

# APPROPRIATE SAMPLING

*(AND OTHER RELEVANT THINGS TO  
CONSIDER WHEN SAMPLING FOR  
AQUATIC SYSTEM CHARACTERIZATION)*

**Presented By:**

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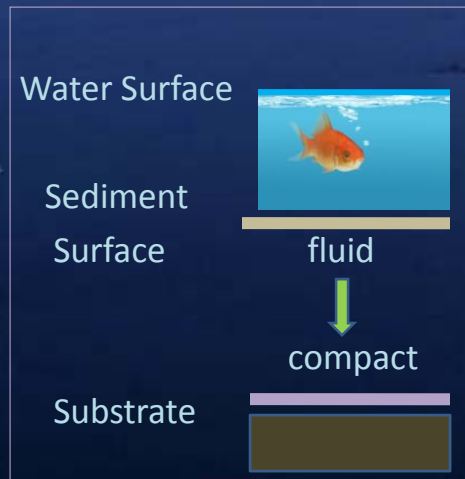
## TOPICS

- Contaminants of Concern
- Sample Collection Planning (Not to be Confused with a Sampling Plan)
- Sampling Environments
- Field Conditions
- Parameters to Consider:
  - Physical, Chemical, Biological
- Sampling Equipment
- Cost Considerations



## THE PROBLEM

- Sediments are by their nature “Transitional”
- Sediments by their nature are “Compressible”
- The System is Dynamic



## “BE ALL THAT YOU CAN BE”

- BE PREPARED!!

25% “Rule of Thumb in Dredge Project Contracting”



**Does your  
Sampling  
Plan Leave  
you Hanging?**



**IMPLEMENTING the  
SAMPLING PLAN**



THIS IS  
NOT  
U.S.-191



## SAMPLE COLLECTION PLANNING (*Not to be Confused with Planning for Sampling*)

### CONTAMINANTS OF CONCERN

Elements & compounds chosen because of their:

- Toxicity;
- Persistence in the environment;
- Ability to bio accumulate; and
- Widespread & consistent occurrence in NE in estuarine, marine, and freshwater sediments and organisms.



## HELP SOURCES


- **Regional Implementation Manual (RIM)**
- **A joint Army Corps & USEPA document for Sediments.**



REGIONAL IMPLEMENTATION MANUAL  
for the  
EVALUATION OF DREDGED MATERIAL PROPOSED FOR DISPOSAL  
IN NEW ENGLAND WATERS

Prepared by  
U.S. EPA NEW ENGLAND  
and the  
U.S. ARMY CORPS OF ENGINEERS, NEW ENGLAND DISTRICT  
April 2004

## “Green Book” & COMM-94





**EPA**  
United States  
Environmental Protection  
Agency

**EPA 823-B-93-001**  
February 1995

**Evaluation of Dredged Material Proposed for Ocean Disposal**

Testing Manual

Adobe Acrobat Reader is required to view PDF documents. The most recent version of the Adobe Acrobat Reader is available on-line at [www.adobe.com](http://www.adobe.com). An Adobe Acrobat plug-in for Internet Explorer is also available.

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**Appendices**

- A. Title 40, Code of Federal Regulations, Parts 228-229 (Not in electronic edition)

**Interim Policy #COMM-94-007: Sampling, Analysis, Handling & Tracking Requirements for Dredged Sediment Reused or Disposed at Massachusetts Permitted Landfills**

*Approved by Thomas P. Powers, Acting Commissioner on February 15, 1995.*

**Note:** Transportation of dredged sediments to a landfill must be accompanied by a DEP Material Shipping Record (MSR).

**1.0 INTRODUCTION**

This policy is intended to streamline the review and approval process for dredged sediments proposed to be reused or disposed at Massachusetts permitted landfills. All references to landfills in this policy mean Massachusetts permitted landfills operated in compliance with Department of Environmental Protection (Department, DEP) regulations and policies. Reuse means beneficial use of sediments as daily cover, intermediate cover and pre-cap contouring material. Disposal means burial in a landfill. References to lined landfills mean landfills which have a DEP approved, functioning liner with a leachate collection system.

## CONTAMINANTS OF CONCERN

### Chemical analysis for:

- **Routine metals (8):** Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc
- **PAHS (16):** Semi Volatile, Insoluble, Constituents of Petroleum Products, Fuel, etc.
- **PCBS (18):** NOAA Congeners (not reported as Aroclors)
- **Pesticides (14):** including DDT & degradation products, Aldrin, Endrin, Lindane, Methoxychor, Toxaphene, etc.





## CONTAMINANTS OF CONCERN

- Why NOT VOA's?
  - Volatiles dissolve into H<sub>2</sub>O
  - Highly Mobile
  - Only freshest spills stay around
  - Generally not persistent in sediments



## SAMPLE COLLECTION PLANNING

- **Environment Type Considerations:**
  - Natural, Anthropogenic, or Mixed
  - Freshwater:
    - Stream / River
    - Pond / Lake
    - Wetland
    - Vernal Condition
  - Estuarine (Fresh-Water/Marine)
    - Tidal River
    - Salt Marsh
    - Delta



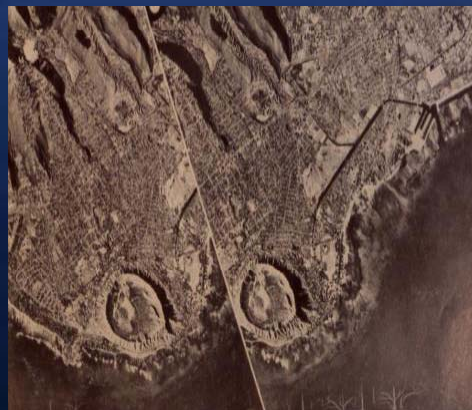
## SAMPLE COLLECTION PLANNING

- **Environment Type:**
  - **Marine:**
    - Coastal – Beach / Dune
    - Coastal – Rocky
    - Embayment
    - Harbor
    - Port
    - Ocean: Shoal / Deep
  - **Anthropogenic**
    - Industrial Lagoon
    - Gully / Drainage Structure
    - Pipeline
    - Outfall



## SAMPLE COLLECTION PLANNING

- **Many Variables that Effect Success/Results:**
  - Environment
  - Field Conditions
  - History
  - Hydrology
  - Geology
  - Biota
  - Anthropogenic Influence
  - Weather



## **SAMPLE COLLECTION PLANNING**

- **Know Your Goals**

- Start with a Clear View of the Finish Line
- What Type of Testing is Going to be Conducted?
- How is the Information Going to be Used?
- What are the Field Conditions?



## **Build a Profile of each Scenario**





## **SAMPLING CONSIDERATIONS FOLLOW THROUGH**

- **Once you have Profiles built – it is then time to consider equipment and procedures.**
- **Four Main Applications to Consider:**
  - **Design**
  - **Construction Monitoring**
  - **Post-Construction Monitoring**
  - **Operation and Maintenance**



## **SAMPLE COLLECTION CONSIDERATIONS**

- **For Each Application, Consider the Parameters for Each Media Assessment:**
  - **Sediment Character**
    - Physical
    - Chemical
  - **Water Quality**
    - Physical
    - Chemical
  - **Biological**
    - Sediment Impact
    - Water Quality Impact



## SAMPLE COLLECTION CONSIDERATIONS

- **Physical Parameters - Sediment:**

- Think about the Reason for Data Need
  - Remediation
  - Dredging (need construction parameters such as ripability)
  - Ecological Restoration Dredging or Filling
  - Capping
  - Material Sorting
- Type of Information Needed
  - Visual Description
    - Color, Organic Content, Grain Size, Density, Liquid Content, Cohesion, Odor, Evidence of Contamination
  - Analytical Parameters
    - Grain Size, Density, Moisture Content, TOC, Compressibility



## SAMPLE COLLECTION CONSIDERATIONS

- **Chemical Parameters - Sediment:**

- What are Reason for Data Need
  - Remediation
  - Capping
  - Dredged Material (DM) Disposal
  - Material Sorting
- Type of Information
  - Chemical Content of Sediment
  - Contamination in Sediment
  - Leachability
- Level of Data Called For
  - Field Screening
  - Field Laboratory Analysis
  - Certified Laboratory Analysis



## SAMPLE COLLECTION CONSIDERATIONS

### Water Quality

- Reason for Data Need
  - Environmental Assessment
  - Design
  - Remediation
  - Construction Monitoring
  - Post-Remediation Monitoring
  - Long Term Monitoring
- Type of Information
  - Water Clarity / Sediment Load
  - Water Chemistry
  - Contamination (Chemical or Biological)
- Level of Data Need
  - Field Screening = Construction Monitoring
  - Field Laboratory Analysis = Characterization
  - Certified Laboratory Analysis = Design



## SAMPLE COLLECTION CONSIDERATIONS

- Biological
  - Reason for Data Need
    - Risk Assessment
    - Remediation/Capping
    - Dredge Project Disposal/Monitoring
    - Ecological Monitoring
  - Type of Information
    - Species Present
    - Numbers and Counts
    - Contamination in Biota
    - Bioaccumulation
  - Level of Data Need
    - Field Counts
    - Field Analysis
    - Certified Laboratory Analysis



## **SAMPLE COLLECTION CONSIDERATIONS**

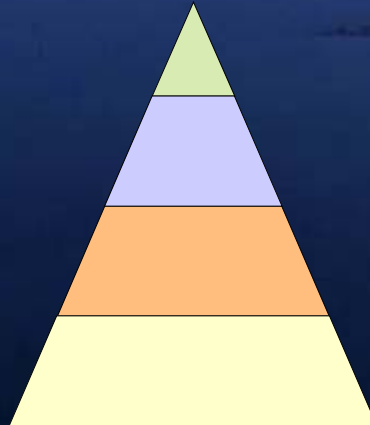
- **Biological**

- Needed for Permitting
- **DO NOT** Assume you will not need Biological sampling just because you are cleaning up contaminated sediments!!



## **EXAMPLE TIERED TESTING APPROACH - RIM**

- Successive levels of investigation with increasing effort & complexity;
- Generates information to evaluate proposed disposal of dredged materials in open water;
- Optimizes resources by focusing on potential impacts from marginal projects (not those where adverse impacts are clear)





## **TIERED TESTING APPROACH - RIM**

- Tier I – Evaluate existing information and identify contaminants of concern.
- Tier II – Water column and potential Bioaccumulation Analyses (based on Sediment Chemistry Data)
- Tier III – Toxicity and Bioaccumulation Testing
- Tier IV – Long-term Bioassays & Bioaccumulation. Tests, Risk Evaluations and other case-specific testing/ evaluations



## **TIER III – WATER COLUMN EVALUATIONS**

- If Tier II chemical testing is inconclusive, water column bioassays are run.
- Evaluate potential toxicity of dissolved and suspended components of dredge material after discharge
- Expose fish and pelagic crustaceans (mysid shrimp) for 96 hrs. and planktonic invertebrate larvae for 48 hrs. to dilution series.



## TIER III – WHOLE SEDIMENT TOXICITY TESTS

- Benthic evaluation of toxic response after deposition of dredge material
- Amphipod and nonamphipod species selected based upon marine/estuarine vs. freshwater
- Observe Mortality, biological activity, physical-behavioral abnormalities.



## TIER III – BIOACCUMULATION TESTING

- Benthic evaluation of exposure to deposit-feeding animals to bioavailable contaminants
- Selected bivalve and polychaete (marine) or oligochaete (freshwater) species are exposed over a 28-day period to dredging site, reference, and control sediments
- Followed by tissue extraction and analytical testing for metals and organic contaminants of concern.

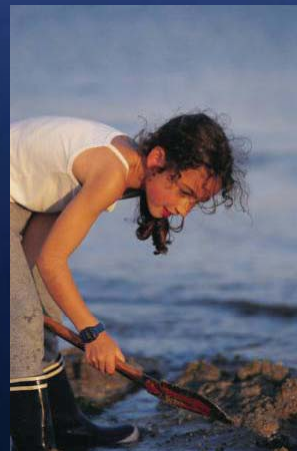


## SEDIMENT SAMPLING CONSIDERATIONS FOR CHEMICAL CHARACTERIZATION

- Containers – provided by the lab as a QC measure, precleaned glass jars with Teflon lids.
- Holding Times – Most Metals – 180 days; Mercury – 28 days; Organic compounds – 14 days until extraction.
- Preservation – For all parameters – refrigeration @ 4 °C.
- Organics – if extracted within 14 days, extract can be held for 180 days.
- Freezing provides indefinite preservation.
- Chain of Custody – (forms, seals and possession)
  - Begins with receipt of sample containers through to delivery to lab.
- QA/QC Samples – the lab may require collection of blank, duplicate and split samples.

## EQUIPMENT: “Disturbed” Sediment Sampling

- Hand Sampling / Coring
  - “Disturbed”
    - Shovel / Trowel
    - Hand-auger
    - Modified Hand Drilling Technique
  - “Un-Disturbed”:
    - Push-Tube
    - Russian Peat Corer



## EQUIPMENT:

### “Disturbed” Sediment Sampling

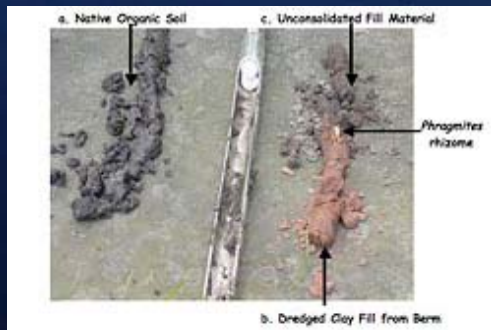
- Hand Coring
  - Hand-auger
  - “Bucket Auger”



## EQUIPMENT:

### “Semi-Disturbed” Sediment Sampling

- Modified Hand Drilling Technique

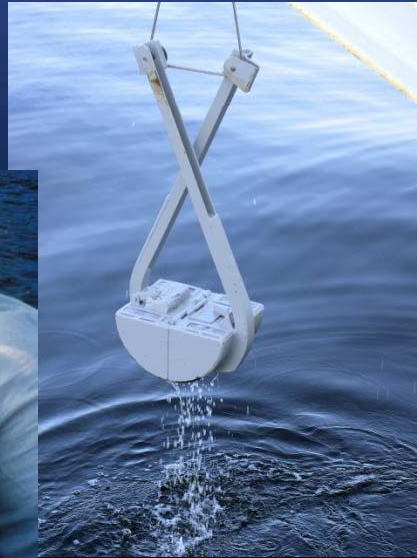




## **“Semi-Disturbed” Sediment Sampling**

### **Grab Sampling:**

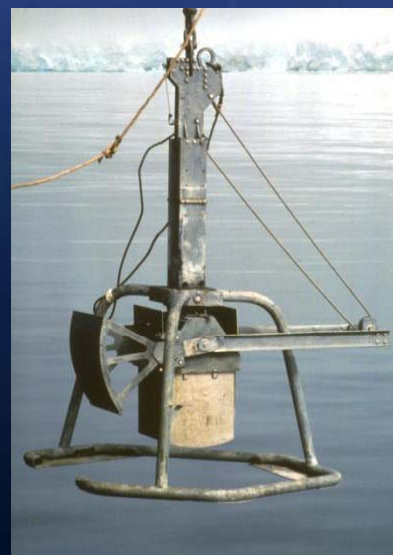
- Van Veen or Ponar Grab**



## **“Semi-Disturbed” Sediment Sampling**

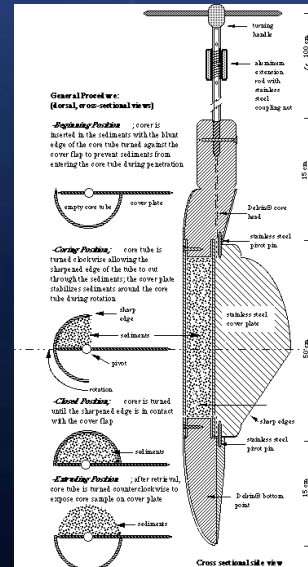
### **Grab Sampling:**

- Box Corer and Ekman Sampler**



## “Undisturbed” Sediment Sampling

- “Un-Disturbed”:
  - Push-Tube
  - Russian Peat Corer
  - Paleocological analysis of bog and salt marsh sediments
  - Collection of uncompressed cores in poorly decomposed woody peat
  - Shallow water applications



## “Undisturbed” Sediment Sampling

- Drop Core
  - Free-fall Drop to Bottom
  - Requires Sufficient Water Depth
  - Short and Long Tube
  - Soft Sediment Only
  - Relatively Undisturbed Core
  - Quick and Easy



## **“Undisturbed” Sediment Sampling**

- **Drop Core**



## **EQUIPMENT: “Undisturbed” Sediment Sampling**

- **Vibracore:**

- Light-duty
- Heavy-duty
- Full-Tube
- Short-Tube







## “Undisturbed” Sediment Sampling

- **Drill Rig:**

- Floating Barge Required
  - Access Considerations
  - Water Depth Limitations
  - Auger or Mud Rotary
  - IDW – Investigation Derived Waste Considerations
  - Split Spoon or Shelby Tube
  - Cost Considerations





## Conventional Drill Rigs



## EQUIPMENT: Water Quality

- Indirect Measurement:

Turbidity Monitoring =  
Turbidity Meter

Current Monitoring =  
ADCP (Acoustic  
Doppler Current  
Profiler)



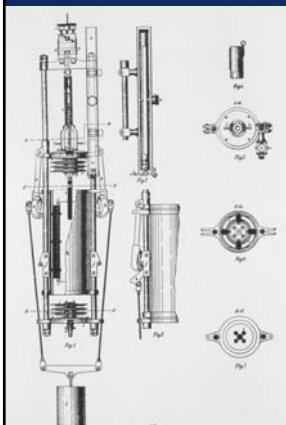
## EQUIPMENT: Water Sampling

- Direct Sampling:
  - Dip Sampling
  - Container Cast Sampling



## EQUIPMENT: Water Sampling

- Direct Sampling
  - Nansen Bottle (Niskin Bottle)



## EQUIPMENT: Biotic Sampling

- Benthic Organism Sampling
  - Grab Samples (Diving)



## Benthic/Shellfish Sampling



## EQUIPMENT: Biotic Sampling



- Benthic Sampling:
  - Clamshell Sampler
  - Box Core
  - Sift Sampling



## EQUIPMENT: Biotic Sampling

- Pelagic Sampling
  - Net Sampling
  - Trapping
  - Line Sampling





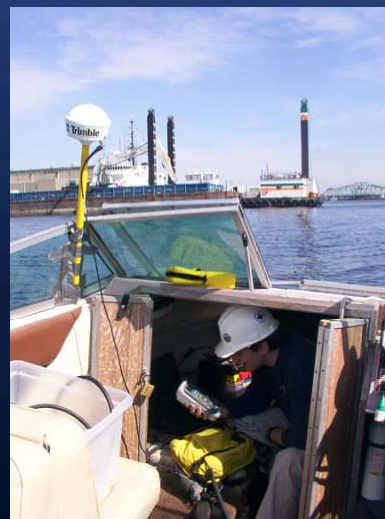
## EQUIPMENT: Biotic Sampling

- Benthic Organism Sampling
  - Suction Sampler



## Critical Issues, Pitfalls, and What-to-do-about-Them

- Position and Location Accuracy!!!
  - Use Global Positioning !!!
  - Differential GPS !!!
  - Real Time Corrections !!!
  - Tide Gauge Readings every 15-minutes !!!
  - Collect Position Reading Directly Over Sampler !!!
  - Measure Water Depth !!!
    - We Use A Fathometer !!



## Critical Issues, Pitfalls, and What-to-do-about-Them

### • Sediment Thickness!!

#### ➤ Sediment Compression

- Push-Tube
- Vibracore
- Drill Rig
- “Fluff Layer” = Mayonnaise !!!

#### ➤ Measurements

- Accurate Bottom Depth
- Penetration
- Recovery

#### ➤ Apply Corrections Accurately !



## Critical Issues, Pitfalls, and What-to-do

### • “Fluff Layer”

- Liquidy Sediment = difficult to discern top
- Accurate Measure = Fathometer
- If Probe, must have sensitive probe plate
- Mayonnaise grades to clayey texture = so bottom of layer is not easy to define either!!



## Critical Issues, Pitfalls, and What-to-do-about-Them

- **Water Content in Sediments**

- Importance

- For Analytical Calibration
    - For Material Handling
    - For Disposal

- Preservation

- Water-tight Sampler
    - Sealed Sample Container
    - Careful Collection



## Benefits of Remote Sensing and Imaging for Sampling

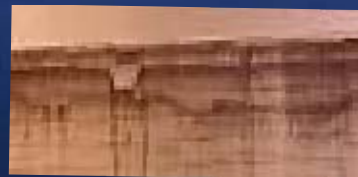
- **Removes Blind Approach**

- Provides Guiding Information

- Sub-bottom Profiling
    - Side Scan Sonar

- Ensures Accurate Position Information During Collection

- Fathometry
    - Positioning



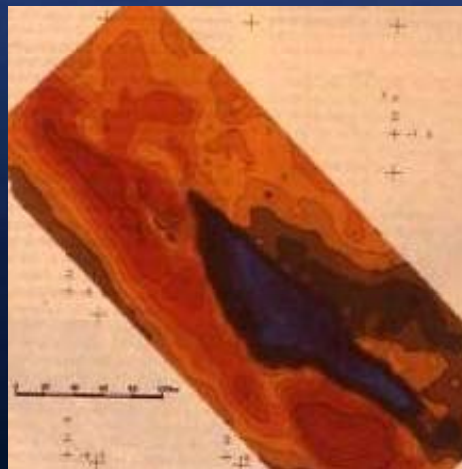
## Know Your Bottom !!!

- Is It:
  - Muddy / Clayey / Peaty
  - Sandy
  - Gravelly
- Check It:
  - Probes
  - Geophysics



## Data Use Considerations

- Know the Final Use
  - Comparison to Standards
  - Relative Values
  - Maps and Charts
  - Contoured Values vs. Sectors
  - Statistics
  - GIS

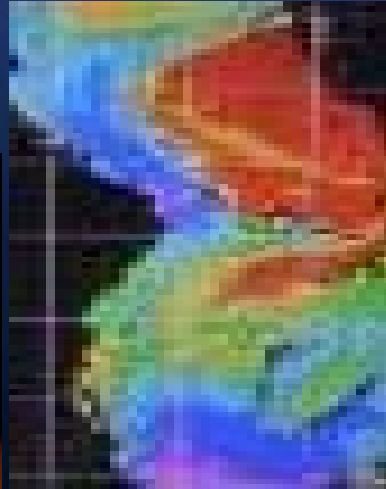




## Data Use Considerations

- Scale of Use Considerations

- Small Area
- System-wide
- Regional



## Cost Considerations

- Large vs. Small Project

- Appropriate Planning
- Wise Use of Resources
- Proper Equipment Selection
- Statistically Relevant Minimal Sampling

- Cheap and Cheery Strategies

- Hand Sampling and Hand Drilling
- Vibracore over Drill Rig
- Composite Samples

### Example Costs

- Grab Sampling = \$50/sample
- Hand Drilling = \$100 ea. core
- Vibracore = \$ 500 ea. Core
- Drill Rig = \$ 1,000 ea. Hole  
to  
\$10,000 ea. Hole

