NC	6	C	1.2	7,900	0.08	1	NC	1
2-Chloronapthalene	91-58-7	6000/2000		71,000	NC	39,000	NC	560	NC	560	12		8.2	NC	8.2
2-Chlorophenol [6]	95-57-8	6000/2000	22,000	2,200	NC	580	NC	10	NC	10	22,000		0.51	NC	0.51
Chromium III [6]	16065-83-1	10,000		1,000,000	NC	1,000,000	NC	1,000,000	NC	10,000		0.1	150	NC	150
Chromium VI [6,12]	18540-29-9	10,000		3,400	NC	650	C	120	C	120		0.1	0.31	NC	0.31
Chrysene [14]	218-01-9	6000/2000		79,000	C	1,500	C	25	C	25	0.0016		0.39	C	0.0016
Copper [6]	7440-50-8	10,000		42,000	NC	57,000	NC	2,700	NC	2,700		1.3	3.8	NC	3.8
Cyanide, Free [13]	57-12-5	6000/2000	0	23,000	NC	31,000	NC	9.6	NC	9.6	1,000,000	0.2	2	NC	2
Cyclohexane [2,14]	110-82-7	6000/2000	69	51,000	NC	9,300	NC	1,400	NC	69	55		170	NC	55

Exhibit A-22. (continued)

Table A	Default	Closure	Industrial										January 1, 2004		
Constituent	CAS	SOIL									GROUNDWATER				
		Soil Attenuation Capacity	Soil Saturation (Csat)	Construction		Soil Direct		Migration to GW		Default Closure Level	Groundwater Solubility	MCL	Industrial		Default Closure Level
		(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)	(mg/l)	(mg/l)	(mg/l)		(mg/l)
Dibenzofuran	132-64-9	6000/2000		1,800	NC	980	NC	65	NC	65	3.1		0.2	NC	0.2
1,2-Dichlorobenzene [2]	95-50-1	6000/2000	220	18,000	NC	3,900	NC	270	NC	220	160	0.6	9.2	NC	9.2
1,3-Dichlorobenzene	541-73-1	6000/2000	230	250	NC	58	NC	2.7	NC	2.7	160		0.092	NC	0.092
1,4-Dichlorobenzene	106-46-7	6000/2000		8,000	C	73	C	3.4	C	3.4	74	0.075	0.12	C	0.12
3,3-Dichlorobenzidine	91-94-1	6000/2000		1,400	C	31	C	0.21	C	0.21	3.1		0.0064	C	0.0064
1,1-Dichloroethane	75-34-3	6000/2000	1,400	8,600	NC	1,700	NC	58	NC	58	5,100		10	NC	10
1,2-Dichloroethane	107-06-2	6000/2000	2,000	150	NC	5.8	C	0.15	C	0.15	8,500	0.005	0.031	C	0.031
1,1-Dichloroethylene	75-35-4	6000/2000	930	2,200	NC	410	NC	42	NC	42	2,300	0.007	5.1	NC	5.1
cis-1,2-Dichloroethylene	156-59-2	6000/2000	1,000	750	NC	140	NC	5.8	NC	5.8	3,500	0.07	1	NC	1
trans-1,2-Dichloroethylene	156-60-5	6000/2000	2,100	1,200	NC	230	NC	14	NC	14	6,300	0.1	2	NC	2
2,4-Dichlorophenol [6]	120-83-2	6000/2000		2,700	NC	1,500	NC	3	NC	3	4,500		0.31	NC	0.31
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	6000/2000		9,100	NC	5,200	NC	5.2	NC	5.2	680	0.07	1	NC	1
1,2-Dichloropropane	78-87-5	6000/2000	830	100	NC	7.2	C	0.25	C	0.25	2,800	0.005	0.042	C	0.042
1,3-Dichloropropene	542-75-6	6000/2000	1,000	290	NC	16	C	0.2	C	0.2	2,800		0.029	C	0.029
Dieldrin	60-57-1	6000/2000		39	C	0.86	C	0.15	C	0.15	0.2		0.00018	C	0.00018
Diethylphthalate	84-66-2	6000/2000	840	710,000	NC	390,000	NC	1,300	NC	840	1,100		82	NC	82
2,4-Dimethylphenol [6]	105-67-9	6000/2000		18,000	NC	9,800	NC	25	NC	25	7,900		2	NC	2
Dimethylphthalate [2]	131-11-3	6000/2000	1,100	1,000,000	NC	1,000,000	NC	5,600	NC	1,100	4,000		1,000	NC	1,000
Di-n-butyl phthalate [2]	84-74-2	6000/2000	760	89,000	NC	49,000	NC	14,000	NC	760	11		10	NC	10
2,4-Dinitrophenol [6]	51-28-5	6000/2000		1,800	NC	980	NC	0.82	NC	0.82	2,800		0.2	NC	0.2
Dinitrotoluene mixture	25321-14-6	6000/2000		890	NC	20	C	0.031	C	0.031	230		0.0042	C	0.0042
Di-n-octyl phthalate [14]	117-84-0	6000/2000	3,300	18,000	NC	9,800	NC	67,000	NC	2,000	0.02		2	NC	0.02
Endosulfan [14]	115-29-7	6000/2000		5,300	NC	2,900	NC	46	NC	46	0.51		0.61	NC	0.51
Endrin	72-20-8	6000/2000		270	NC	150	NC	15	NC	15	0.25	0.002	0.031	NC	0.031
Ethylbenzene [2]	100-41-4	6000/2000	160	29,000	NC	6,800	NC	200	NC	160	170	0.7	10	NC	10
Fluoranthene [14]	206-44-0	6000/2000		33,000	NC	16,000	NC	880	NC	880	0.21		4.1	NC	0.21
Fluorene [14]	86-73-7	6000/2000		33,000	NC	16,000	NC	1,100	NC	1,100	2		4.1	NC	2
alpha-HCH(alpha-BHC)	319-84-6	6000/2000		120	C	4	C	0.024	C	0.024	2		0.00045	C	0.00045
beta-HCH(beta-BHC)	319-85-7	6000/2000		410	C	14	C	0.086	C	0.086	0.24		0.0016	C	0.0016
gamma-HCH(Lindane)	58-89-9	6000/2000		310	NC	19	C	0.1	C	0.1	6.8	0.0002	0.0022	C	0.0022
Heptachlor	76-44-8	6000/2000		140	C	2.9	C	36	C	2.9	0.18	0.0004	0.00064	C	0.00064
Heptachlor epoxide	1024-57-3	6000/2000		12	NC	1.5	C	1	C	1	0.2	0.0002	0.00031	C	0.00031
Hexachloro-1,3-butadiene	87-68-3	6000/2000	350	180	NC	98	NC	44	C	44	3.2		0.02	NC	0.02
Hexachlorobenzene	118-74-1	6000/2000		390	C	8.6	C	3.9	C	3.9	6.2	0.001	0.0018	C	0.0018
Hexachlorocyclopentadiene [2]	77-47-4	6000/2000	720	5,300	NC	2,900	NC	4,900	NC	720	1.8	0.05	0.61	NC	0.61
Hexachloroethane	67-72-1	6000/2000		660	NC	240	NC	7.7	C	7.7	50		0.1	NC	0.1
n-Hexane [2]	110-54-3	6000/2000	100	1,200	NC	220	NC	1,300	NC	100	9.5		6.1	NC	6.1
Indeno(1,2,3-cd)pyrene [14]	193-39-5	6000/2000		790	C	15	C	3.1	C	3.1	0.000022		0.0039	C	0.000022
Iodomethane	74-88-4	6000/2000	3,600	620	C	14	C	0.015	C	0.015	14,000		0.0029	C	0.0029
Isophorone	78-59-1	6000/2000	3,500	180,000	NC	14,000	C	18	C	18	12,000		3	C	3
Lead [8]	7439-92-1	10,000		970	NC	1,300	NC	230	NC	230		0.015	.042	NC	.042
Mercury and compounds [9]	7439-97-6	10,000		340	NC	470	NC	32	NC	32	69,000	0.002	0.031	NC	0.031
Methoxychlor [14]	72-43-5	6000/2000		4,400	NC	2,500	NC	180	NC	180	0.045	0.04	0.51	NC	0.045

Exhibit A-22. (concluded)

Table A	Default	Closure	Industrial										January 1, 2004		
Constituent	CAS	SOIL									GROUNDWATER				
		Soil Attenuation Capacity	Soil Saturation (Csat)	Construction		Soil Direct		Migration to GW		Default Closure Level	Groundwater Solubility	MCL	Industrial		Default Closure Level
		(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)	(mg/l)	(mg/l)	(mg/l)		(mg/l)
Methylene chloride	75-09-2	6000/2000	3,000	22,000	C	200	C	1.8	C	1.8	13,000	0.005	0.38	C	0.38
2-Methylnaphthalene	91-57-6	6000/2000		17,000	NC	8,000	NC	210	NC	210	25		2	NC	2
3-Methylphenol (m-cresol) [6]	108-39-4	6000/2000	6,100	44,000	NC	25,000	NC	28	NC	28	23,000		5.1	NC	5.1
4-Methylphenol (p-cresol) [6]	106-44-5	6000/2000		4,400	NC	2,500	NC	3	NC	3	22,000		0.51	NC	0.51
2-Methylphenol(o-cresol) [6]	95-48-7	6000/2000		39,000	NC	17,000	NC	39	NC	39	26,000		5.1	NC	5.1
Naphthalene	91-20-3	6000/2000		17,000	NC	8,000	NC	170	NC	170	31		2	NC	2
Nickel, soluble salts	various	10,000		23,000	NC	31,000	NC	2,700	C	2,700			2	NC	2
2-Nitroaniline	88-74-4	6000/2000		51	NC	28	NC	0.036	NC	0.036	1,500		0.0058	NC	0.0058
Nitrobenzene	98-95-3	6000/2000	690	440	NC	250	NC	0.34	NC	0.34	2,100		0.051	NC	0.051
N-Nitrosodi-n-propylamine [5,6]	621-64-7	6000/2000	2,500	89	C	2	C	0.002	C	0.002	9,900		0.00041	C	0.00041
N-Nitrosodiphenylamine [6]	86-30-6	6000/2000		130,000	C	2,800	C	32	C	32	35		0.58	C	0.58
PCBs (polychorinated biphenyls) [11]	1336-36-3	6000/2000		16	NC	5.3	C	18	C	5.3	0.7	0.0005	0.0014	C	0.0014
Pentachlorophenol [6]	87-86-5	6000/2000		3,800	C	54	C	0.66	C	0.66	2,000	0.001	0.024	C	0.024
Phenanthrene	85-01-8	6000/2000		2,500	NC	1,200	NC	170	NC	170	1.2		0.31	NC	0.31
Phenol [6]	108-95-2	6000/2000		230,000	NC	96,000	NC	160	NC	160	83,000		31	NC	31
Pyrene [14]	129-00-0	6000/2000		25,000	NC	12,000	NC	570	NC	570	0.14		3.1	NC	0.14
Selenium [6]	7782-49-2	10,000		5,700	NC	7,800	NC	53	NC	53		0.05	0.51	NC	0.51
Silver [6]	7440-22-4	10,000		5,700	NC	7,800	NC	87	NC	87			0.51	NC	0.51
Styrene [2]	100-42-5	6000/2000	550	68,000	NC	16,000	NC	720	NC	550	310	0.1	20	NC	20
1,1,1,2-Tetrachloroethane	630-20-6	6000/2000	1,200	7,400	C	67	C	0.85	C	0.85	3,000		0.11	C	0.11
1,1,2,2-Tetrachloroethane	79-34-5	6000/2000	1,200	960	C	8.7	C	0.11	C	0.11	3,000		0.014	C	0.014
Tetrachloroethylene (PCE)	127-18-4	6000/2000	120	720	NC	27	C	0.64	C	0.64	200	0.005	0.055	C	0.055
Thallium (and compounds) [6]	7440-28-0	10,000		80	NC	110	NC	10	NC	10		0.002	0.0072	NC	0.0072
Toluene	108-88-3	6000/2000	310	11,000	NC	2,200	NC	240	NC	240	530	1	20	NC	20
Toxaphene	8001-35-2	6000/2000		560	C	12	C	31	C	12	0.74	0.003	0.0026	C	0.003
1,2,4-Trichlorobenzene	120-82-1	6000/2000	1,100	8,900	NC	4,900	NC	77	NC	77	300	0.07	1	NC	1
1,1,1-Trichloroethane	71-55-6	6000/2000	640	34,000	NC	6,700	NC	280	NC	280	1,300	0.2	29	NC	29
1,1,2-Trichloroethane	79-00-5	6000/2000	1,300	600	NC	15	C	0.3	C	0.3	4,400	0.005	0.05	C	0.05
Trichloroethylene (TCE)	79-01-6	6000/2000	630	150	C	1.1	C	0.082	C	0.082	1,100	0.005	0.0072	C	0.0072
2,4,5-Trichlorophenol [6]	95-95-4	6000/2000		89,000	NC	49,000	NC	690	NC	690	1,200		10	NC	10
2,4,6-Trichlorophenol [6]	88-06-2	6000/2000		89	NC	49	NC	0.2	C	0.2	800		0.01	NC	0.01
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5	6000/2000		8,900	NC	4,900	NC	6.1	NC	6.1	270		1	NC	1
1,2,4-Trimethylbenzene	95-63-6	6000/2000	430	920	NC	170	NC	780	NC	170	57		5.1	NC	5.1
1,3,5-Trimethylbenzene	108-67-8	6000/2000	90	380	NC	68	NC	190	NC	68	48		5.1	NC	5.1
Vinyl acetate	108-05-4	6000/2000	4,200	7,600	NC	1,400	NC	430	NC	430	20,000		100	NC	100
Vinyl chloride (chloroethene) [15]	75-01-4	6000/2000	930	250	C	3.1	C	0.013	C	0.013	2,800	0.002	0.0019	C	0.002
Xylene mixed (total) [2]	1330-20-7	6000/2000	170	4,800	NC	890	NC	430	NC	170	160	10	20	NC	20
Zinc [6]	7440-66-6	10,000		340,000	NC	470,000	NC	38,000	NC	10,000			31	NC	31

Source: Indiana Department of Environmental Management (2002). *http://www.in.gov/idem/land/risc/techguide/riscapp1.pdf*.

Exhibit A-23. Louisiana screening option.

Compound	Soil_SSni* mg/kg	note	Soil_SSi** mg/kg	note	Soil_SSgw*** mg/kg	note
Acenaphthene	260	N	3900	N	220	A
Anthracene	1400	N	25000	N	120	A
Antimony	3.0	N	75	N	12	L1
Arsenic	0.38	C	3.0	C	100	L
Barium	520	N	13000	N	2000	L
Benzene	1.5	C	3.2	C	0.051	A
Benz(a)anthracene	0.56	C	3.6	C	8.6	A
Benzo(a)pyrene	0.33	Q	0.36	C	23	A
Benzo(b)fluoranthene	0.56	C	3.6	C	30	A
Benzo(k)fluoranthene	5.5	C	35	C	120	A
1,1-Biphenyl	220	N	230	P	190	A
Cadmium	3.7	N	94	N	20	L
Carbon Disulfide	37	N	260	N	11	A
Chromium(III)	7500	N	190000	N	100	L
Chromium(VI)	37	N	940	N	100	L
Chrysene	61	C	400	C	76	A
Dibenz(a,h)anthracene	0.33	Q	0.36	C	540	A
Dibenzofuran	21	N	150	P	24	A
1,1-Dichloroethene (mixture)	0.11	C	0.25	C	0.085	A
cis-1,2-Dichloroethene	4.8	N	34	N	0.49	A
trans-1,2-Dichloroethene	7.0	N	49	N	0.77	A

Exhibit A-23. (continued)

Compound	Soil_SSni* mg/kg	note	Soil_SSi** mg/kg	note	Soil_SSgw*** mg/kg	note
2,4-Dinitrotoluene	8.3	N	110	N	1	A
Ethylbenzene	150	N	230	P	19	A
Fluoranthene	200	N	3600	N	1200	A
Fluorene	180	N	3100	N	230	A
Indeno(1,2,3-cd)pyrene	0.56	C	3.6	C	170	A
Lead (inorganic)	400	B	1700	B	100	L
Mercury (inorganic)	2.2	N	56	N	4	L
MTBE	26	N	480	N	0.68	A
Naphthalene	0.78	N	5.2	N	0.11	A
Nickel	150	N	3700	N	200	L1
Pyrene	150	N	2700	N	1100	A
Toluene	69	N	480	N	20	A
Vanadium	52	N	1300	N	2000	L1
Xylenes (total)	150	P	150	P	180	A
Zinc	2200	N	56000	N	2800	S

Exhibit A-23. (concluded)

Compound	Soil_SSni* mg/kg	note	Soil_SSi** mg/kg	note	Soil_SSgw*** mg/kg	note
TPH-G	61	N,I	500	N, I	6.5	A
TPH-D	61	N,I	500	N, I	6.5	A
TPH-O	140	N,I	10000	O,T	210	A

*Soil_SSni - Soil Screening for Non-industrial
** Soil_SSi - Soil Screening Standard for Industrial
*** Soil_SSgw - Soil Screening Standard for Groundwater
A - Based on algorithm contained in Appendix H
B - Based on EPA's biokinetic and adult lead cleanup level models for lead
C - Based on carcinogenic health effects
I - TPH Standards are only applicable when used in conjunction with Standards for indicator compounds
L - Soil level protective of groundwater for inorganic constituents based on leachability
L1 - Soil level protective of groundwater for inorganic constituents based on GW 1 because TCLP value not listed
N - Based on non-carcinogenic health effects
O - Ceiling value based on aesthetic considerations
P - Soil Saturation Limit is less than health based level thus default to soil saturation limit
Q - Based on analytical quantitation limit
S - Soil level protective of groundwater for inorganic constituents based on the maximum concentration for the beneficial use of sewage sludge
T - TPH shall not exceed 10,000

Source: *http://www.aehs.com/surveys/soil/03/LA.HTM*

Exhibit A-24. NJ soil cleanup criteria.

Compound	Criteria Residential SCC (mg/Kg)	Criteria Non-Residential SCC (mg/Kg)
Volatiles		
Vinyl Chloride	2	7
Acetone	1000	1000
Chloroform	19	28
Carbon Tetrachloride	2	4
Benzene	3	13
Chlorobenzene	37	680
Toluene	1000	1000
Semivolatiles		
Phenol	10,000	10,000
2-Chlorophenol	280	5200
Nitrobenzene	28	520
Naphthalene	230	4200
Acenaphthene	3,400	10,000
Fluorene	2,300	10,000
Pyrene	1,700	10,000
Chrysene	9	40
Pesticides/Aroclors		
Heptachlor	0.15	0.65
Aldrin	0.04	0.17
Dieldrin	0.042	0.18
Endrin	17	310
Inorganics		
Arsenic	20	20
Cadmium	1	100
Copper	600	2,600
Lead	400	600
Mercury	14	270
Nickel	250	2,400
Zinc	1,500	1,500

Source: New Jersey Department of Environmental Protection Dredging Task Force (1997).

Exhibit A-25. New York dredged material screening levels.

Parameter	Unrestricted Use, Placement, or Disposal [1] (mg/kg)	Restricted Use or Disposal [2] (mg/kg)
Hg	<0.1	0.1 to 0.5
Cd	<0.6	0.6 to 3.0
Pb	<30	30 to 100
Cu*	<16	16 to 110
Σ DDT+DDE + DDD	<0.005	0.005 to 0.025
Dieldrin	<0.003	0.003 to 0.015
PCB (total)	<0.1	0.1 to 1.0
Σ PAH	<1	1.0 to 5.0
Anthracene	<0.1	0.0 to 1.0
Benzo(a) Anthracene	<0.04	0.04 to 0.22
Chrysene	<0.4	0.4 to 2.8
2-Butanone (Methylethyiketone)	<1	1.0 to 5.0
Trichloroethylene	<0.1	0.1 to 0.5
Σ BTX	<0.05	0.05 to 0.25
Benzene	<0.014	0.014 to 0.07
Dioxin	<0.0000045	$4.5x10^{-6}$ to $5.0x10^{-5}$

* Denotes a case-specific parameter which the department may require in instances where information suggests a problem.
[1] No adverse human health or environmental impact presumed.
[2] Potential for adverse human health or environmental impacts unless material is managed as recommended.
Source: New York State Department of Environmental Conservation (1994b).

Exhibit A-26. New York soil cleanup criteria table.

Compound	Allowable Soil Concentration (ppm)
Volatiles	
Vinyl Chloride	0.0012
Acetone	0.0011
Chloroform	0.003
Carbon Tetrachloride	0.006
Benzene	0.0006
Chlorobenzene	0.017
Toluene	0.015
Semivolatiles	
Phenol	0.0003
2-Chlorophenol	0.008
Nitrobenzene	0.002
Naphthalene	0.130
Acenaphthene	0.9
Fluorene	3.5
Pyrene	6.65
Chrysene	0.004
Pesticides/Aroclors	
Heptachlor	0.001
Aldrin	0.005
Dieldrin	0.001
Endrin	0.001
Inorganics	
Arsenic	7.5 or SB
Cadmium	1 or SB
Copper	25 of SB
Lead	SB
Mercury	0.1
Nickel	13 or SB
Zinc	20 or SB
SB is Site Background Source: New York State Department of Environmental Conservation (1994). *http://www.dec.state.ny.us/website/der/tagms/prtg4046.html*	

Exhibit A-27. Oregon screening level values for plants, invertebrates, and wildlife exposed to soil and surface water.

CHEMICAL	CAS No.	Soils (mg/kg)				Surface Water (mg/L)		
		Terrestrial Receptors				Fresh		
		Plants	Inverts	Birds	Mammals	Aquatic	Birds	Mammals
INORGANICS								
Aluminum	7429-90-5	50 c	600 b	450 g	107 e	0.087 n,t	797 h	8 f
Antimony and compounds	7440-36-0	5 c			15 e	1.6 q		1 f
Arsenic III	7440-38-2	10 c	60 a	10 g	29 e,i	0.150 t	18 h	6 f,i
Arsenic V						0.150 t		
Barium and compounds	7440-39-3	500 c	3000 b	85 g	638 e	0.004 o	150 h	39 f
Beryllium and compounds	7440-41-7	10 c			83 e	0.0053 q		5 f
Bismuth		20 d						
Boron	7440-42-8	0.5 c	20 b	120 g	3500 e	0.0016 o	209 h	213 f
Bromine		10 c						
Cadmium and compounds	7440-43-9	4 c	20 a	6 g	125 e,i	0.0022 t	10 h	8 f,i
Calcium						116 p		
Chromium III		1 c	0.4 a	4 g	3.4×10^{5} e	0.074 t	7.2 h	2.1×10^{4} f
Chromium VI	7440-47-3				410 e	0.011 n,q,t		25 f
Cobalt	7440-48-4	20 c	1000 b		150 e,i	0.023 o		9 f,i
Copper and compounds	7440-50-8	100 c	50 a	190 g	390 e,i	0.009 t	341 h	53 f,i
Cyanides						0.0052 q,t		
Fluorine (soluble fluoride)	7782-41-4	200 c	30 b	32 g	2285 e		57 h	317 f
Iron		10 d	200 b			1.000 n,q,t		
Iodine		4 c						
Lanthanum			50 b					
Lead	7439-92-1	50 c	500 a	16 g	4000 e,i	0.0025 t	28 h	323 f,i
Lithium	7439-93-2	2 c	10 b		1175 e	0.014 o		72 f
Magnesium						82 p		
Manganese and compounds	7439-96-5	500 c	100 b	4125 g	11000 e,i	0.120 o	7242 h	676 f,i
Mercury (elemental, total)	7439-97-6	0.3 c	0.1 a	1.5 g	73 e	0.00077 t	3.3 h	10 f
Mercury (methyl)	22967-92-6	0.0002 d		0.025 g	4 e,i		0.05 h	0.25 f,i
Molybdenum	7439-98-7	2 c	200 b	15 g	14 e	0.370 o	25 h	1 f
Nickel	7440-02-0	30 c	200 a	320 g	625 e,i	0.052 t	562 h	38 f,i
Niobium					9 e			0.6 f
Potassium						53 p		
Selenium	7782-49-2	1 c	70 a	2 g	25 e,i	0.005 t	3.6 h	1.5 f,i
Silver and compounds	7440-22-4	2 c	50 b			0.00012 q		
Sodium						680 p		
Strontium	7440-24-6				32875 e	1.500 o		2001 f
Technetium		0.2 c						
Tellurium		2 d						
Thallium		1 c			1 e,i	0.040 q		0.06 f,i
Tin (inorganic)		50 c	2000 b			0.073 o		
Titanium			1000 b					
Tungsten			400 b					
Uranium	7440-61-1	5 c		65 g	170 e	0.0026 o	116 h	12 f
Vanadium	7440-62-2	2 c		47 g	25 e	0.020 o	82 h	1.6 f
Zinc	7440-66-6	50 c	200 a	60 g	20000 e,i	0.120 t	105 h	1230 f,i
Zirconium					97 e	0.017 o		7 f
ORGANICS								
Acenaphthene	83-32-9	20 c				0.520 q		
Acetone	67-64-1				1250 e	1.500 o		76 f
Acrolein	107-02-8					0.021 q		
Acrylonitrile	107-13-1		1000 b			2.6 q		
Aldrin	309-00-2				25 e,i	0.00006 r		1.5 f,i
Ammonia	7664-41-7					0.017 p		
Aniline	62-53-3	200 d						
Anthracene	120-12-7					0.013 o		
Benzene	71-43-2				3300 e	0.13 o		200 f
Benzidine	92-87-5					0.0039 o		

Exhibit A-27. (continued)

CHEMICAL	CAS No.	Soils (mg/kg)				Surface Water (mg/L)		
		Terrestrial Receptors				Fresh		
		Plants	Inverts	Birds	Mammals	Aquatic	Birds	Mammals
Benzo[a]anthracene	56-55-3					0.000027 o		
Benzo[a]pyrene	50-32-8				125 e,i	0.000014 o		8 f,i
Benzoic acid	65-85-0					0.042 o		
Benzyl alcohol	100-51-6					0.0086 o		
BHC (alpha)	319-84-6					0.0022 o		
BHC (beta)	319-85-7					0.0022 o		
BHC (gamma) Lindane	58-89-9			8 g	1000 e,i	0.00008 n,q	14.5 h	62 f,i
BHC-technical	58-89-9			2.5 g	200 e		4 h	12 f
1,1-Biphenyl	92-52-4	60 c				0.014 o		
Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7			4.5 g	1020 e	0.003 o	8 h	73 f
4-Bromoaniline		100 d						
4-Bromophenyl phenyl ether	101-55-3					0.0015 o		
2-Butanone						14 o		
Butyl benzyl phthalate	85-68-7					0.019 o		
Carbon disulfide	75-15-0					0.00092 o		
Carbon tetrachloride	56-23-5		1000 b		2000 e	0.074 r		123 f
Chlordane	57-74-9			9 g	250 e	4.3×10^{-6} q,t	15.5 h	18 f
Chloroacetamide			2 a					
3-Chloraniline		20 c	30 a					
4-Chloroaniline	106-47-8	40 d						
Chlorobenzene	108-90-7		40 a			0.05 q		
2-Chloroethyl vinyl ether	110-75-8					4.76 r		
Chloroform	67-66-3				1875 e	1.24 q		115 f
beta-Chloronaphthalene	91-58-7					0.032 r		
2-Chlorophenol	95-57-8	60 d				2.0 q		
3-Chlorophenol		7 c	10 a					
4-Chlorophenol		50 d						
Chlorpyrifos	2921-88-2					0.000041 t		

CHEMICAL	CAS No.	Soils (mg/kg)				Surface Water (mg/L)		
		Terrestrial Receptors				Fresh		
		Plants	Inverts	Birds	Mammals	Aquatic	Birds	Mammals
DDD	72-54-8			0.01 g	100 e	0.000001 t	0.02 h	6 f
DDE	72-55-9			0.01 g	100 e		0.02 h	6 f
DDT	50-29-3			0.01 g	100 e,i	0.000001 q	0.02 h	6 f,i
Decane						0.049 o		
Demeton	8065-48-3					0.0001 q,t		
Diazinon	333-41-5					0.000043 o		
Dibenzofuran	132-64-9				2.0×10^{-3} e	0.0037 o		
Di-n-butyl phthalate	84-74-2	200 c		0.45 g	30000 e	0.035 o	0.8 h	2200 f
2,4-Dichloroaniline			100 a					
3,4-Dichloroaniline		10 d	20 a					
1,2-Dichlorobenzene	95-50-1					0.014 o		
1,3-Dichlorobenzene	541-73-1					0.071 o		
1,4-Dichlorobenzene	106-46-7		20 a			0.015 o		
cis-1,4-Dichloro-2-butene	764-41-0		1000 b					
trans-1,4-Dichloro-2-butene			1000 b					
1,1-Dichloroethane	75-34-3					0.047 o		
1,2-Dichloroethane (EDC)	107-06-2			70 g	2780 e	20.0 q	125 h	200 f
1,1-Dichloroethylene	75-35-4				3750 e	0.025 o		230 f
1,2-Dichloroethylene (cis)	156-59-2				2500 e	0.590 o		180 f
1,2-Dichloroethylene (trans)	156-60-5				2500 e	0.590 o		180 f
1,2-Dichloroethylene (mixture)	540-59-0				2500 e	0.590 o		180 f
2,4-Dichlorophenol	120-83-2	20 d				3.65 q		
3,4-Dichlorophenol		20 c	20 a					
1,2-Dichloropropane	78-87-5		700 a			5.7 q		
1,3-Dichloropropene	542-75-6					0.244 q		
Dieldrin	60-57-1			0.3 g	3 e	0.000056 t	0.6 h	0.15 f
Diethyl phthalate	84-66-2	100 c			2.5×10^{5} e	0.210 o		1.8×10^{4} f
Di-n-hexylphthalate					3050 e			220 f

Exhibit A-27. (continued)

CHEMICAL	CAS No.	Soils (mg/kg) Terrestrial Receptors				Surface Water (mg/L) Fresh		
		Plants	Inverts	Birds	Mammals	Aquatic	Birds	Mammals
2,4-Dimethylphenol	105-67-9	20 c				0.042 r		
Dimethyl phthalate	131-11-3		200 a			0.003 q		
Dimethyl terephthalate	120-61-6					0.003 q		
2,4-Dinitrophenol	51-28-5	20 c						
Dinitrotoluene mixture	25321-14-6					0.230 q		
2,4-Dinitrotoluene	121-14-2					0.230 q		
2,6-Dinitrotoluene	606-20-2					0.230 q		
Di-n-octyl phthalate	117-84-0					0.708 p		
1,4-Dioxane	123-91-1				63 e			4 f
1,2-Diphenylhydrazine	122-66-7					0.0054 r		
Endosulfan	115-29-7			42 g	20 e	0.000056 q,t	72 h	1 f
Endrin	72-20-8			0.04 g	5 e	0.000036 t	0.07 h	0.3 f
Ethanol					4000 e			245 f
Ethyl acetate	141-78-6				11250 e			690 f
Ethylbenzene	100-41-4					0.0073 o		
Fluoranthene	206-44-0					0.00616 n		
Fluorene	86-73-7		30 a			0.0039 p		
Formaldehyde	50-00-0				3900 e			184 f
Furan	110-00-9	600 c						
Guthion	86-50-0					0.00001 t		
Heptachlor	76-44-8				15 e,i	3.8×10^{-6} q,t		2 f,i
Heptachlor epoxide	102-45-73					3.8×10^{-5} t		
Heptane		1 d						
Hexachlorobenzene	118-74-1		1000 b					
Hexachlorobutadiene	87-68-3					0.0093 q		
Hexachlorocyclopentadiene	77-47-4	10 c				0.0052 q		
Hexachloroethane	67-72-1					0.540 q		
n-Hexane	110-54-3					0.00058 o		

CHEMICAL	CAS No.	Soils (mg/kg) Terrestrial Receptors				Surface Water (mg/L) Fresh		
		Plants	Inverts	Birds	Mammals	Aquatic	Birds	Mammals
Pentachlorophenol	87-86-5	3 c	4 a		30 e	0.015 t		1.8 f
1-Pentanol						0.110 o		
Phenanthrene						0.0063 n		
Phenol	108-95-2	70 c	30 a			0.110 n		
Polychlorinated biphenyls (Total)	1336-36-3	40 c			4 e,i	0.000014 q,t		0.27 e,i
Aroclor 1016	12674-11-2				100 e			13 f
Aroclor 1221						0.00028 o		
Aroclor 1232						0.00058 o		
Aroclor 1242				1.5 g	5 e	0.000053 o	3.0 h	0.7 f
Aroclor 1248						0.000081 o		
Aroclor 1254	11097-69-1			0.7 g	4 e	0.000033 o	1.3 h	0.3 f
Aroclor 1260						0.094 o		
2-Propanol						0.0075 o		
Styrene	100-42-5	300 c						
2,3,7,8-TCDD (dioxin)	1746-01-6			5.5×10^{-5} g	1.2×10^{-4} e		1.0×10^{-4} h	7.6×10^{-6} f
2,3,5,6-Tetrachloroaniline		20 c	20 a					
1,2,3,4-Tetrachlorobenzene			10 a					
1,1,1,2-Tetrachloroethane	630-20-6					0.186 r		
1,1,2,2-Tetrachloroethane	79-34-5					2.4 q		
Tetrachloroethylene (PCE)	127-18-4	10 d			80 e	0.840 q		6 f
Tetrachloromethane						0.240 o		
2,3,4,6-Tetrachlorophenol	58-90-2		20 a					
Toluene	108-88-3	200 c			1440 e	0.0098 o		104 f
p-Toluidine	106-49-0	100 d						
Toxaphene	8001-35-2				1000 e	2.0×10^{-7} q,t		60 f
Tribromomethane						0.320 o		
Tributyltin						0.000063 t		
Tributyltin oxide (TBTO)	56-35-9			28 g	1300 e,i	0.01 s	49 h	94 f,i

Exhibit A-27. (concluded)

CHEMICAL	CAS No.	Soils (mg/kg) Terrestrial Receptors				Surface Water (mg/L) Fresh		
		Plants	Inverts	Birds	Mammals	Aquatic	Birds	Mammals
2,4,5-Trichloroaniline		20 c	20 a					
1,2,3-Trichlorobenzene			20 a					
1,2,4-Trichlorobenzene	120-82-1		20 a			0.110 o		
1,1,1-Trichloroethane	71-55-6				55550 e	0.011 o		4000 f
1,1,2-Trichloroethane	79-00-5					9.4 q		
Trichloroethylene (TCE)	79-01-6				40 e	21.9 q		3 f
2,4,5-Trichlorophenol	95-95-4	4 c	9 a					
2,4,6-Trichlorophenol	88-06-2	10 d	10 a			0.970 q		
Vinyl acetate	108-05-4					0.016 o		
Vinyl chloride	75-01-4				20 e			1.3 f
m-Xylene	108-38-3					0.0018 o		
o-Xylene	95-47-6	1 d						
Xylene (mixed)	1330-20-7	100 d			120 e	0.013 o		8 f

Table 1 Notes

a) Oak Ridge National Laboratory (ORNL) TM-126 [1995] Table 1 (earthworms)
b) ORNL TM-126 [1995] Table 2 (microbial processes)
c) ORNL TM-85/R3 [1997] Table 1 (soil)
d) ORNL TM-85/R3 [1997] Table 1 (soil solution)
e) NOAEL equivalent concentration in food (i.e., the dietary level in food of a chemical that would result in a dose equivalent to the NOAEL, assuming no other exposures) for mammals. Calculated per Equation (10) in ORNL TM-86/R3 [1996], with NOAEL values from Appendix A of same reference. Assumes diet is 10% soil – approximately the 95th percentile of estimated percent soil in diet (dry weight) values for mammals given in Tables 4-4 and 4-5 of the *Wildlife Exposure Factors Handbook* (EPA/600/R-93/187, 1993).
f) NOAEL equivalent concentration in drinking water (i.e., the level of a chemical in the drinking water of an animal that would result in a dose equivalent to the NOAEL, assuming no other exposures) for mammals. Calculated per Equation (22) in ORNL TM-86/R3 [1996], with NOAEL values from Appendix A of same reference. Assumes all drinking water is consumed from source contaminated with the given chemical.
g) NOAEL equivalent concentration in food for birds (represented by the American Robin) from ORNL TM-86/R3 [1996], Appendix D, Table 12. Assumes diet is 20% soil – approximately the 95th percentile of estimated percent soil in diet (dry weight) values for birds given in Table 4-4 of the *Wildlife Exposure Factors Handbook* (EPA/600/R-93/187, 1993).
h) NOAEL equivalent concentration in water for birds (represented by the American Robin) from ORNL TM-86/R3 [1996], Appendix D, Table 12.
i) Reflects limited re-assessment (based on new and/or different toxicology data) of values originally appearing in ORNL TM-86/R3. Further details available upon request.
j) reserved
k) Order of precedence for surface (fresh) water values is: (1) corrected NRWQC [t], (2) NAWQC chronic value [n], (3) Oregon chronic WQC [q], (4) Oregon acute WQC [r], (5) ORNL secondary chronic value [l], (6) ORNL Tier II secondary chronic value [o], and (7) ORNL lowest chronic value, other organisms [p].
l) ORNL TM-95/R4 [1997] Table 3 (secondary chronic value)
m) reserved
n) ORNL TM-96/R2 [1996] Table 1 (NAWQC chronic value)
o) ORNL TM-96/R2 [1996] Table 1 (Tier II secondary chronic value)
p) ORNL TM-96/R2 [1996] Table 1 (lowest chronic value, all other organisms)
q) Oregon Water Quality Criteria [1992] Freshwater chronic criteria (OAR 340-41)
r) Oregon Water Quality Criteria [1992] Freshwater acute criteria (OAR 340-41) divided by 50 for acute > chronic conversion.
s) USEPA [1991] *Draft Proposed Ambient Aquatic Life Water Quality Criteria for Tributyltin*
t) USEPA [EPA 822-Z-99-001; April 1999] *National Recommended Water Quality Criteria - Correction* (chronic values)

Source: Oregon Department of Environmental Quality (2001).
http://www.deq.state.or.us/wmc/documents/eco-2slv.pdf

Exhibit A-28. Oregon screening level values for freshwater and marine sediments.

CHEMICAL	CAS No.	SEDIMENT		
		Freshwater	Marine	Bioaccumulation
INORGANICS (mg/kg)				
Antimony and compounds	7440-36-0	3 g	9 f	10 k
Arsenic III	7440-38-2	6 c	7 c	4 k
Barium and compounds	7440-39-3		48 f	
Beryllium				122 k
Cadmium and compounds	7440-43-9	0.6 c	0.7 d	0.003 k
Chromium (total)		37 c	52 d	4200 k
Copper and compounds	7440-50-8	36 c	19 d	10 k
Lead	7439-92-1	35 c	30 d	128 k
Manganese and compounds	7439-96-5	1100 g		
Mercury (elemental, total)	7439-97-6	0.2 c, j	0.1 d	
Mercury (methyl)	22967-92-6			
Nickel	7440-02-0	18 c	16 d	316 k
Selenium	7782-49-2		1 f	0.1 k
Silver and compounds	7440-22-4	4.5 b, g	0.7 d	
Thallium				0.7 k
Vanadium	7440-62-2		57 f	
Zinc	7440-66-6	123 c	124 d	3 k
ORGANICS (µg/kg)				
Acetone				290 k
Acenaphthene	83-32-9	290 g	7 d	
Acenaphthylene	208-96-8	160 g	6 d	
Aldrin	309-00-2	40 g	10 f	40 k
Anthracene	120-12-7	57 j	47 d	
Benzene				3920 k
Benzo[a]anthracene	56-55-3	32 c	75 d	
Benzo[b]fluoranthene	205-99-2		1800 f	
Benzo[k]fluoranthene	207-08-9	27 c	1800 f	
Benzo[a]pyrene	50-32-8	32 c	89 d	100 k
Benzo[g,h,i]perylene	191-24-2	300 g	670 a, f	
Benzoic acid	65-85-0		65 f	
Benzyl alcohol	100-51-6		52~57 a, f	
BHC (beta)	319-85-7			220 k
BHC (gamma) Lindane	58-89-9	0.9 c	0.3 d	1160 k
BHC (technical)	608-73-1	100 g		4 k
Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	750 b, g	1300 f	330 k

Exhibit A-28. (continued)

CHEMICAL	CAS No.	SEDIMENT		
		Freshwater	Marine	Bioaccumulation
Chrysene	218-01-9	57 c	107 d	
DDD	72-54-8	4 c	1 d	0.3 k
DDE	72-55-9	1.5 c	2 d	0.3 k
DDT	50-29-3	4 j	1 d	0.3 k
DDT (Total)		7 c	4 d	0.3 k
Dibenz[a,h]anthracene	53-70-3	33 j	6 d	
Dibenzofuran	132-64-9	5100 g	110 f	
Di-n-butyl phthalate	84-74-2	110 g	58 f	60 k
1,2-Dichlorobenzene	95-50-1		13 f	
1,3-Dichlorobenzene	541-73-1		170 a	
1,4-Dichlorobenzene	106-46-7		110 a, f	
1,1-Dichloroethylene				1590 k
1,2-Dichloroethane				3430 k
1,2-Dichloroethylene				5760 k
Dieldrin	60-57-1	3 c	0.7 d	4 k
Diethyl phthalate	84-66-2		6 f	8.3×10^{5} k
2,4-Dimethylphenol	105-67-9		18 f	
Dimethyl phthalate	131-11-3		6 f	
Di-n-octyl phthalate	117-84-0		61 f	
1,4-Dioxane				10 k
Endosulfan	115-29-7			110 k
Endrin	72-20-8	3 c		4 k
Ethanol				840 k
Ethyl acetate				8950 k
Ethylbenzene	100-41-4		4 f	
Fluoranthene	206-44-0	111 c	113 d	
Fluorene	86-73-7	77 j	21 d	
Formaldehyde				900 k
Heptachlor	76-44-8	10 g	0.3 f	24 k
Heptachlor epoxide	102-45-73	0.6 c		
Hexachlorobenzene (HCB)	118-74-1	100 g	6 f	
Hexachlorobutadiene	87-68-3		1 f	
Hexachloroethane	67-72-1		73 f	
Indeno[1,2,3-cd]pyrene	193-39-5	17 c	600 f	
Kepone (Chlordecone)	143-50-0			24 k

Exhibit A-28. (continued)

CHEMICAL	CAS No.	SEDIMENT		
		Freshwater	Marine	Bioaccumulation
4-Methyl-2-pentanone				3810 k
Mirex	2385-85-5	800 g		
Naphthalene	91-20-3	176 j	35 d	
Nitrobenzene	98-95-3		21 f	
N-Nitrosodiphenylamine	86-30-6		28 a, f	
Pentachloronitrobenzene	82-68-8			3640 k
Pentachlorophenol	87-86-5		17 f	370 k
Phenanthrene	85-01-8	42 c	86 d	
Phenol	108-95-2	48 b, g	130 f	
Polychlorinated biphenyls (total)	1336-36-3	34 c	22 d	
Aroclor 1016	12674-11-2			420 k
Aroclor 1242				2 k
Aroclor 1248		21 b		4 k
Aroclor 1254	11097-69-1	7 b		10 k
Polycyclic aromatic hydrocarbons				
Total PAH		1610 j	1684 d	
Total LPAH		76 c	312 d	
Total HPAH		193 c	655 d	
Pyrene	129-00-0	53 c	152 d	
2,3,7,8-TCDD (dioxin)	1746-01-6	0.009 g	0.004 f	8.5×10^{-4} k
Tetrachloroethylene (PCE)	127-18-4		57 f	280 k
Toluene				5300 k
Toxaphene	8001-35-2			2550 k
Tributyltin	56573-85-4		3 f	190 k
1,2,4-Trichlorobenzene	120-82-1		5 f	
1,1,1-Trichloroethane				1.8×10^{5} k
Trichloroethylene (TCE)	79-01-6		41 f	140 k
2,4,5-Trichlorophenol	95-95-4		3 f	
2,4,6-Trichlorophenol	88-06-2		6 f	
Vinyl chloride				30 k
Xylene (mixed)	1330-20-7		4 f	

Exhibit A-28. (concluded)

Table 2 Notes

a) Screening Level (SL), Table 8-1, *Dredged Material Evaluation Framework, Lower Columbia River Management Area*, U.S. Army Corps of Engineers, April 1998 Draft.

b) Lowest Apparent Effects Threshold (LAET), Table 11, *Creation and Analysis of Freshwater Sediment Quality Values in Washington State*, Washington Department of Ecology, Pub. No. 97-323a, July 1997.

c) Threshold Effects Level (TEL) or lowest ARCs *H. azteca* TEL, Freshwater Sediment, Screening Quick Reference Tables (SQuiRTs), NOAA, Coastal Resource Coordination Branch, Hazmat Report 99-1, 1999.

d) Threshold Effects Level (TEL), Marine Sediment, SquiRTs.

e) Apparent Effects Threshold (AET), Freshwater Sediment, SquiRTs.

f) Apparent Effects Threshold (AET), Marine Sediment, SquiRTs.

g) Upper Effects Threshold (UET), Freshwater Sediment, SquiRTs.

h) Upper Effects Threshold (UET), Marine Sediment, SquiRTs.

i) Freshwater Chronic Criteria, *Ambient Water Quality Criteria Document for Tributyltin*, U.S. Environmental Protection Agency, 62 FR 42554, August 7, 1997.

j) Threshold Effects Concentration (TEC). Smith, SL., MacDonald, DD, Keenleyside, KA, Ingersoll, CG, and Field, J. 1996. A preliminary evaluation of sediment quality assessment values for freshwater ecosystems. *Journal of Great Lakes Research* 22:624-638.

k) Allowable water concentrations (C_w) calculated per Equation (28), Section 3.5 of ORNL TM-86/R3 [1996]. Value is lowest for representative piscivorous bird (Great Blue Heron) or piscivorous mammal (mink) species. Conversion of water (C_w) to sediment concentrations assumes 1% organic carbon content and organic carbon partition coefficient (K_{oc}) estimated from the octanol water partition coefficient (K_{ow}; taken from ORNL TM-86/R3 [1996]) using the regression relationship: log K_{oc} = 0.00028 + 0.983(log K_{ow}) [Di Toro et al. 1991. Technical basis for establishing sediment quality criteria for nonionic organic chemicals using equilibrium partitioning. *Environmental Toxicology and Chemistry* 10: 1541 - 1583].

Source: Oregon Department of Environmental Quality (2001).
http://www.deq.state.or.us/wmc/documents/eco-2slv.pdf

Exhibit A-29. Pennsylvania general permit for dredged material in road applications

Compound	Total Level (mg/kg)	Leachate Level (mg/l)
Volatiles		
Vinyl Chloride	2	0.02
1,2-Dichloroethane	0.3	0.005
Chloroform	0.5	0.10
Carbon Tetrachloride	2.1	0.004
Benzene	0.8	0.005
Chlorobenzene	--	0.10
Tetrachloroethene	2.0	0.005
Semivolatiles		
Phenol	400	21
2-Chlorophenol	--	0.175
Nitrobenzene	--	0.0175
Naphthalene	8.0	--
Acenaphthene	30	2.1
Fluorene	40	1.4
Pyrene	300	1.05
Chrysene	500	--
Pesticides		
Heptachlor	1.0	0.0004
Aldrin	0.3	2.06×10^{-6}
Dieldrin	0.3	2.19×10^{-6}
Endrin	20	0.02
Inorganics		
Arsenic	41	1.25
Cadmium	20	0.125
Copper	700	32.50
Lead	200	1.25
Mercury	20	0.05
Nickel	200	17.50
Zinc	1,000	125
Source: Bureau of Land Recycling and Waste Management (Number: WMGR072).		

Exhibit A-30. Washington administrative code sediment management standards "no adverse effects."

CHEMICAL PARAMETER	MG/KG DRY WEIGHT (PARTS PER MILLION (PPM) DRY)
ARSENIC	57
CADMIUM	5.1
CHROMIUM	260
COPPER	390
LEAD	450
MERCURY	0.41
SILVER	6.1
ZINC	410

CHEMICAL PARAMETER	MG/KG ORGANIC CARBON (PPM CARBON)
LPAH	370
NAPHTHALENE	99
ACENAPHTHYLENE	66
ACENAPHTHENE	16
FLUORENE	23
PHENANTHRENE	100
ANTHRACENE	220
2-METHYLNAPHTHALENE	38
HPAH	960
FLUORANTHENE	160
PYRENE	1000
BENZ(A)ANTHRACENE	110
CHRYSENE	110
TOTAL BENZOFLUORANTHENES	230
BENZO(A)PYRENE	99
INDENO (1,2,3,-C,D) PYRENE	34
DIBENZO (A,H) ANTHRACENE	12
BENZO(G,H,I)PERYLENE	31
1,2-DICHLOROBENZENE	2.3
1,4-DICHLOROBENZENE	3.1
1,2,4-TRICHLOROBENZENE	0.81
HEXACHLOROBENZENE	0.38
DIMETHYL PHTHALATE	53
DIETHYL PHTHALATE	61
DI-N-BUTYL PHTHALATE	220
BUTYL BENZYL PHTHALATE	4.9
BIS (2-ETHYLHEXYL) PHTHALATE	47
DI-N-OCTYL PHTHALATE	58
DIBENZOFURAN	15
HEXACHLOROBUTADIENE	3.9
N-NITROSODIPHENYLAMINE	11
TOTAL PCB'S	12

CHEMICAL PARAMETER	UG/KG DRY WEIGHT (PARTS PER BILLION (PPB) DRY)
PHENOL	420
2-METHYLPHENOL	63
4-METHYLPHENOL	670
2,4-DIMETHYL PHENOL	29
PENTACHLOROPHENOL	360
BENZYL ALCOHOL	57
BENZOIC ACID	650

Source: Washington Administrative Code 173-204-320 (*http://www.leg.wa.gov/WAC/*).

Exhibit A-31. Washington administrative code sediment management standards "minor adverse effects."

CHEMICAL PARAMETER	MG/KG DRY WEIGHT (PARTS PER MILLION (PPM) DRY)
ARSENIC	93
CADMIUM	6.7
CHROMIUM	270
COPPER	390
LEAD	530
MERCURY	0.59
SILVER	6.1
ZINC	960

CHEMICAL PARAMETER	MG/KG ORGANIC CARBON (PPM CARBON)
LPAH	780
NAPHTHALENE	170
ACENAPHTHYLENE	66
ACENAPHTHENE	57
FLUORENE	79
PHENANTHRENE	480
ANTHRACENE	1200
2-METHYLNAPHTHALENE	64
HPAH	5300
FLUORANTHENE	1200
PYRENE	1400
BENZ(A)ANTHRACENE	270
CHRYSENE	460
TOTAL BENZOFLUORANTHENES	450
BENZO(A)PYRENE	210
INDENO (1,2,3,-C,D) PYRENE	88
DIBENZO (A,H) ANTHRACENE	33
BENZO(G,H,I)PERYLENE	78
1,2-DICHLOROBENZENE	2.3
1,4-DICHLOROBENZENE	9
1,2,4-TRICHLOROBENZENE	1.8
HEXACHLOROBENZENE	2.3
DIMETHYL PHTHALATE	53
DIETHYL PHTHALATE	110
DI-N-BUTYL PHTHALATE	1700
BUTYL BENZYL PHTHALATE	64
BIS (2-ETHYLHEXYL) PHTHALATE	78
DI-N-OCTYL PHTHALATE	4500
DIBENZOFURAN	58
HEXACHLOROBUTADIENE	6.2
N-NITROSODIPHENYLAMINE	11
TOTAL PCB'S	65

CHEMICAL PARAMETER	UG/KG DRY WEIGHT (PARTS PER BILLION (PPB) DRY)
PHENOL	1200
2-METHYLPHENOL	63
4-METHYLPHENOL	670
2,4-DIMETHYL PHENOL	29
PENTACHLOROPHENOL	690
BENZYL ALCOHOL	73
BENZOIC ACID	650

Source: Washington Administrative Code 173-204-420 (*http://www.leg.wa.gov/WAC/*).

Exhibit A-32. Mammalian and avian soil values.

RECEPTOR	SOIL CRITERION
SC (shrews)	4.94 µg PCBs / kg soil = 4.94 ppb
SC (moles)	4.91 µg PCBs / kg soil = 4.91 ppb
SC (weasels)	0.26 µg PCBs / kg soil = 0.26 ppb
Geometric Mean For Mammalian Receptors	**1.9 µg PCBs / kg soil = 1.9 ppb**

RECEPTOR	SOIL CRITERION
Prairie Chicken	323.1 µg PCBs / kg soil = 323.1 ppb
Pheasant	913.16 µg PCBs / kg soil = 913.2 ppb
Woodcock	24.6 µg PCBs / kg soil = 24.6 ppb
Red-tailed Hawk	3.6 µg PCBs / kg soil = 3.6 ppb
Geometric Mean For Avian Receptors	**71.3 µg PCBs / kg soil = 71.3 ppb**

Source: Wisconsin Department of Natural Resources (2001).

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14. ABSTRACT

The Corps of Engineers has the responsibility to maintain navigation of waterways across the United States. The Corps dredges more than 300 million cubic yards of sediment annually. Subsequently, methods to evaluate and determine environmentally and economically sound management alternatives are needed. Technological advances in equipment, treatment, and handling technologies continue to increase the options for beneficial uses (BUs). Ten categories of BU are: 1) Habitat development, 2) Beach nourishment, 3) Aquaculture, 4) Parks and recreation, 5) Agriculture, forestry, and horticulture, 6) Strip mine reclamation and solid waste management, 7) Shoreline stabilization and erosion control, 8) Construction and industrial use, 9) Material transfer, and 10) Multiple purpose. BUs of dredged material have a productive history resulting in over 2,000 man-made islands, more than 100 marshes, and nearly 1,000 habitat development projects. Corps islands provide vital habitat for rare, threatened, or endangered species. It is estimated that 1,000,000 birds nest on dredged material islands each year. BUs of existing dredged material in confined disposal facilities (CDF) should be considered along with all the alternatives available for CDF management. This report compiles current guidance and best practices useful to evaluate dredged material from ongoing dredging projects or CDFs for BUs.

15. SUBJECT TERMS
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Beach nourishment
Contaminated sediment
Dredged material management
Suitability for beneficial uses

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