State of Wisconsin Department of Natural Resources

Guidance for Applying the Sediment Sampling and Analysis Requirements of Chapter NR 347, Wisconsin Administrative Code

Developed by the Contaminated Sediment Standing Team

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Guidance for Applying the Sediment Sampling and Analysis Requirements of Chapter NR 347, Wisconsin Administrative Code

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1. Purpose

Chapter NR 347 Wisconsin Administrative Code (Adm. Code), "Sediment Sampling and Analysis, Monitoring Protocol and Disposal Criteria for Dredging Projects", was promulgated "...to protect the public rights and interest in the waters of the state by specifying definitions, sediment sampling and analysis requirements, disposal criteria and monitoring requirements for dredging projects..." (NR 347.01 (1), Adm. Code). In addition, the code states "It is department policy to encourage reuse of dredged material and to minimize environmental harm resulting from a dredging project."

NR 347, Adm. Code requires the collection of information on a given project including, where necessary, collection and analysis of sediment from the project site. This information can then be used by various Department programs to evaluate appropriate actions, including permit conditions, which are necessary to manage potential environmental risk.

This guidance document is designed to assist staff in interpreting the requirements of NR 347, Adm. Code, to shape the initial information submittal required of any party who proposes a dredging project in the State of Wisconsin. In particular this document provides guidance and additional resources for determining the appropriate number of *in situ* samples, the parameters to be tested, and sampling procedures and analyses to be used to characterize the sediment quality in a proposed project area.

This document **is not** designed to provide complete guidance for complex cases, such as those where large volumes of sediment with elevated levels of contaminants are present. Complex cases require more extensive review and input from staff with specialized expertise in wastewater, waste management, and sediment management.

Department staff are encouraged to use knowledgeable professional judgment and consultation with other programs to modify the information requirements, including sample numbers and analyses, as necessary to meet the purpose and requirements of the code. Existing data on the site and the degree of risk posed by the project should also be used to guide the determination of the scope of the information required from a project applicant. Results of the sampling and analyses may lead to project modifications and will guide the inclusion of specific conditions in the final dredging permit to address the dredging, handling, and disposal of the excavated sediments.

2. Introduction

Contamination of a chemical nature, or a contaminant, is a substance or substances, either organic or inorganic, which are present in sediments or surface waters that are found above levels that would normally occur. Contaminants at elevated levels in sediment have the potential to cause environmental impacts during and after a dredging operation. Some of the potential concerns include:

1. Release of contaminants through:
    a. bottom disturbances and releases to the water column from the dredging
    b. spills or leaks from barges, scows, discharge pipelines and other sediment transport methods at the dredging site or near shore
    c. infiltration of sediment pore water into groundwater at an upland dewatering facility
    d. discharge of contaminants back into waterways via hydraulic dredge carriage water
2. Exposure of contaminants at the proposed project depth and along the sidewalls at the project boundaries after dredging.
3. Suitability of sediments planned for reuse and disposal for shoreline beach nourishment projects under NR 347.07 (4), Adm. Code.
4. Suitability of sediments for on-land disposal.

An example of a potential risk from a dredging project is the release of sediment into the water column from excavation activities. At some sites, particularly in more industrial waterways, contaminants from spills or industrial discharges have settled to the bed and accumulated in sediment. In some conditions the excavation of sediments with high levels of contamination can release the contaminants to the water column and pose a risk to down stream areas or to the biota. Contaminants in sediments at high concentrations can also pose a potential risk during disposal or beneficial reuse through pathways such as bioaccumulation or toxicity to aquatic or terrestrial organisms. In general, the expected degree of risk from a project will dictate the effort required in a sampling and analysis plan. NR 347, Adm. Code provides the Department with the latitude to increase, decrease or waive sampling requirements as appropriate to the project conditions.

To evaluate contamination, it is necessary to understand the normal or background levels for the project area. Background for metals is the levels of metals which originate from the natural soil types and the geochemical components of the watershed. Background for natural organic compounds would generally be those compounds that originate from vegetative or animal matter that are deposited on the bottoms of lakes, streams, and wetlands. Organic chemicals manufactured by humans and released to the environment by various mechanisms generally do not have counterparts found in nature and therefore any levels found in environmental media would be considered potential contamination. Many manufactured organic compounds may be found ubiquitously at low levels in sediments, especially in urban areas.

Environmental concerns arise when the concentration of contaminants in surface waters and sediments leads to observed and measurable effects to biological receptors. The contaminant in these circumstances becomes a toxicant. Some examples of these effects are:

1) chronic and/or acute toxicity to aquatic receptors such as bottom inhabiting macroinvertebrates or water column organisms; and/or
2) concerns about humans and wildlife that are upper food chain organisms who may become exposed to the harmful levels of contaminants principally through consumption of aquatic organisms that have bioaccumulated.

Some key conditions must exist for the toxicity to aquatic organisms to be realized and/or unacceptable levels of bioaccumulation to occur:

(a) the aquatic organism has to be exposed to the potential toxicant in its habitat,

(b) the potential toxicant has to be in a form available for uptake, and

(c) the uptake or dose of the contaminant has to be at a level that causes toxicity to the particular exposed receptor or results in levels of bioaccumulation that may pose risks to humans and/or wildlife who consume the exposed receptor as food.

Collection of sampling and analytical information under NR 347, Adm. Code, is premised on the need to obtain adequate information to characterize the quality of sediments within the proposed project area. These data are used to identify if there are any potential environmental concerns that may arise during the dredging, handling, and disposal of those sediments. Assessing sediment quality as it relates to identifying surface water issues can be based on a tiered framework utilizing numerical sediment quality guidelines found in Consensus Based Sediment Quality Guidelines, WDNR Publ WT-732 2002. More comprehensive risk-based assessments may be needed for sites that are more complex. The diversity of dredging projects and objectives calls for the need for a flexible framework for assessing sediment quality. More extensive assessments and greater information is obtained in successively higher tiers.

Reasons for designing and conducting risk-based studies at higher assessment tiers may include:

1) the complexity of the interactions of the aquatic ecosystems and the contaminant stressors may increase,
2) diverse mixtures of contaminants may be present at a site,
3) outstanding exposure issues where a risk assessment will allow realistic use of information about the natural history of a species such as foraging areas, breeding times, and migration patterns (Moore et al. 1998),
4) there are unresolved issues with regard to potential human or ecological exposures,
5) potential for a proposed dredging project to impact local sensitive species or habitats,
6) determining environmental windows, e.g. when dredging should be prohibited to avoid environmentally sensitive periods such as fish spawning.

As needed, site-specific studies can progress to effects-based testing and risk-based studies of various designs and scope. A formal risk assessment is not something that needs to be conducted at every proposed dredging project. Decisions on typical dredging projects will be based on information collected in the lower tiers of the assessment framework. Guidance for carrying out

such risk-based studies are contained in WDNR guidance documents (1992a; 1992b) and a number of U.S. EPA guidance documents (e.g. U.S. EPA, 1998).

In those situations where a potential risk has been identified after review of the data, there are many ways that the potential risk can be safely and cost effectively managed in the performance of a dredging project. The selection of the risk management options can range from simple such as following good construction standards to minimize dredge material spillage to very complex engineered environmental controls such as isolation barriers, specialized equipment, and extensive monitoring systems. The process for selection of appropriate and cost effective controls to manage potential risk is beyond the scope of this guidance and staff are encouraged to contact program experts with experience in these areas.

3. Dredging Process and Program Reviews

Figure 1 shows the steps in the permit review process for a dredging project. The Water Management Specialist processes each dredging permit application, and seeks comments from staff with expertise in fisheries, wildlife, water resources, wastewater and waste management.

Figure 2 shows the recommended program review and routing for staff review of different sized projects. This reflects the basic coordination that needs to be done, to ensure all staff has input at the appropriate steps and that the reviews and permitting are done in a timely manner.

Projects smaller than 50 cubic yards of material, where elevated levels of contaminants are not known or anticipated, are expected to pose a low risk, and therefore require far less review from other programs. In these cases, the Water Management Specialist may process the application without extensive routing to others for review. In the case of large projects that may involve a number of complicated issues, such as high levels of contaminants, formation of a team with designated members from the appropriate programs is recommended to ensure that all issues are addressed and coordinated into the permitting process.

Figure 1. The State of Wisconsin Dredging Review Process

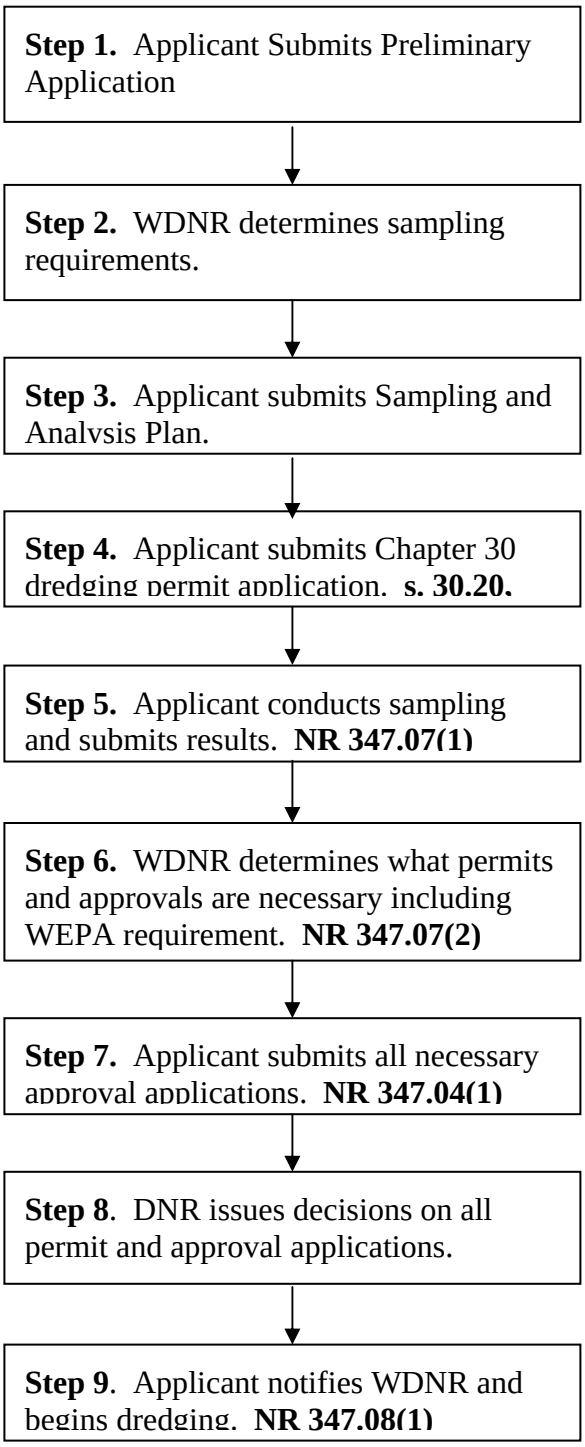
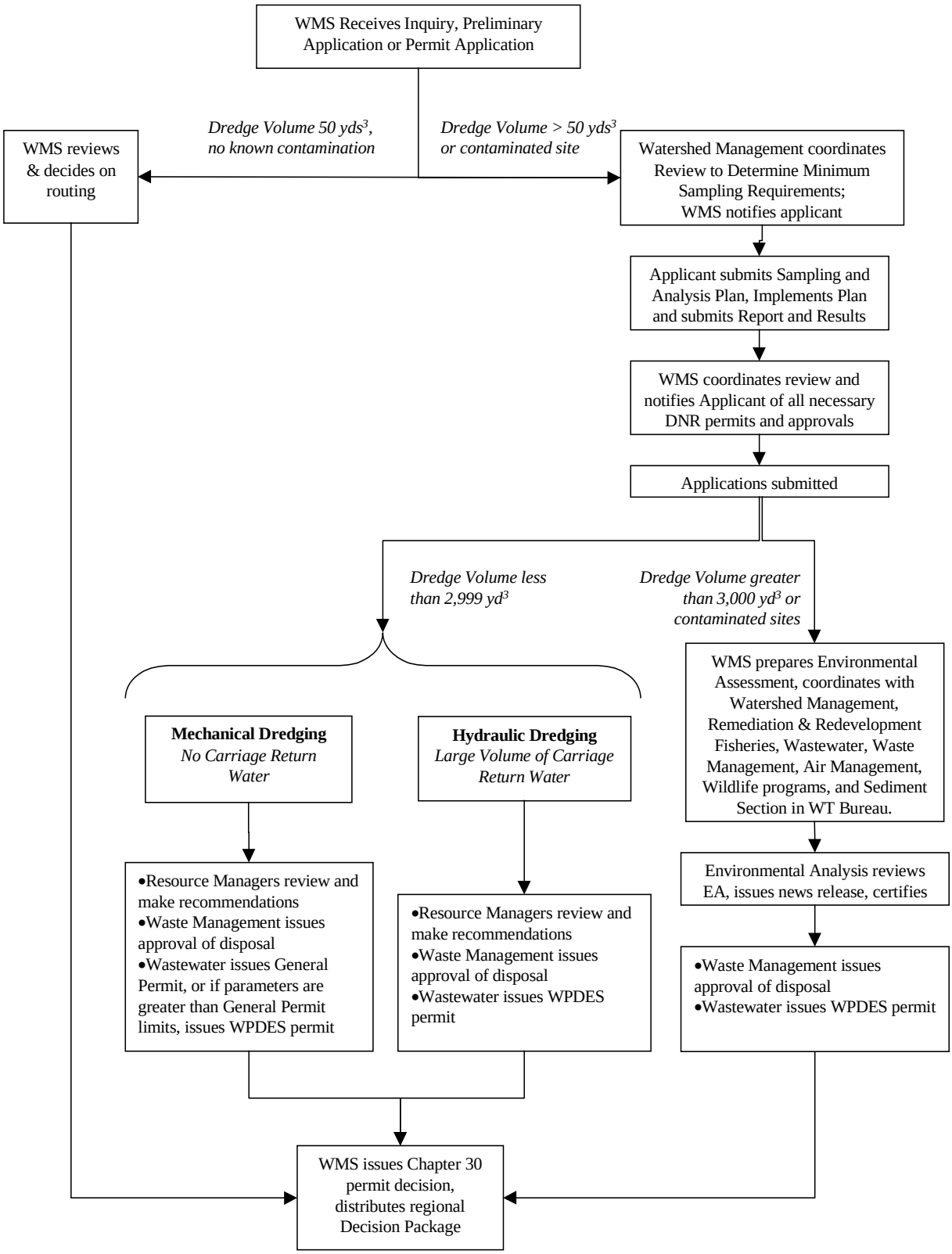


Figure 2. Internal Review and Routing for Dredging Projects under NR 347, Adm. Code



4. Dredging Project Submittals

4.1. Dredging Applicant Submittals

The dredging applicant will generally be making three submittals to the Department regarding the sampling and analytical requirements. These three submittals are:

- Preliminary Application under NR 347.05, Adm. Code. This contains the applicant's initial proposal. The Department is required to respond within 30 business days to identify sampling requirements.
- Sampling and Analysis Plan is prepared by the applicant based on the Department's determination of sampling requirements, and submitted for Department approval prior to implementation.
- Sampling Report and Analytical Results is submitted by the applicant under NR 347.07(1), Adm. Code. The Department is required to respond within 30 business days to identify all necessary permits and approvals.

Depending on the results, the Department may require additional sampling and reporting to adequately evaluate potential risk. Applicants are encouraged to submit Chapter 30 dredging permit applications at the same time as the Sampling and Analysis Plan. Applications for other permits and approvals are generally submitted after the Department notifies the applicant of all permit and approval requirements.

4.2. Preliminary Application Requirements

NR 347.05 (1), Adm. Code, requires the dredging applicant to submit preliminary information about the potential dredging project to the Department before a formal dredging permit application is submitted. The required preliminary information that should be submitted by the applicant is listed under NR 347.05 (1), Adm. Code, and includes:

- Name of waterbody and location of project
- Volume of material to be dredged
- Brief description of dredging method and equipment
- Brief description of proposed disposal method and location
- Brief description of known historical chemical use in the waterbody for vegetation / algae control, including year, chemical, and amount applied.
- Any previous sediment sampling and analysis data from the area to be dredged
- A copy of a map showing the area to be dredged, the depth of cut, the specific location of the proposed sediment sampling sites and the bathymetry of the area to be dredged, and
- Anticipated starting and completion dates of the proposed project.

The Department reviews the Preliminary Application and must respond within 30 business days (NR 347.05(2), Adm. Code) to identify the appropriate sampling and analytical requirements

necessary for characterizing the sediment quality and identifying any possible contamination. Department review should include analysis of other available information and resources relevant to the project site. The Preliminary Application and review steps can save the applicant time and expense by consulting with Department staff prior to the collection and analysis of sediment samples from the proposed project area. If the applicant collects and analyzes sediments prior to submitting the preliminary permit application and does not consult with the Department, they risk using inappropriate sample collection techniques, collecting too few or too many samples, sampling in the wrong places, analyzing for the wrong or incomplete list of parameters, or using unacceptable laboratory methods with inadequate detection limits. Any of the above may require the applicant to resample and reanalyze at additional costs to them to provide the specific data and information the Department needs to adequately review the proposed dredging project for possible environmental impacts.

Preliminary applications should be reviewed for any concerns that may trigger further review related to potential risk to human health or the environment. Examples might include dredging projects proposed in environmentally sensitive areas, located in exceptional or outstanding waterways, or projects where contaminants are present at high levels. The preliminary application process provides an opportunity for the Department to identify project concerns and notify the applicant early in the process. The applicant can then respond or make changes to the project to address regulatory concerns.

NR 347.05(2), Adm. Code, describes the responsibilities of the Department in the initial evaluation of the Preliminary Application. Department review should include researching existing sediment databases to see if past data has been collected at or near the site. Sources of data on potential sediment contaminants include:

- Department's Fish and Sediment Database,
- Department's BRRTS Database (http://www.dnr.state.wi.us/org/aw/rr/brrts/index.htm),
- USEPA's STORET Database (http://www.epa.gov/STORET/),
- Regional files of Water program or Remediation and Redevelopment program staff.

The Fish and Sediment Database is maintained jointly by two bureaus within the Water Division. Fisheries and Habitat is responsible for the fish contaminant components and Watershed Management is responsible for maintaining the sediment data contained in the database. Generally, a Watershed Management staff person in each Region has been trained to access this database. The Central Office contact for this information is the Sediment Monitoring and Database Coordinator, currently Jim Killian [phone (608) 264-6123, e-mail James.Killian@dnr.state.wi.us]. The contact person for the fish contaminant database is the Fish Toxicologist, currently Candy Schrank [phone (608) 267-7614, e-mail Candy.Schrank@dnr.state.wi.us]. The Fish and Sediment Database primarily contains fish contaminant and sediment data collected by Department staff and analyzed through the State Lab of Hygiene. Other fish contaminant and sediment data may exist in hard copy in various files. There are many other projects generally managed through other Department programs, for example the Remediation and Redevelopment (R&R) Program, which have generated significant amounts of sediment data through responsible parties and their consultants (e.g., investigations conducted at a manufactured gas plants). Contact the Regional R&R supervisor who may know of past or present projects that may have generated such data.

Depending on the project site and scope, the following other sources may be useful in the review of a Preliminary Application:

- Appropriate maps, aerial photographs, or other graphics that show surface watercourses and groundwater flow patterns, land use, building locations, and other features.
- The current and past land uses on the surrounding watershed to identify potential contaminant sources and the list of parameters that will need to be tested.
- Records of past spills and discharges (point and nonpoint) from various sources.
- Current and past industrial, municipal and stormwater outfalls (consult with the wastewater engineer).
- Levels of naturally-occurring parameters in the soils and sediments of the watershed and ubiquitous parameters (e.g., PAHs, PCBs, and heavy metals including lead and zinc) from anthropogenic sources.
- Fish and wildlife public health advisories issued for the waterbody involved.
- Surface waters historically treated with copper and arsenic-containing herbicides or herbicides that may have contained dioxins as an unwanted manufacturing byproduct.
- Location of former manufactured gas plants that may have historically discharged wastes including coal tars to the waterway.
- Contaminated groundwater plumes from landfills and other sources (current and historical)
- Wastewater and Waste Management regulations that may require certain sampling data to characterize the dredged material for determining dewatering and disposal options.
- Resources on DNR's web site www.dnr.state.wi.us/org/water/wm/wqs/sediment.
- Presence of a brownfield in vicinity of the project site.
- Location of the dredging project within the boundaries of, or in the vicinity of, any Superfund, Resource Conservation and Recovery Act (RCRA), or Remediation and Redevelopment Program site.
- For projects located within one of the five designated Great Lakes Areas of Concern (Milwaukee Estuary and Harbor, Sheboygan River, Menominee River at Marinette, Lower Fox River and Green Bay, or St. Louis River Estuary at Superior) – specific management plans such as Remedial Action Plans (RAPs) or Lakewide Area Management Plans (LAMPs) may be available.

Field investigations of the proposed dredging site and the disposal location should be conducted. During the site visit, the physical and biological characteristics of the site can be identified and linked to any of the file, map, and other information compiled from the reviews done on the subjects listed above.

4.3. Waiving, Increasing or Decreasing Sampling Requirements

Based on the preliminary information supplied by the permit applicant and the DNR initial investigation and evaluation under NR 347.05 (2), Adm. Code, staff will specify the number and

locations of samples to be collected and the parameters to be analyzed. NR 347, Adm. Code, provides flexibility in sampling requirements, whereby the type and amount of sampling required can be increased, decreased, or waived altogether depending on the information available. Note that if there will be any wastewater generated for surface or groundwater disposal, or any solid waste exemption sought, sampling will be necessary.

The applicable code sections related to sampling and analyses include:

1. Waiving sampling and analytical requirements

- The department may waive sediment sampling if it determines from the review of previous sampling data or other available information under NR 347.05(2), Adm. Code, that sediment contamination is unlikely. (NR 347.06 (3)(a), Adm. Code)
- If previous sampling data or other adequate information demonstrates that the possibility of contamination is negligible, analysis for any chemical may be waived in writing by the department. (NR 347.06 (6)(d), Adm. Code)
- All sediment samples and sediment elutriate samples shall be analyzed for those parameters listed in NR 347 Table 1 unless waived by the department. (NR 347.06 (6)(b), Adm. Code)

2. Sampling and analysis related to disposal areas

- For a project involving the disposal of dredged material at an upland disposal site, the department may require samples to be taken from the proposed disposal site and analyzed for parameters found elevated in samples from sediments in the project area. (NR 347.06 (3)(c), Adm. Code)
- Great Lakes beach nourishment disposal sites have additional sampling and analytical requirements. (NR 347.06 (3)(d), Adm. Code)

3. Specifying additional sampling and analysis

- If previous sampling data or other available information indicates the possible presence of chemicals not listed in Table 1, the department may require analysis for those chemicals. (NR 347.06 (6)(c), Adm. Code)
- If available information is either insufficient to determine the possibility for sediment contamination, or shows a possibility for sediment contamination, the department shall require the applicant to collect sufficient samples to describe the chemical, physical and biological properties of the sediment. The exact number and location of sediment samples and parameters to be analyzed will be determined by the information and factors related to the site. (NR 347.06 (3)(b), Adm. Code)
- Based on the testing report submitted, the department can require additional sediment sampling and analyses when there is evidence of contamination. (NR 347.07(3), Adm. Code)
- The department may require additional samples and analysis as specified by law or for other appropriate reasons. (NR 347.06 (6)(e), Adm. Code)

Based on a review of all the applicable, available information for the site, the Department determines the sampling and analytical requirements, and notifies the applicant in writing. The applicant will then incorporate the requirements into a sampling plan, which should be submitted to staff for a final review prior to implementation.

4.4. Sampling and Analysis Plan

The applicant incorporates the requirements into a plan, and submits it to the Department for review before implementation. This Sampling and Analysis Plan should include:

- parameters to be analyzed for, including analytical methods and detection levels
- updated sampling location map
- planned sectioning of cores at each sample location
- sampling methods and sample handling procedures
- analytical laboratory certified under NR 149, Adm. Code to conduct parameter analysis

Department staff should compare the applicant's plan against the established sampling and analytical requirements, and ensure that the various programs' initial data needs will be met. Once approved, the applicant can implement the Sampling and Analysis Plan.

5. Parameter and Test Method Selection

5.1. General Guidance for Parameter Selection

Sediment sampling is performed to characterize the material for the purpose of identifying potential risk to human health and the environment that may occur during the dredging and disposal process. Data on the physical and chemical characteristics may be used to set appropriate permit conditions to protect the environment. NR 347, Adm. Code, contains a list of physical and chemical analyses to be performed on sediment samples. As discussed earlier the code also provides leeway for the Department to increase, decrease, or waive the number of samples and the parameter list. **Table 1** is an enhanced version of Table 1 from NR 347.06, Adm. Code that includes additional updated information and reflects the results of scientific research and experience with dredging projects. To the extent that the enhanced version includes parameters not included in Table 1 from NR 347.06, those additional parameters are to be considered suggestions only. Table 1 has an additional column for Suggested Analytical Method, along with the detection level for the parameter in the method. The Suggested Base Parameter Analyses column is based on experience gained by the review of data from numerous sediment projects. The Waste Management program may request additional contaminant analyses necessary for making dredged material disposal determinations. Hence, be sure to consult with the Waste Management program to provide as complete of a parameter list as possible to the applicant.

5.2. Site-Specific Guidance for Parameters

For certain projects, knowledge of the past site use or adjacent land use history can be used to help identify particular contaminants that may be present in the sediment. For example, in the Great Lakes Basin, especially in the large tributaries and harbors, a more extensive list of parameters may be appropriate depending on the scope of the project and past data.

Polycyclic aromatic hydrocarbons (PAHs) are common urban and industrial contaminants commonly contributed by former coal gasification plants, urban runoff, oil spills, and vehicle and smoke stack particulate emissions. Where past data or the site location would indicate that these potential sources had occurred, e.g., petroleum spill, PAHs should be added to the sampling and analysis plan. If PAHs are not added to the sampling and analysis plan, the plan should include an explanation as to why PAHs were not addressed. The number of samples for PAHs can be adjusted based on consideration of the site, the scale of the project and anticipated risk.

PCBs (polychlorinated biphenyls) and mercury are two contaminants that bioconcentrate up aquatic food chains and are highly bioaccumulative in upper trophic level organisms like game fish. Fish consumption advisories issued by the Department and the Division of Health should be reviewed to determine if the project area is in a waterbody included in the advisory. While sampling for mercury and PCBs is recommended for any project in a waterbody that has a fish and/or wildlife consumption advisory, the number of samples can be adjusted depending on the nature of the fish advisory, past knowledge of sediment contamination, and the scope and scale of the project. The most widespread source of mercury to sediments in the state's waterways has been through atmospheric deposition. For example, for a small project in a waterway where the source of the fish advisory is suspected to be low levels of contaminants from atmospheric deposition, permit decision-making with respect to the risk of the project may be achieved with fewer samples specific to mercury. The goal of varying sampling requirements is to provide sufficient data for risk-based decisions on permit conditions without collecting more samples than are necessary for this task.

Table 2 identifies potential sources where particular contaminants may have been discharged to waterways and ended up in bottom sediments at elevated levels. This table may be used to identify other parameters that may need sampling on a case-by-case basis and using professional judgment and site-specific knowledge.

Table 1. Sediment Sampling Parameters with Suggested Methods and Analyses

Parameter	Suggested Analytical Method (Suggested Detection Level) *(mg/kg, dry weight unless noted)*	Suggested Base Parameter Analyses[1]	
		Great Lakes or Urban/ Industrial	Inland Waters (Rural/ Forested)
Inorganics – Metals			
Arsenic	SW-846 3050B/6010B EPA 6010 or 7060 (5)	X	X
Barium	SW-846 3050B/6010B (0.2)		
Cadmium	SW-846 3050B/6010B EPA 7131 (0.6)	X	X
Chromium (total)	SW-846 3050B/6010B EPA 6010 or 7191 (0.6)	X	X
Copper	SW-846 3050B/6010B EPA 6010 or 7211 (0.5)	X	X
Cyanide	SW-846 9010B/9014 (0.4)		
Lead	SW-846 3050B/6010B EPA 6010 or 7421 (3)	X	X
Manganese	SW-846 3050B/6010B (0.1)		
Mercury	SW-846 7471A EPA 7471 (0.015)	X	X
Nickel	SW-846 3050B/6010B EPA 6010 (2)	X	X
Selenium	SW-846 3050B/6010B (8)	X	
Zinc	SW-846 3050B/6010B EPA 6010 or 7951 (2)	X	X
Inorganics – Nutrients			
Oil & Grease	SW-846 9070	X	
Total Phosphorus	EPA 365.2/365.3 or USGS I-6600-85 (9.9)	X	X
Nitrate + Nitrite	LACHAT 12-107-04-1-B (0.25)	X	X
Ammonia-Nitrogen	LACHAT 12-107-06-1-A (0.16)	X	X
Total Kjeldahl Nitrogen		X	X
Organics			
Aldrin	SW-846 8081 EPA 8081, 354440B, 3541 (0.01)		
Chlordane	SW-846 8081 EPA 8081, 354440B, 3541 (0.009)	X	
Dieldrin	SW-846 8081 EPA 8081, 354440B, 3541 (0.01)		
Endrin	SW-846 8081 EPA 8081, 354440B, 3541 (0.01)		
Heptachlor	SW-846 8081 EPA 8081, 354440B, 3541 (0.01)		
Lindane (Gamma BHC)	SW-846 8081 EPA 8081, 354440B, 3541 (0.01)		

[1] Suggested base parameter list reflects additions to NR347 Table 1, based on scientific research and experience with dredging projects.

Parameter	Suggested Analytical Method (Suggested Detection Level) *(mg/kg, dry weight unless noted)*	Suggested Base Parameter Analyses[1]	
		Great Lakes or Urban/ Industrial	Inland Waters (Rural/ Forested)
DDT	SW-846 8081 EPA 8081, 354440B, 3541 (0.01)	X	
DDD & DDE	SW-846 8081 EPA 8081, 354440B, 3541 (0.01)	X	
Toxaphene	SW-846 8081 (0.01)		
PCBs (Total)	SW-846 8081 EPA 8081, 3540B, 3541 (0.04)	X	X
		Tied to Fish Advisories	
2,3,7,8-dioxin, 2,3,7,8-furan and 15 2,3,7,8-substituted dioxin and furan congeners	EPA 8290 (1 – 10 pg/g)		
Total Organic Carbon	SW 846 8081 SW846-EPA 9060 (0.2%)	X	X
Polycyclic Aromatic Hydrocarbons (PAHs)	EPA 8310	X	
Naphthalene	(0.019)		
Phenanthrene	(0.017)		
Pyrene	(0.012)		
Fluorene	(0.058)		
2-Methylnapthelene			
Acenapthene	(0.017)		
Acenaphthlyene	(0.021)		
Anthracene	(0.0071)		
Benzo (a) anthracene	(0.019)		
Benzo (a) pyrene	(0.023)		
Benzo (e) pyrene			
Benzo (b) fluoranthene	(0.032)		
Benzo (g,h,i) perylene	(0.022)		
Benzo (k) fluoranthene	(0.021)		
Chrysene	(0.0074)		
Dibenzo(a,h)anthracene	(0.008)		
Fluoranthene	(0.029)		
Indeno (1,2,3-cd) pyrene	(0.034)		
Physical Tests			
Particle Size Analysis – Sieve and Hydrometer Analysis	ASTM D-422 (%)	X	X
Moisture Content	ASTM D-2216 (%)	X	X
Atterburg Limits (Liquid Limit and Plastic Limit)	ASTM D4318 (as moisture content)		
Specific Gravity	ASTM D-854 (Ratio, unitless)		

Table 2. Contaminants and Source Industries.

Adapted from Inland Testing Manual (EPA/Corps, 1998)

	Acenapthene	Aldrin	Ammonia	Aniline	Arsenic	Benzo(a)anthracene	Benzo(a)pyrene	Cadmium	Chlordane	Chromium	Copper	Cyanide	DDE	DDT	Dieldrin	Endrin	Ethyl Parathion	Fluoranthene	Heptachlor	Hexachlorobenzene	Hexachlorocyclopentadiene	Lead	Mercury	2-Methylnaphthalene	Nickel	Oil and Grease	Organotin / Tin	PCB	Phenathrene	Phosphorus	Pyrene	Selenium	Tetrachlorodibenzodioxin (TCDD)	Tetrachlorodibenzofuran (TCDF)	Toxaphene	Zinc
Aluminum Die-Casting								■		■															■	■		■								
Ammunitions											■																			■						■
Anti-fouling Paints											■											■	■				■									
Automotive					■		■	■		■	■															■		■								■
Batteries																					■	■														
Boat Manufacturing / Repair						■	■	■		■	■							■					■		■	■	■	■	■		■	■				■
Boat Refueling						■	■											■							■				■		■					
Chemical Manufacturing			■					■		■													■	■		■						■			■	
Commercial Farming	■	■	■										■	■	■															■					■	
Corrosion Metallurgy										■	■	■										■			■											■
Dairy			■																											■						
Detergents / Surfactants																														■						■
Dye	■			■																																
Electrical								■			■											■	■		■			■				■				■
Explosives			■								■																									
Fish / Wildlife Consumption Advisory																							■					■								
Fruits and Vegetables			■																											■						
Leather / Tanning										■																										
Manufactured Gas Plant (MGP)	■					■	■					■						■						■		■			■		■					
Meat Products			■																																	
Metal Finishing / Refining				■	■		■	■		■	■	■									■	■			■	■									■
Metallurgical Processes					■																				■	■									■
Nitric Acid Manufacturing			■																																	
Oxide Manufacturing										■	■																									■
Pesticides / Fertilizers	■	■	■												■	■	■		■	■										■				■		
Petroleum Refining			■																			■										■	■	■		
Phosphate Mining																														■						
Photographic					■					■																				■		■				
Pigments / Inks			■	■																		■	■									■				
Plastics	■																					■														
Printing Plates																														■						■
Pulp and Paper Mills																							■		■	■		■					■	■		
Rubber																																■				■
Steam Power				■	■		■	■		■	■											■			■										
Steel / Iron			■	■	■	■	■					■										■				■		■	■	■	■				■
Sulfuric Acid			■	■																																
Textiles			■				■																													
Utilities																							■						■	■		■				■
Valuable Mineral Mining												■										■														■
Wastewater Treatment Plants			■						■	■	■											■	■		■	■		■		■	■					■

5.3. Considerations for Settleability Testing

Projects planning to discharge carriage return water from hydraulic dredging projects back to surface waters may need to perform column settling tests to gauge the retention time needed to settle out suspended or particulate matter. Information on settleabilty is needed to assist in reviewing settling pond plan designs. Column settling test protocols and the techniques used to evaluate the test results may be found in the U.S. Army Corps of Engineers' Testing Manual on "Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities" (see Section 9.2 for reference).

5.4. Considerations for Elutriate Testing for Contaminants of Concern

NR 347.06 (6)(b), Adm. Code specifies that sediment elutriate testing for Table 1 parameters can be required. Elutriate testing may be needed to determine whether carriage return water will meet surface water quality criteria in NR 105, Adm. Code, or groundwater standards in NR 140, Adm. Code, requirements for a WPDES permit. In some cases, the Waste Management program also needs elutriate test results. Results provide an estimate of the mobility of the chemical constituents in the sediments to the water column or to groundwater. Waste Management and wastewater staff should be consulted as early in the project review as possible, in order to determine whether elutriate testing of any type is desirable.

Depending on what questions need to be answered about the potential impacts to particular environmental media, the elutriate testing methodologies differ. The effluent elutriate test, the Toxicity Characteristic Leaching Procedure, and the Synthetic Precipitation Leaching Procedure are often requested. The chart below outlines the issues each test may be expected to address:

Test Name	**Effluent Elutriate Test (EET)**	**Synthetic Precipitation Leaching Procedure (SPLP)**	**Toxicity Characteristic Leaching Procedure (TCLP)**
Used to Evaluate	Carriage return water quality from a hydraulic dredging operation, to either surface or groundwater	Leachate or runoff from an upland confined disposal facility	Hazardous Waste Classification

A. Effluent Elutriate Test – The effluent elutriate test is a sample preparation procedure designed to simulate the quality of water discharged as effluent from a confined disposal facility (CDF) and accounts for geochemical changes occurring in the CDF during active disposal operations. It is most recently referenced in the ACOE Upland Testing Manual (EL TR-03-1), Appendix B; and may also be called the 'modified elutriate' test. It is appropriate for dredging that involves fine-grained sediment which requires extended settling time. The effluent elutriate test requires that a volume of site water is collected along with the sediment sample.

The EET should be done on a proportional composite sample of all sediment to be removed, which is diluted with water from the site. The methods of analysis for the contaminants should be NR219, Adm. Code approved for wastewater, the results expressed in ug/L or mg/L. The results need to be sensitive enough to compare with the WQ criteria in NR 105, Adm. Code. In addition to contaminants, elutriate TSS must also be reported.

If the EET is run after the dry weight data have been screened for Contaminants of Concern (COC), it may not be possible to observe all the holding times in NR 219, Adm. Code from the time of original sediment sampling. Samples should be frozen after initial aliquots are taken for dry weight analysis.

Elutriate manipulations are also applicable to any situation where the resuspension of sediment-bound toxicants is of concern, such as bioturbation and storms, that might disturb sediments and affect water quality. Samples for sediment elutriate analyses may be required in cases where potential contaminant concentrations pose water column water quality concerns and to meet conditions for water quality certification (see NR 347.06(6)(b), Adm. Code).

B. Toxicity Characteristic Leaching Procedure (TCLP) SW 846, Method 1311 - The purpose of the TCLP test is to determine if a solid waste exhibits hazardous characteristics. This test will determine whether dredged material might be classified as a hazardous waste. The waste is leached with an acidic solution similar to conditions found in a landfill. The resulting leachate quality is used to gauge the potential of toxic constituents in a waste material contaminate the groundwater and cause environmental or health concerns. Regulatory levels for 39 compounds in the leachate have been established in NR 605.08(5)(b), Adm. Code. The waste to water ratio in the TCLP test is 1:20.

A "desktop" calculation can be performed where the dry weight bulk sediment concentrations of the parameters of interest are divided by 20 to estimate the maximum leachable concentrations. If the estimated leachable concentrations exceed the regulatory levels, then the TCLP test needs to be performed on the sediments. Historically, dredged material seldom fails the TCLP test, and the test results are not good predictors of actual leaching behavior or leachate composition. However, if there is concern about this issue, the test could be performed on the sediment core with the highest contaminant concentration.

C. Synthetic Precipitation Leaching Procedure (SPLP) SW 846, Method 1312 - This test procedure is commonly used to predict the leaching of contaminants from waste materials from soil by rainfall. It has been used in the past to simulate carriage return water. The SPLP uses the same equipment as the TCLP test, but is run at the pH of rainfall instead of simulating the more acidic conditions of a landfill. The SPLP can be used for both organic and inorganic contaminants. Soils contaminated with VOCs can be analyzed using this method, by using the zero headspace vessel option. This test is essentially a single-point batch desorption experiment with standard solutions, preparation of the materials, soil:solution ratio, and equilibration time being established.

The results from an SPLP test may be compared directly to groundwater preventative action levels (PALs), or may be used to calculate a site-specific residual contaminant for a dredge spoil disposal area. Consult with Remediation and Redevelopment program staff for additional information on how to apply and interpret this test.

Other leaching test methods are also available. The ASTM D 3987-85 method is a shake extraction method that is similar to the SPLP, and can be performed with distilled water, tap water, or other aqueous media. It may more accurately simulate slurry conditions due to hydraulic transport. This might be useful for assessing effects of return water flows. The ASTM D 4874-95 method is a column test, which can also be performed with distilled water, tap water, or project water. It may simulate leaching of the dredged material after placement in a non-landfill disposal environment.

6. Sampling Procedures

6.1. Number of Samples

The number of samples to be collected to characterize the sediments at a particular project is not specified in NR 347, Adm. Code (except for beach nourishment, see below), and is left to the professional judgment of staff. **Table 3** provides general recommendations for the number of initial core samples, based on the volume of proposed dredging. The exact number of samples should be determined by factors and circumstances specific to each site. If existing information or data suggests that there are contaminants present in the project area or vicinity, and if there is reason to believe that these contaminants are elevated to levels that may be of concern to humans or aquatic organisms during dredging or disposal, additional samples should be required.

Table 3. General Recommendations for *Initial* Number of Core Samples.

VOLUME PLANNED FOR REMOVAL in CUBIC YARDS	NUMBER OF CORE SAMPLE SITES
3,000-10,000	3 or less
10,000-30,000	3
30,000-100,000	5
100,000-500,000	6
500,000-1,000,000	8
>1,000,000	>8

For some contaminated sediment remediation projects, the sampling design may be determined by the state or federal regulatory program under which the removal is being done. Some examples include federal Superfund law, state hazardous substances Spill Law (s. 292.111, Wis. Stats.), state Environmental Repair law (s. 292.31, Wis. Stats.) and state Groundwater law (s. 160.23 and 160.25, Wis. Stats.). In cases involving contaminated sediments, the number of samples may be greater than recommended in Table 3, in order to define the vertical and lateral extent as part of the remedial investigation, and for determining the actual volume of contamination to be removed.

The Department may request that the applicant collect reference or control samples outside the project area. This is especially true where the preliminary review of information suggests that some background sediment contamination is likely (e.g., PAHs are often elevated in urban settings from man-made sources). Ideally, the reference site should have similar physical and locational characteristics as the project sediments.

Beach nourishment disposal is only allowed in the Great Lakes. NR 347, Adm. Code, specifies the number of samples to be collected at the proposed beach nourishment site, for use in particle size (grain-size) and color matching of the proposed dredged material and the beach substrates. NR 347.06 (3)(d), Adm. Code, requires a sample to be collected every 250 linear feet of the beach nourishment disposal area, with a minimum of two samples. The code does not specify the number of sediment samples from the proposed dredging site.

6.2. Sample Collection and Handling Methods

The method of taking samples and handling samples after collection is described in NR 347.06(4) and NR 347.06(5), Adm. Code, respectively. The samples should be taken with a core sample device or other device that takes a vertical, continuous length of sediment. The core sample should extend 2-feet below the proposed project depth to determine if any contaminants will be left exposed or potentially available at this interface upon project completion. If bedrock or parent hardpan materials prevent obtaining this lower 2-foot length, the length obtained to hardpan will be used for analysis. Distinct strata in the core profile based on physical appearances (e.g., texture or coloring) should be separated out as distinct segments for analysis based on NR 347.06(6)(a), Adm. Code. The applicant must provide a written description including length, odor, texture, and color of any strata visually observed in the core profile in the sampling result report submitted to the Department under NR 347.06(4)(e), Adm. Code. If there are no distinct strata or the strata are not of any significant thickness, the core sample should be divided into 2-foot long segments for analysis of the specified chemical and physical parameters. Under NR 347.06(6)(a), Adm. Code, the Department has flexibility to approve other sub-sampling methods if they are found to be appropriate.

Samples collected for PCB's and other organics should use stainless steel collection equipment. Samples collected primarily for metals, nutrients, and physical analyses can use plastic (e.g. Lexan) coring equipment but stainless steel sampling equipment can be used. Sediment samples should be well mixed before being placed in sample containers and handled according to standards in NR 219, Adm. Code and approved by the analytical laboratory prior to use. The same depth segments from a number of cores collected at a single sample station can be combined or composited in order to obtain sufficient sample volume for analysis as needed. Combining different sample stations into a composite should be avoided, as this would mask trends in contaminant concentrations across the deposit.

There are number of guidance publications for sampling sediments available. Department-prepared guidance for its sediment sampling projects can be viewed on Bureau of Watershed Management's web site: http://www.dnr.state.wi.us/org/water/wm/wqs/sediment/sampling. U.S. EPA has recently published a useful guidance manual about collecting, storing, and handling sediments for chemical and toxicological analyses (See Section 9.1 below for reference).

7. Evaluating Results

Once the dredging applicant submits the results of sampling and analysis in a report under NR 347.07(1), Adm. Code, the report needs to be reviewed under NR 347.07(2), Adm. Code, to determine if all applicable information has been supplied and requirements met. The Department has 30 business days to review the information submitted. Based on NR 347.07 (4)-(6), Adm. Code, and depending on the type of project components and media tested (sediments, elutriate,

beach disposal substrates, potential wastewater discharges), several comparisons with standards and benchmarks may take place in the report review process.

As a follow up to the review, the Department has the ability to request additional information of the applicant and to request additional sediment sampling and analyses when evidence of contamination is indicated in the submitted sampling results (NR 347.07(3), Adm. Code). If the results submitted by the applicant indicate that the project area may contain significant contaminated sediments, additional sampling may better define the degree and extent of the contamination, how much of the project area is involved, and the sediment management decisions to be made.

7.1. Sediment Quality Evaluations

Currently there are no state or federal promulgated numeric criteria for determining contaminated versus non-contaminated sediment. Pollutants at various levels can have differing effects depending on site conditions. Sediment quality guidance has been developed by a number agencies and researchers in the past decade [e.g. MacDonald et al. (2000) and Long & Morgan (1991)] along with reviews of how the guidelines can be used [e.g. Peddicord et al. 1998)].

The Department's Contaminated Sediment Standing Team published guidance in 2002 titled "Consensus-Based Sediment Quality Guidelines: Recommendations for Use & Application." (DNR Publication # WT-732 2002). The Consensus-Based Sediment Quality Guidelines (CBSQGs) can assist staff in making an initial evaluation of sediment sampling results. The results of the project sediment sampling for each parameter are compared with the effect level concentrations described in the CBSQGs document. In the event that a project's analytical results exceed sediment quality guidelines, further evaluation of the risk may be necessary

Following are some examples of situations or operational controls that may be appropriate for many routine dredging projects:

- Deployment of silt curtains to limit turbidity plumes away from the dredging site.
- Specify newer types of hydraulic dredges that limit sediment resuspension during removal.
- Require upstream and downstream monitoring of total suspended solids during the dredging with maximum levels not to be exceeded downstream, as a condition of the dredging permit. If levels are exceeded, dredging must be halted under NR 347.08(3), Adm. Code until changes are made in operations to limit release of suspended solids.
- If elevated levels of contaminants are found at the proposed project depth, additional sampling may be necessary to determine degree and extent of contamination. The applicant can also pursue the option of over-dredging at the project bottom to remove the contaminants, if practical.

If sediment monitoring is conducted and high concentrations of PCBs, mercury, dioxin/furans or other bioaccumulating chemicals are found, this information should be provided to the water biologist and fish contaminant specialist to determine if fish contaminant monitoring is warranted.

7.2. Background Data and Reference Sites

It is useful to have an idea of the background or reference site concentrations for the parameters in the soils or sediments of the watershed to compare with the lower or threshold effect concentration in the sediment quality guidelines (CBSQGs) to be used by the Department in doing evaluations of sediment quality (See Section 2 and 7.1 above for discussion of these guidelines). In many parts of the state, arsenic, copper, cadmium, chromium, lead, nickel, and mercury concentrations in sediments can exceed the threshold effects concentration (TEC). In many cases, these background sediment concentrations are elevated in areas with no obvious point source, and with no historical land uses that would explain the elevated concentrations. If this is the case, the background or ubiquitous concentration should override the CBSQG TEC value in assessing the sediment quality.

It may be to the applicant's advantage to obtain enough samples from adjacent or upstream areas in order to calculate a maximum probable background concentration (MPBC) to gauge the significance of the concentrations observed from within a proposed dredge project boundary. The MPBC is based on calculating the 95% upper confidence limit (UCL) of the mean of a data set of background concentrations for a parameter.

Regional databases or site-specific background data may also be used to refine the suggested parameter list as given in this document. If a regional database, for example, shows that PCBs in a given watershed are rarely detected, and if the waterbody in question does not show up on a fish and wildlife consumption advisory, it may be appropriate to delete PCB analysis from the requested parameter list. Generally, as the size and potential impact of a dredging project increases, the parameter list should be more inclusive, regardless of whether background data suggests a potential problem.

8. Disposal of Dredged Material

8.1. Codified Solid Waste Exemptions

Disposal of dredged material may be eligible for codified exemptions in NR 500.08(3), Adm. Code, if disposal site and operations would comply with performance standards in NR 504.04(4), Adm. Code, i.e., no significant adverse effects on wetlands or critical habitat areas or detrimental effects on surface water quality or groundwater quality. Small projects seldom produce quantitative support to document acceptability of disposal options, so judgments have to be made by Waste Management program staff. Generally, if a project does not raise qualitative concerns and is eligible for a codified exemption, Waste Management staff can be consulted for advice but disposal details should be handled within the Chapter 30 dredging permit.

If the dredging project exceeds 3,000 cubic yards and is located in the Great Lakes, in certain rivers listed in NR 500.08(3)(b), Adm. Code, or in a lake which has been treated with arsenicals, then the disposal site must go through the licensed landfill siting process or seek a statutory exemption under s. 289.43(8), Stats.

Contaminated sediment dredged from a river or lake is a solid waste. In certain cases, if PCB concentrations in sediment are 50 mg/kg or greater, dredged material from the project would be subject to waste management regulations under the federal Toxic Substances Control Act

(TSCA) in addition to state regulations (NR 500 and NR 157, Adm. Code). Management of this material would require approval by EPA Region 5 as well as the Department.

For remediation projects being conducted under Superfund authority, disposal of dredged material within the Superfund project area would be subject to Superfund preemption and, thus, formally regulated under Superfund. If a chosen disposal is located outside the Superfund project area, it would be regulated either as a licensed solid waste landfill under chapters NR 500 to 520, Adm. Code or under a statutory exemption under s. 289.43(8), Stats.

8.2. Considerations for Formal Waste Management Program Review

Disposal sites and methods that are not eligible for codified solid waste exemptions may be dealt with under statutory low-hazard waste exemption in s. 289.43(8), Stats., rather than going through landfill siting process. Statutory exemptions require formal grants of exemption, based on proposed plans for disposal site, and usually contain conditions of approval.

The Department's Waste Management representative will review the dry weight sediment results, and may ask for additional testing in order to fully characterize the waste. Decisions usually are based on mix of professional judgment and information known about contaminant properties and leachabilities.

Generic characteristics of disposal options that Waste Management program expect include:

- de-water dredged material as much as possible
- upland location that is not wetland, critical habitat area, recharge area for private or public water supply wells
- confine to as limited an area as practicable
- confine to as limited a volume as practicable
- cover with clean soil if necessary to prevent erosion and direct contact, thicker cover (1 to 3 feet) with greater concern for contact.
- post-dredging reporting to the Department to document location, cover, volume used, changes made, etc.

Landspreading of dredged material is possible under NR 518, Adm. Code or the statutory low-hazard waste exemption in s. 289.43, Stats., if there are low levels of contamination and the material is determined to have value as a soil conditioner or fertilizer. A written approval is needed from the department to landspread dredged material.

9. References

This guidance document was written to provide sampling recommendations for relatively common and straightforward cases. In cases requiring substantial sediment dewatering and/or upland disposal in a confined disposal facility, we recommend following the guidance documents listed below, in addition to consulting with staff from waste management, wastewater, and watershed management programs. These references are in addition to those presented in the sections 1-8 above.

9.1. General Internet Links

Index of Corps Engineering Manuals:

Link: http://www.usace.army.mil/inet/usace-docs/eng-manuals/cecw.htm

Wisconsin Department of Natural Resources web site:

Link: http://www.dnr.state.wi.us/org/water/wm/wqs/sediment/

9.2. Sediment Sampling and Evaluation

U.S. EPA, U.S. Army Corps of Engineers, 1998. Evaluation of Dredged Material Proposed For Discharge in Waters of the U.S. - Testing Manual: Inland Testing Manual. EPA-823-B-98-004. Washington, D.C.

Link: http://www.epa.gov/ost/itm/itmpdf.html

U.S. EPA. 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA 823-B-01-002. Washington, D.C.

Link: http://www.epa.gov/waterscience/cs/collection.html

U.S. Army Corps of Engineers, January 2003. Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities - Testing Manual. ERDC/ EL TR-03-1. Washington, D.C.

Link: http://www.wes.army.mil/el/elpubs/pdf/trel03-1.pdf

Wisconsin Department of Natural Resources, 1997. Interim Guidance on the Use of Leaching Tests for Unsaturated Contaminated Soils to Determine Groundwater Contamination. PUBL RR-523 1997. Bureau of Remediation and Redevelopment. Madison, WI.

Link: www.dnr.state.wi.us/org/aw/rr/archives/pubs/RR523.pdf

9.3. Risk Assessment and Sediment Quality

Long, E.R., and L.G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, Washington.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental Contamination and Toxicology. 39:20-31.

Moore, D.W., T.S. Bridges, and J. Cora. 1998. Use of risk assessment in dredging and dredged materials management. Technical Note DOER-RI. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

Peddicord, R.K, C.R. Lee, and R.M. Engler. 1998. Use of sediment quality guidelines (SQGs) in dredged material management. Dredging Research Technical Note EEDP-04-29. Long-Term Effects of Dredging Operations (LEDO) Program. U.S. EPA, U.S. Army Corps of Engineers, Vicksburg, MS

U.S. EPA. Guidelines for ecological risk assessment. EPA/630/R95/002F. April 1998. Risk Assessment Forum.

Wisconsin Department of Natural Resources. 1992a. Background document on assessing ecological impacts and threats from contaminated sediments. PUBL-WR-322-93.

Wisconsin Department of Natural Resources. 1992b. Guidance for assessing ecological impacts and threats from contaminated sediments. PUBL-WR-321-93.

Wisconsin Department of Natural Resources. 2002. Consensus-Based Sediment Quality Guidelines: Recommendations for Use & Application. Developed by the Contaminated Sediment Standing Team. December 2003. PUBL-WT-732 2002.