SUMMARY AND ANALYSIS OF U.S. EPA'S SEDIMENT REMEDIATION GUIDANCE (December 2005)

Prepared on behalf of the Sediment Management Work Group
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History of the U.S. EPA Sediment Guidance

- 1998: Concept of Guidance born
- Contaminated Aquatic Sediments Work Group (CASRGW) formed
- CASRGW included U.S. EPA HQ, RPMs, ORD, GLNPO, U.S.ACE, NOAA, USF&W and Others
- HQ – 15 Participants
- RPMs – 20 Participants
- ORD – 11 Participants

History of the U.S. EPA Sediment Guidance

- Over 85 individuals served on the Committee or worked on the draft
- Original concept – start the Guidance at the remedy selection stage
- Later expanded to commence at the initial discovery of the potential sediment issue

Statistics Cited by the Guidance

- Statistics:
  - Fish Consumption Advisories – 3,221 (up from 2,800 in 1997)
  - 35% of the nation's total lake acreage (excluding the Great Lakes); 100% of the Great Lakes
  - 24% of the nation's total river miles contain sediment contamination which could be associated with probable or possible adverse affects to aquatic life and/or human health [Source: *Updated Report on the Incidence and Severity of Sediment Contamination in Surface Waters of the U.S. (U.S. EPA 2004)*]
  - As of 2004, U.S. EPA had decided to take action at 140 sites (including federal facilities)
  - Remedies for more than 60 sites (Tier I) are large enough to be tracked at the national level

Web Link U.S. EPA Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (Dec. 2005)

- A complete version of the U.S. EPA Contaminated Sediment Remediation Guidance for Hazardous Waste Sites can be found at: http://www.epa.gov/oerrpage/superfund/resources/sediment/documents.htm

Table of Contents: U.S. EPA Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (Dec. 2005)

Overview of Key Provisions of U.S. EPA's Contaminated Sediment Guidance:

- The Guidance recognizes and emphasizes:
  - The need to consider all sediment management options on equal footing
  - The importance of source control and watershed considerations
  - The importance of developing and utilizing an accurate conceptual site model
  - The need to evaluate the resuspension and release aspects of dredging as part of the remedy evaluation process
  - The need to evaluate the impacts of residual contaminant concentrations as part of the remedy evaluation process
  - The importance of utilizing a risk-based approach
  - The need to apply risk management principles to the decision-making process, not just traditional risk assessment concepts
  - The concept of Comparative Net Risk
  - The need for comprehensive monitoring before and after implementation of the remedial option(s)
- The Guidance also provides realistic descriptions of each of the three primary remedies' advantages and disadvantages

Chapter 1.0: Introduction

- Purpose (1.1)
  - "This document provides technical and policy guidance for project managers and management teams making risk management decisions for contaminated sediment sites. It is primarily intended for federal and state project managers considering remedial response actions or non-time-critical removal actions under [CERCLA and RCRA]." (1-1)

- Contaminated Sediments (1.2)

- Risk Management Principles and Remedial Approaches (1.3)
  - The 11 "*Sediment Management Principles*" are discussed

- Decision-Making Process (1.4)

- State, Tribal, and Trustee Involvement (1.5)

- Stakeholder Involvement (1.6)

Chapter 2.0: Remedial Investigation Considerations

- Site Characterization (2.1)
  - Identify historical sources and quantify continuing sources
  - Geomorphological considerations
  - Vertical and horizontal distribution of contaminants
  - Fate and transport
  - Evaluation of human health and ecological risks
  - Collect data necessary to evaluate MNR, capping and dredging
  - Establish baseline of data to use to evaluate remedy effectiveness (2-4)
  - PCBs may be analyzed on a congener-specific basis (but this is not required) (2-4)
  - The Guidance notes the limitations of the bulk (total dry weight) metals analysis method and encourages use of the alternative methods of acid volatile sulfide (AVS), simultaneously extracted metals (SEM) or total organic carbon (TOC), where appropriate. [Citing to the U.S. EPA Technical Paper, Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms, ORD, EPA-600-R-02_011 2005.] (2-6)

- Conceptual Site Models (2.2)
  - Strong discussion of importance and scope of Conceptual Site Models (CSMs) (2-7)

- Risk Assessment (2.3)
  - Risks from various remedial alternatives are discussed (2-14)

- Risks from Remedial Alternatives (2.3.3)
  - Discussion of importance of evaluating all of the risks of remedy implementation (2-14)
  - Examples are provided of the risks from implementation of each of the three remedial options

- Cleanup Goals (2.4)
  - Discussion of RAOs and RGs:
    - Remediation Objectives (RAOs) are big picture/long-term goals such as elimination of fish advisories, elimination of major exposure pathways, etc. (2-15)
    - Remedial Goals (RGs) – typically site-specific cleanup levels

- Watershed Considerations (2.5)
  - Important discussion of the watershed's role and contribution to site conditions (2-18)

- Source Control (2.6)
  - Re-invigorated emphasis of the importance of source control (2-20)

- Phased Approaches, Adaptive Management and Early Actions (2.7)
  - Important endorsement of the use of these concepts in order to promote efficiency and to allow pilots or operable units in sites where uncertainty exists on potential remedial effectiveness (2-21)

- Sediment and Contaminant Fate and Transport (2.8)
  - Note the important new terminology "sediment and contaminant fate and transport" versus "sediment stability" (2-23)
  - Emphasis in the original terminology by regulators and the regulated community conveyed the wrong impression – sediment need not be "stable" per se – the real question is the potential for the creation of unacceptable future risk by movement of exposure to contaminants if/when sediment moves
  - Two other possible names under consideration by the SMWG are: "Sediment Remobilization and Exposure Analysis" or "Sediment Mobilization Risk Analysis"
  - Important focus shift – emphasis on whether unreasonable risk is created by the stability of contaminants
  - Sediments can move without causing unacceptable increases in risk

- Modeling (2.9)
  - A balanced discussion of models is included (2-22)
  - Discussion of importance of using a model appropriate to the size and complexity of the site (2-36)
  - Peer reviews of models are acknowledged to be a viable tool at complex sites (2-41)

Chapter 3.0: Feasibility Study Considerations

- Importance of identifying and controlling ongoing sources (3-1)

- Developing Remedial Alternatives for Sediment (3.1)
  - Flexibility and use of adaptive or iterative approaches should be considered (3-2)

- NCP Remedy Selection Criteria (3.2)
  - Review of the NCP Remedy Selection Criteria, including "threshold" criteria, "balancing" criteria and "modifying" criteria (3-5)

- Applicable Or Relevant And Appropriate Requirements (ARARs) (3.3)
  - The role of TMDLs is discussed (3-8)
  - Highlight 3-2: Examples of Potential ARARs for Sediment Sites (3-9)

- Effectiveness And Permanence Of Sediment Alternatives (3.4)
  - Excellent and realistic discussion of short-term risks, including risks to the community and workers during dredging or capping (3-14)
  - Important consideration that when comparing the time to achieve protection by the MNR remedy, the time for design and implementation of capping and dredging remedies should be considered (3-14)
  - Each of the three major approaches may be capable of reaching acceptable levels of both short-term effectiveness and long-term effectiveness and permanence, based on a site-specific evaluation (3-15)
  - "There should not be necessarily a presumption that removal of contaminated sediments from a water body will be necessarily more effective or permanent than capping or MNR." (3-16)
  - Discussion of residual risk and permanence for all three remedies (3-17)
  - Residual risk for dredging includes risks from contaminated sediment left behind from contaminated sediment outside the dredged area, residual contamination left in place in the dredged area and remedy failure at the disposal location (3-17)

- Cost (3.5)
  - Need for accurate cost estimates as an essential part of remedy evaluation emphasized (3-17)
  - Highlight 3-3: Examples of Categories of Capital Costs for Sediment Remediation (3-18)

- Institutional Controls (3.6)
  - Discussion of fish advisories, waterway use restrictions and other institutional controls (3-23)

Chapter 4.0: Monitored Natural Recovery

- Introduction (4.1)
  - Reference to promising results at some MNR sites (4-3)
  - MNR, just as the other two primary sediment remedies, should be considered at every site where site conditions are appropriate (4-3)
  - Highlight 4-2: Some Site Conditions Especially Conducive to MNR (4-3)

- Potential Advantages and Limitations (4.2)
  - MNR may be slower than capping or dredging but the uncertainties of the time to achieve RAOs for both of those remedies also should be taken into account (4-4)
  - Realistic estimates of the time to complete the design and remediation of capping and dredging should be compared to MNR's time frame (4-4)

- Evaluation of Natural Recovery (4.4)
  - Discussion of the lines of evidence approach for evaluating MNR (4-9)

- Enhanced Natural Recovery (4.5)

- Additional Considerations (4.6)
  - Regions should consider MNR either in conjunction with source control or active sediment remediation or as a follow-up measure to active remedies (4-12)
  - Reiteration of the importance of considering the time frames of design and implementation for active remedies in evaluating time to reach targets (4-12)

- Important reminder:
  - MNR is viewed as capable of meeting CERCLA's criteria of long-term effectiveness and preference for permanence

Chapter 5.0: In-Situ Capping

- Introduction (5.1)
  - As of 2004, capping has been selected as a component of the remedy at approximately 15 superfund sites (5-1)
  - Highlight 5-1: Some Site Conditions Especially Conducive to Capping (5-2)

- Potential Advantages and Limitations of Capping (5.2)
  - Capping typically quickly reduces exposure and requires less infrastructure (5-2)

- Evaluating Site Conditions (5.3)
  - Physical Environment (5-3)
  - Sediment Characteristics (5-4)
  - Waterway Uses and Infrastructure (5-5)
  - Habitat Alterations (5-6)

- Functional Components of a Cap (5.4)

- Other Capping Considerations (5.5)
  - Detailed review of the technical aspects of capping included in this chapter (5-7)
  - Performance monitoring of caps discussed (5-14)
  - Highlight 5-4: Some Key Points to Remember When Considering In-Situ Capping (5-16)

- Important Reminder:
  - Capping is not limited to only "low concentrations" of contaminants or to "low energy" environments (3-17)

  - Caps are acknowledged as being capable of meeting the permanency preference of CERCLA based on site-specific circumstances (3-15)

Chapter 6.0: Dredging And Excavation

- Introduction (6.1)
  - The Guidance acknowledges that the key components of a dredging remedy must be evaluated, including: sediment removal, transport, staging, treatment (including pre-treatment, treatment of water, and sediment, if necessary) and disposal (6-1)
  - Interesting concept – "Five-year review" may be required if dredging residuals are left in place above levels allowing for unlimited use and unrestricted exposure. (6-2)
  - Highlight 6-2: Some Site Conditions Especially Conducive to Dredging or Excavation (6-2)

- Potential Advantages and Limitations (6.2)
  - Guidance acknowledges that the effectiveness of the remedy is dependent upon "achieving cleanup levels" and notes that perceived benefits only occur when "dredging residuals are low" (6-3)
  - Estimating extent of residual contamination following removal is acknowledged to involve a high level of uncertainty (6-3)
  - Residual factors include the equipment, the operator, best practices implementation, sediment characteristics and site conditions (6-3)
  - Residual contamination is likely to be greater in the presence of cobbles, boulders, or buried debris, in high energy environments, at greater water depths and where more highly contaminated sediment lies near the bottom of the dredge thickness or directly overlies bedrock or a hard bottom (6-3)
  - Another potential limitation of dredging effectiveness includes contaminant losses through resuspension and, generally to a lesser extent, through volatilization (6-4)
  - Dredging leads to "at least" a temporary destruction of the aquatic community and habitat (6-4)

- Site Conditions (6.3)
  - Dredging residuals have been underestimated at some sites, even where no complicating factors are present (6-4)

- Excavation Technologies (6.4)
  - Discussion of excavation techniques and related information (6-7)

- Dredging Technologies (6.5)
  - A detailed review of various types of dredging equipment and their respective advantages and limitations is provided (6-9 through 6-27)

- Predicting and Minimizing Sediment Resuspension and Contaminant Release and Transport During Dredging (6.5.5)
  - The Guidance acknowledges that dredging results in sediment resuspension and transport and release to the water body (6-21)
  - Sources of resuspension include: the dredge head, work boats and tug boats, deployment and movement of control measures, and losses from barges (6-21)
  - Tides or currents can carry resuspension away from the site (6-21)
  - Project managers should consider that control measures will reduce production rates (6-22)
  - The magnitude of sediment resuspension and transport is affected by:
    - Physical properties of the sediment (grain size distribution, organic carbon content, AVS concentration)
    - Vertical distribution of contaminants
    - Water velocity and turbulence
    - Type of dredge
    - Methods of dredge operation
    - Skill of operators
    - Extent of debris
    - Water salinity
    - Extent of work boat/tug boat activity (6-22)
  - The Project manager is directed to attempt to estimate the amount of potential resuspension losses and consider it in the remedy selection process (6-22)
  - The Guidance references resuspension studies and recites ranges of 0.5% to 9%

- Predicting and Minimizing Dredging Residuals (6.5.7)
  - The Guidance acknowledges that all dredging leaves some residuals (6-20)
  - Primary sources of residuals:
    - Contaminated sediment below the dredge line that was not removed
    - Sediment loosened by the dredge head or bucket but not captured and removed
    - Sediment on steep slopes that falls into the dredged area
    - Resettling of sediment during the dredging operation

  - Factors causing residuals:
    - Skill of operator and size of dredging equipment
    - Steepness of dredge cut slopes
    - Amount of contaminated sediment resuspended by the dredging operation;
    - Extent of controls on dispersion of resuspended sediment (e.g., silt curtains, sheet pilings);
    - Vertical profile of contaminant concentrations in sediment relative to the thickness of sediment to be removed;
    - Contaminant concentrations in surrounding undredged areas;
    - Characteristics of underlying sediment or bedrock (e.g., whether over-dredging is feasible); and

        - Extent of debris, obstructions, or confined operating areas (e.g., which may limit effectiveness of dredge operation)

    - Field results from some completed dredging projects suggest that average post-dredging residual levels have not met desired cleanup levels (6-26)
    - Project managers should factor a realistic estimate of dredging residuals into their evaluation of alternatives (6-26)
    - No precise method of estimated residuals exists yet (6-26)
    - Preliminary research has shown that the residual concentration may be expected to be similar to the average contaminant concentration within the dredging prism (Desrosiers, *et al.*, 2005) (6-26)
    - Where residuals may cause an unacceptable risk, alternatives include additional dredge passes or thin layer placement of clean material (6-26)
    - Contingency remedies should be considered if uncertainty exists about the ability to achieve low cleanup levels (6-26)
    - "Where a contingency remedy involves containment of residuals by in-situ capping, project managers should consider whether containment without dredging may be a more appropriate solution to manage long-term risks in that area." (6-26)
    - Post-dredging sampling is advisable to confirm residual contamination levels (6-26)

- <u>Transport, Staging and Dewatering</u> (6.6)
    - Discussion of the significance (in terms of operation, facilities and cost) of the steps needed to process the sediments once they are removed from the water (6-27)

- <u>Sediment Treatment</u> (6.7)
    - A description of the complex and expensive post-removal sediment handling issues is included (6-29 through 6-33)

- <u>Sediment Disposal</u> (6.8)
    - Discussion of types of disposal: landfills, CDFs, CADs, etc. (6-34 through 6-37)

<u>Chapter 7.0: Remedy Selection Considerations</u>

- Discussion of decisions in the face of uncertainty:
    - Management decisions must be made even with imperfect knowledge (7-1)
    - Uncertainties need to be weighed, evaluated and communicated (7-1)
    - Imperfect knowledge must not become an excuse for not making a decision (citing the NRC 2001 Report) (7-1)

- <u>Risk Management Decision Making</u> (7.1)
    - "Site-specific, project-specific and sediment-specific risk management approaches that will achieve risk-based goals" should be selected (7-1)

- The remedy decision should consider “the advantages and limitations of available approaches and a balancing of tradeoffs among alternatives” (7-1)
- “A risk management process should be used to select a remedy designed to reduce key human and ecological risks effectively” (7-1)
- “Another important risk management function generally is to compare and contrast the cost and benefits of various remedies” (7-1)

- <u>NCP Remedy Selection Framework</u> (7.2)
  - A discussion of the NCP remedy selection criteria as they should be applied in the context of evaluation of sediment remedies is included (7-2)

- <u>Considering Remedies</u> (7.3)
  - Remedial alternatives should be developed to reduce risk to acceptable levels
  - Project managers should remember that deeper contaminated sediment that is not currently bioavailable or bioaccessible, and that analyses have shown to be stable to a reasonable degree, do not necessarily contribute to site risks (7-3)
  - <u>Highlight 7-1</u> – NCP Remedy Expectations and Their Potential Application to Contaminated Sediment (7-4)
  - <u>Highlight 7-2</u> – Site Characteristics Conducive to Particular Remedial Approaches (7-5 to 7-13)

- <u>Comparing Net Risk Reduction</u> (7.4)
  - Each approach for sediment management has its own uncertainties and potential relative risk (7-13)
  - The NRC introduced the concept of net risk reduction -- the need to consider the overall or “net” risk in addition to specific risks (7-13)
  - Under net risk reduction, all of the advantages and disadvantages of each remedy should be considered when evaluating remedy selection (7-13)
  - Project managers are encouraged to use the concept of comparing net risk reduction between alternatives a part of the remedy selection process (7-13)
  - <u>Highlight 7-4</u>: Covers elements of comparative net risk for MNR, capping and dredging (7-14)

- <u>Considering Institutional Controls (ICs)</u> (7.5)

- <u>Considering No-Action</u> (7.6)

- <u>Conclusions</u> (7.7)
  - “The focus of remedy selection should be on selecting the alternative best representing the overall risk reduction strategy for the site according to the NCP nine remedy selection criteria” (7-16)
  - “EPA’s policy has been and continues to be that there is no presumptive remedy for any contaminated sediment site, regardless of the contaminant level or level of risk.” (7-16)
  - “Controlling any continuing sources of contaminants is an important factor for any sediment remedy.” (7-17)

    - Where source control is uncertain, cannot be achieved, or is outside the scope of the remedial actual, project managers should consider the potential for recontamination and factor that potential into the remedy selection process and to the long-term monitoring plan for the site (7-17)

  - "At many sites, but especially at large sites, the project manager should consider a combination of sediment approaches as the most effective way to manage the risk." (7-17)
  - "The project manager should include a scientific analysis of sediment stability in the remedy selection process for all sites where sediment erosion or contaminant transport is a potential concern. Typically, it is not sufficient to assume that a site as a whole is depositional or erosional." (7-17)
  - "The project manager should include in the remedy selection process a clear analysis of the uncertainties involved, including uncertainties concerning the predicted effectiveness of various alternatives and the time frames for achieving cleanup levels and a remedial actions objective." (7-17)
  - Monitoring of all sediment remedies during and after implementation is required to determine remedy effectiveness and if the cleanup levels and RAOs are being met. (7-17)

<u>Chapter 8.0: Remedial Action Long Term Monitoring</u>

- Post-remedial monitoring will now be required at virtually every sediment site
  - <u>Highlight 8-1</u>: Sample Measures of Sediment Remedy Effectiveness (8-1)
  - <u>Highlight 8-2</u>: Key Questions for Environmental Monitoring (8-3)
  - Pre-implementation monitoring as a baseline also will be required in order to assess remedy effectiveness

- <u>Six Recommended Steps for Site Monitoring</u> (8.2)
  - <u>Highlight 8-3</u>: Recommended 6-Step Process for Developing and Implementing a Monitoring Plan
  - Guidelines for site monitoring (6 steps) are recommended (8-4)
    - Step 1. Identify Monitoring Plan Objectives (8-4)
    - Step 2. Develop Monitoring Plan Hypotheses (8-6)
    - Step 3. Formulate Monitoring Decision Rules (8-6)
    - Step 4. Design the Monitoring Plan (8-7)
    - Step 5. Conduct Monitoring Analysis and Characterize Results (8-8)
    - Step 6. Establish the Management Decision (8-9)

- <u>Potential Monitoring Techniques</u> (8.3)
  - This section provides a brief overview of the types of monitoring techniques and data endpoints that the project manager should consider when developing a monitoring plan

- <u>Physical Measurements</u> (8.3.1)

- Chemical Measurements (8.3.2)

- Biological Measurements (8.3.3)

- Remedy-Specific Monitoring Approaches (8.4)

- Monitoring Natural Recovery (8.4.1)

- Monitoring In-Situ Capping (8.4.2)
  - Highlight 8-4: Sample Cap Monitoring Phases and Elements (8-15)

- Monitoring Dredging or Excavation (8.4.3)
  - Highlight 8-5: Some Key Points to Remember About Monitoring Sediment Sites (8-18)
- Consistency of monitoring techniques and specimen are encouraged
- Specific monitoring pointers for each of the three primary sediment alternatives are identified

Bottom Line

- The long awaited U.S. EPA Sediment Guidance creates a strong framework emphasizing risk reduction and a risk-based approach, placing all remedies on an even playing field and requiring all advantages and disadvantages of the competing options to be objectively and scientifically evaluated.
- The key to success of this positive statement of national sediment policy depends upon uniform implementation throughout the regions and remedy selection in keeping with its stated principles.
- It is incumbent upon the regulated community to insist on the Guidance's appropriate application.

FOR FURTHER INFORMATION CONTACT:

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