2015 SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING

MEETING SUMMARY

OCTOBER 2015

Prepared by DMMP Agencies:

United States Army Corps of Engineers

Washington Department of Ecology

United States Environmental Protection Agency

Washington Department of Natural Resources

LIST OF ACRONYMS AND ABBREVIATIONS

AET	Apparent Effects Threshold
BMP	Best Management Practice
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CSL	Cleanup Screening Level
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Program
DNR	Washington State Department of Natural Resources
DY15	Dredge Year 2015
EIM	Environmental Information Management (environmental database)
ECY	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FPM	Floating Percentile Method
ITRC	Interstate Technology and Regulatory Council
LOD	Limit of Detection
LOQ	Limit of Quantitation
LEKT	Lower Elwha Klallam Tribe
MDL	Method Detection Limit
MTCA	Model Toxics Control Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
PCB	Polychlorinated Biphenyl
PLP	Potentially Liable Party
PNWA	Pacific Northwest Waterway Association
PQL	Practical Quantification Limit
PRG	Project Review Group
PSDDA	Puget Sound Dredged Disposal Analysis, the precursor to DMMP
PSEP	Puget Sound Estuary Program
PSET	Portland Sediment Evaluation Team
QA/QC	Quality Assurance/Quality Control
RI/FS	Remedial Investigation/Feasibility Study
RSET	Regional Sediment Evaluation Team
SCUM II	Sediment Cleanup Users Manual, 2015 Update
SEF	Sediment Evaluation Framework
SCO	Sediment Cleanup Objective
SL	Screening Level
SMS	Sediment Management Standards
SQV	Sediment Quality Value
SRM	Sediment Reference Material
TEQ	Toxic Equivalence
TOC	Total Organic Carbon
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
WAC	Washington Administrative Code

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INTRODUCTION

1. Meeting Overview

The 27th annual review of sediment management issues in the Pacific Northwest region was held on May 6, 2015. The Sediment Management Annual Review Meeting (SMARM) is a joint meeting of the Dredged Material Management Program (DMMP) and the Washington Department of Ecology Sediment Management Standards (SMS), open to all. The DMMP is an interagency cooperative program that includes the Seattle District of the U.S. Army Corps of Engineers (USACE), Region 10 of the Environmental Protection Agency (EPA), the Washington Department of Natural Resources (DNR); and the Washington Department of Ecology (Ecology). The DMMP partners with Ecology's SMS annually to engage and inform interested parties on sediment management issues in Washington.

The meeting moderator was Justine Barton of the EPA. Lieutenant Colonel (LTC) Andrew Park, Deputy Commander of the Seattle District Corps of Engineers, gave welcoming remarks. Representing management from each participating agency at the head table were the following:

EPA: Linda Anderson-Carnahan – Associate Director, Office of Ecosystems, Tribal and Public Affairs

DNR: Kristin Swenddal – Manager, Aquatic Resources Division

ECY: Jim Pendowski – Manager, Toxic Cleanup Program

USACE: Amy Reese – Chief, Operations Support Branch

This meeting summary gives a short digest of each presentation, the questions and associated answers that followed the presentation, and reproductions of slides shown. It also documents any proposed program updates and their resolution (Table 1). Attached as appendices are the following documents:

Appendix 1: Meeting Announcement (distributed via e-mail 30 days before the meeting to known interested parties and previous attendees)

Appendix 2: Agenda

Appendix 3: List of Attendees

Appendix 4: SMARM Comments and DMMP Responses to Comments

Appendix 5: Program Updates: Final Issue and Clarification Papers

2. SMARM Program Updates

All changes to the DMMP program since its inception have been through the SMARM process: papers proposing updates are presented, public comments are taken, and proposals are then adopted as originally presented, modified based on comments, or not implemented at all. Program updates considered at this SMARM, and their resolutions, are shown in Table 1. For more details on specific comments and revisions, see Appendix 4 (DMMP Response to Comments).

DMMP identifies three kinds of papers: Issue, Clarification and Status. ***Issue papers*** propose program-level changes that require approval by all four DMMP agencies in order to implement. ***Clarification papers*** propose updates and modifications to existing guidance that do not substantively change program or policy. ***Status papers*** are for information only. Status papers may report on current investigations that may eventually result in an Issue or Clarification, or they may simply be information of interest to stakeholders.

Table 1. SMARM 2015 Program Updates

PAPER TITLE	PAPER TYPE	DMMP ACTION
Revised Freshwater Sediment Screening Levels	Issue	Paper originally proposed for SMARM 2014, then revised into three-part paper for RSET 2014. Substantial written comments on Part 2 of paper led to withdrawal of that portion. Parts 1 and 3 of RSET paper are now being implemented, per 2015 SMARM presentation *Freshwater Guidelines: Follow-up from 2014.*
Reporting Summed Concentrations with J and/or U Flags	Clarification	Implemented with revisions based on e-mail comments.
Freshwater Bioassays Species, Endpoint, Methods and Interpretive Criteria	Clarification	Updated from 2014 paper; implemented with no further revisions.
Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites	Clarification	Implemented with revisions based on comments and coordination.
Tributyltin (TBT) Measurement Basis	Clarification	Implemented with revisions based on comments and coordination.
Modification to Ammonia and Sulfide Triggers for Purging and Reference Toxicant Testing for Marine Bioassays	Clarification	Originally proposed in 2014 but not implemented. 2015 version incorporates revisions based on written comments and coordination since SMARM 2014. Implemented with no further comments or revisions.

PRESENTATIONS

1. SCUM II & Regional Background Updates - Chance Asher, Ecology

Summary:

Chance Asher discussed the implementation phase of the updated 2013 Sediment Management Standards rule, including some success stories. Implementation has included finalizing the Sediment Cleanup Users Manual (referred to SCUM II) and establishing regional background in select Puget Sound embayments. Chance outlined the chapters of the SCUM II Manual, highlighting content and lessons learned. Ecology staff will be trained on the SMS rule and SCUM II implementation during summer 2015. SCUM II is considered a living document, and feedback on what does or doesn't work is welcomed.

Discussion:

Q: Jeff Stern (King County) – Have you worked out compliance in situations where activated carbon (AC) is used? This is something that will need to be figured out.

A: Chance Asher (ECY) – This hasn't yet been worked out since AC is still in an experimental stage of usage. Guidance, when it comes, would likely be an update to SCUM 2. Chapters 12 and 4 discuss assessment of bioavailability and AC techniques and concerns about benthos. A weight of evidence approach is likely the solution but ECY is not committing to it yet in this round of revisions.

A: Teresa Michelsen (Avocet) – Remember that almost every chapter in SCUM II has been revised based on comments. If there've been no revisions, it's because comments are still being considered. Don't look at previous version since this is a completely new document. We hope it's useful.

Q: Deborah Williston (King County) – For regional background, we understand that ECY must approve the process used to develop concentrations. Is this the same with natural background? In the future, will ECY approve site-specific natural or regional background values themselves or just the approach used to develop them?

A: Chance Asher (ECY) – Ecology would need to approve both the process and the actual numbers for both regional and natural background to be used at state-led sites. At this point, SCUM II (Chapter 10) strongly recommends a process for developing regional background values and includes a table of recommended values for natural background. If there's new data for a given location, ECY will look at what's being calculated. But if an applicant is simply using old data and a new calculation process, it's unlikely that ECY will consider it.

Q: Kathy Kreps (TestAmerica) – Please discuss the basis for changes made to the PQL section.

A: Laura Inouye (ECY) - Originally, the list included a large number of chemicals including many not covered by the SMS. For cleanup purposes, the list was pared down to SMS and bioaccumulative compounds, which is why the list is smaller. We included more data on PCB congeners, dioxins, and metals for tissues and sediments. We needed enough lab survey numbers to get a range to set a PQL with guidance. So the numbers have also changed based on obtaining more data.

Q: Colin Elliott (King County lab) – EPA is in the process of updating the method for MDL determination. Will that be implemented? That is, redo the survey of labs to update the PQLs. They will re-evaluate and so will other labs. That could make that table's data obsolete.

A: Laura Inouye (ECY) - The PQLs will not be updated in the next year. They may be updated every 5 years, depending on staff availability. We are aware of EPA's work on refining detection limit

definitions, but at the time of finalizing SCUM II, it wasn't completed. We will consider redefining this once the guidance is out and then ECY needs time to incorporate and do the new lab survey.

Q: Kathy Godtfredsen (WindWard) – Thanks for all the changes in response to comments. It shows you were listening to feedback. I also appreciate that you are still open to comments on issues not yet fully vetted.

A: Chance Asher (ECY) - We realize the guidance is not perfect. Implementation will identify problems, errors, or issues we need to include or provide further guidance upon. Please keep up the communication so we can improve it. We like free advice.

Q: Roger McGinnis (HartCrowser) – Keep in mind that PQLs for individual samples will vary from what is in the summary tables, for a variety of reasons.

A: Laura Inouye (ECY) – We've heard your comments. The new SCUM II language addresses your comments by allowing more flexibility on meeting PQLs, such as when it is OK to not meet PQL (when there are no non-detects, for example), or when sample characteristics (% solids, matrix interference) make it difficult to impossible to meet.

Q: Michael Lee (Fremont Analytical) – Different labs use different reporting definitions (LODs and LOQs vs. MDLs and PQLs). How does ECY deal with these differences?

A: Laura Inouye (ECY) - The SMS rule was revised to include the MTCA definition of PQL. ECY is trying to meet that intent.

Q: Clay Patmont (Anchor QEA) – Have you been linking up with national efforts (i.e., Interstate Technology and Regulatory Council (ITRC) link with SCUM)? Many folks nationally are struggling with the same issues.

A: Chance Asher (ECY) – I'm not sure what you mean by "link" but we do reference ITRC in SCUM II. Please give us suggestions of where more references should go. We don't want to reinvent the wheel.

We attended a meeting at Battelle regarding multi-increment sampling and other issues to determine whether they could be integrated into SCUM II. We decided to put in place-holders for these concepts. They can be discussed and thought about, but if there's not enough experience and still a national discussion about these things, they are not ready for guidance in SCUM II. The flexibility is there, though.

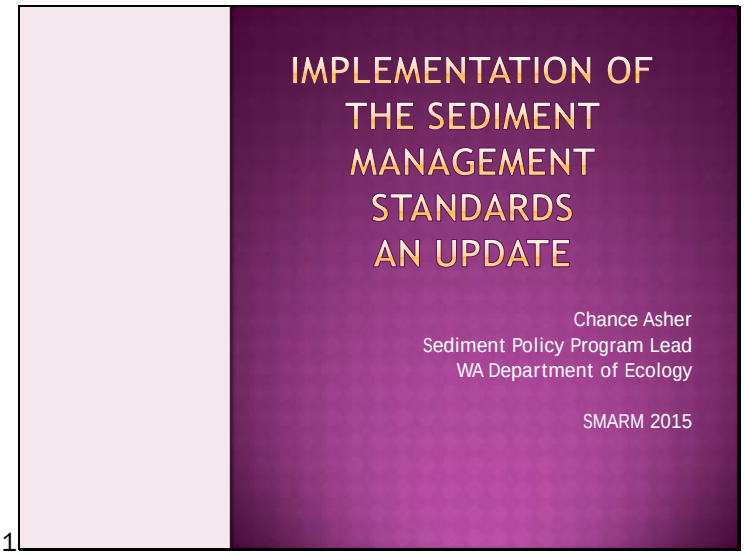
Q: Lon Kissinger (EPA) – Thanks for Appendix L. One important issue that still hasn't been addressed is tissue background, especially given that regional background concentrations are so low.

A: Chance Asher (ECY) - Agreed. Sampling for and determining tissue background would be an expensive proposition and therefore is on hold at this point.

Q: Deborah Williston (King County) – Does the internal SMS/SCUM II training ECY will conduct this summer cover ephemeral wetlands? Do fresh water guidelines apply to these? The SCUM II guidance says they are unique.

A: Chance Asher (ECY) - Specifics on ephemeral wetlands are not planned for this summer's training. Just wetlands generally. The questions of whether standards apply vs. what do you do for the cleanup are very different. We probably won't go into great detail on this at the training until there's a bunch of sites on the list. But, the SMS rule has a definition of sediment in section -505. If the ephemeral wetland meets this definition, then the SMS rule applies.

Slides



Slide 1

Slide 2

SNEAK PREVIEW OF COMING EVENTS

- **Past –** Where we were
  - Rule revisions, developing guidance, establishing background
- **Present –** Where we are
  - Finalized guidance and established background
- **Future –** Where we are going
  - Implementing guidance and establishing background

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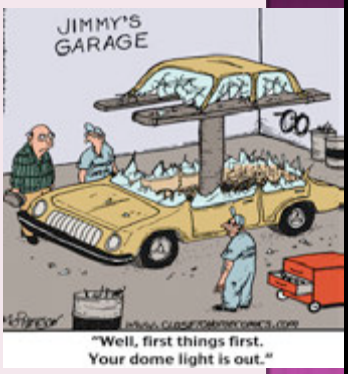
WHERE WE WERE: SMS REVISIONS

- **SMS rule** adopted on February 22, 2013
- **SMS rule** effective on September 1, 2013
- Goal: To solve problems.
- But not like this

Slide 4

SMS RULE REVISIONS: FOCUS ON THE BIG PICTURE

- Write a rule that is:
  - Protective
  - Implementable
  - Scientifically sound
  - Legally defensible
- Don't get derailed by smaller issues



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WHERE WE ARE: SMS IMPLEMENTATION PHASE I

- **SMS guidance**
  - Finalized the Sediment Cleanup Users Manual II, March 2015
- **Regional Background**
  - Established regional background for two Puget Sound embayments:
    - Port Gardner Bay
    - Bellingham Bay
  - Working to establish for North Olympic Peninsula and Port Angeles
  - Considering and evaluating alternate proposals

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WHERE WE ARE: REGIONAL BACKGROUND

- Incorporated lessons learned to complete Port Gardner Bay and Bellingham Bay
- Multiple technical workshops and public review periods on SAPs and data reports
- Determined regional background for a core set of chemicals:
  - Dioxin
  - Dioxin like PCB congeners
  - cPAHs

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SEDIMENT SUPERHEROES
SCUM II ACKNOWLEDGEMENTS

Authors

- Laura Inouye
- Teresa Michelsen (Avocet)
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SEDIMENT CLEANUP USERS MANUAL II
AKA SCUM II

- Comprehensive sediment cleanup guidance
- Implementation tool for Part V of the SMS
- Recommendations to increase efficiency and effectiveness of cleanup
- Product of lessons learned over the decades
- Collaborative effort – internal and external

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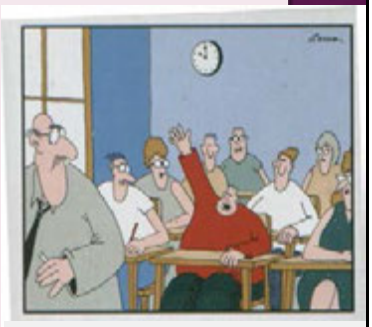
SCUM II - DEVELOPMENT PROCESS
WE LEARNED A LOT FROM YOU

- SMS rule advisory group advice
- Developed two drafts for public comment
- Conducted three technical workshops
- Spent ~ one year
- considering comments
- Final SCUM II highly influenced by this process



"Dave – may I be excused? My brain is full."

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SCUM II – THE INTERESTING STUFF

- Theme throughout: Implementability
- Simplified the document for ease of reading
- Streamlined the cleanup process:
  - Includes simple vs complex site concepts at major points in the cleanup process
  - Includes optional processes, defaults, and off ramps vs a more complex process
- Added more site specific flexibility
- Added more examples for clarity on key points

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SCUM II – TABLE OF CONTENTS

- Chapter 1: Introduction/guidance framework
- Chapter 2: Site identification
- Chapter 3: Remedial investigation
- Chapter 4: Field testing and sampling
- Chapter 5: QA/QC and analytical protocols
- Chapter 6: Data interpretation and reporting
- Chapter 7: Cleanup levels/standards framework
- Chapters 8–11: Cleanup levels
- Chapter 12: Feasibility study/Remedy selection
- Chapter 13: Monitoring
- Chapter 14: Sediment Recovery Zones
- Chapter 15: Applicable laws and permitting
- Chapter 16: References

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SCUM II – CHAPTERS 2 & 3 SITE IDENTIFICATION AND RI

- Site identification using benthic and bioaccumulative criteria
- Sediment cleanup units; complex/simple sites
- RI/FS requirements and recommendations
  - Work plans, SAPs, HSP, PPP
- Conceptual site model development
  - Sources, fate and transport, CoPCs, data gaps
- Study design
  - Benthic, bioaccumulative criteria, water quality issues, FS and remedial design

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SCUM II – CHAPTERS 4 & 5
ANALYTICAL PARAMETERS, FIELD TESTS, SAMPLING, QA/QC

- Field sampling protocols incorporate PSEP protocols and SMARM updates
- Biological tests
- Bioaccumulation testing
- Tool for assessing bioavailability
- Sampling – discrete, composite, porewater, tissue, incremental
- Up to date chemical and biological analytical protocols

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SCUM II – CHAPTER 6
DATA INTERPRETATION & RI REPORT

- RI report requirements – simple and complex site requirements
- Data reporting
- Chemical sums, summing TEQs, non-detects
- Summary statistics
- Data analysis and displaying data
- Source control, MNR, recontamination evaluation
- Revised CSM
- Proposed cleanup levels/standards
- Site boundaries and SMAs

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SCUM II – CHAPTERS 7 - 11
CLEANUP STANDARDS FRAMEWORK

- Sediment cleanup levels and standards
  - Description of each and their relationship
- Two-tier framework
  - Establishing the SCO and CSL
  - How the cleanup level is established
- Adjusting upwards from the SCO
  - Detail on how this can be done
  - Detail on issue of recontamination
- Establishing SCO, CSL based on benthic risk, PQL, or background

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SCUM II – CHAPTER 9
ECO AND HUMAN HEALTH RISK

- Basic requirements for addressing risks to human health and upper trophic levels.
- Streamlined process for establishing cleanup levels:
  - Option 1: Use sediment data only, default to sediment background
  - Option 2: Use sediment and tissue data, calculate site specific risk based tissue and/or sediment concentrations
- Default and recommended exposure parameters
- Appendix E: Detailed information for conducting more detailed risk assessments (Superfund like)
- Appendix K: Spreadsheets to calculate risk based concentrations

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SCUM II – CHAPTER 10
ESTABLISHING BACKGROUND

- How background can be used
- Natural background: Process and options for establishing natural background for marine and freshwater
- Regional background:
  - Process for establishing regional using Ecology led studies (Port Gardner and Bellingham Bay)
  - Options included to use alternate approaches
- Identifying and addressing outliers
- ProUCL to calculate summary statistics
- Table with calculated natural background values using recommended approach and data

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SCUM II – CHAPTER 12
REMEDY SELECTION

- Feasibility study report and cleanup action plan requirements
- Detail on establishing sediment cleanup units and/or sediment management areas
- Remedy selection process:
  - Minimum requirements
  - Technologies
  - Detail on conducting alternatives analysis
  - Detail on conducting a disproportionate cost analysis
  - Case studies: Simple and complex sites

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SCUM II – CHAPTER 13 MONITORING

- Objectives and types of monitoring:
  - Source control
  - Protection (during construction)
  - Performance (post construction)
  - Compliance
  - Confirmation (long-term)
- Determining compliance with cleanup standards
  - Detailed options (Appendix I includes simulations)
  - Statistics and metrics
  - Use of tissue data

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SCUM II – CHAPTER 14 SEDIMENT RECOVERY ZONES

- When a sediment recovery zone (SRZ) is required
- Criteria to authorize an SRZ
- Requirements for an SRZ:
  - Minimum requirements
  - Renewal, expansion, or reduction
  - Monitoring and compliance
  - Recontamination
  - Enforcement
  - Closure

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SCUM II – CHAPTER 15 APPLICABLE LAWS AND PERMITS

- Legally applicable requirements in MTCA and relevant and appropriate requirements (ARARs) to conduct sediment cleanup
- The what and why of the laws and rules
- Permits, approvals, or authorizations required to conduct in water work
- Exemptions from procedural requirements
- Substantive requirements to be met

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SMS IMPLEMENTATION PHASE II SCUM II

- Internal training for sediment staff - summer 2015
- Considered a "living" guidance, which means:
  - Changes will be made on a regular basis
  - Changes will be targeted on key issues
  - Changes will be presented at SMARM:
    - As informational: Presentation or Status paper
    - For public comment: Issue or Clarification paper
  - As SCUM II is implemented, we welcome your comments on what does and doesn't work

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SMS IMPLEMENTATION PHASE II NATURAL AND REGIONAL BACKGROUND

- Regional background:
  - Ecology led efforts currently unfunded
  - Ecology will seek to have PLPs propose regional background and fund efforts
- Natural background:
  - Considering establishing for freshwater systems
  - Depending on budget approval (legislature in special session)

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2. DMMP Project & Issue Summary - Lauran Warner, USACE

Summary

Lauran Warner presented the DMMP project evaluation activities for DY2015. DMMP projects that result in actions or decisions are all documented and posted on the DMMO website. During DY2015 (June 16, 2014-June 15, 2015) there were 24 completed actions. Twelve of these actions resulted in Suitability Determinations, and twelve were other actions, including Tier 1 evaluations, volume changes or recency extensions. This is about an average workload for DMMP, though with DMMO down to 3 people it's getting harder to keep up. There were several projects in Puget Sound, but many others in other parts of the state, including along the Columbia River and on the coast. There were many projects in freshwater or brackish environments this year. Only three projects had sediment that failed open-water disposal guidelines: Kenmore Navigation Channel in Lake Washington (all material failed due to dioxin), Port of Tacoma Pier 4 (with extremely high TBT in some sediments), and Westport Marina (with 2 DMMU bioassay failures, and one DMMU dioxin failure). Exceedances of Benzyl Alcohol & Benzoic Acid were noted, with the DMMP not requiring bioassays in projects with exceedances only of those compounds. In anticipation of potentially modifying the COC list, the DMMP may need to pursue bioassays on these projects in the future to develop data to support any future action. Finally, the DMMP User Manual was updated in December 2014 and will be updated annually after SMARM.

Discussion

Q: Susan McGroddy (WindWard) – Regarding the increase in detection of benzoic acid in recent years - my theory is that this is the result of improved analytical techniques and that these detections don't reflect new sources. I'm wondering if it would be helpful to review existing data (in EIM) to see if there's been any associated toxicity instead of asking projects to run bioassays for these exceedances (which is costly).

A: Lauran Warner (USACE) – That sounds like a good idea that we will consider pursuing.

A: Teresa Michelsen (Avocet) – I agree this could be easily done and we could recalculate AETs.

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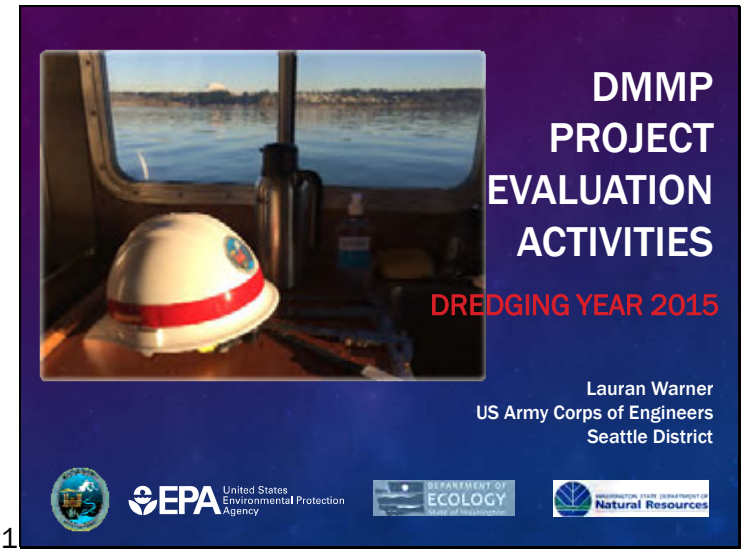

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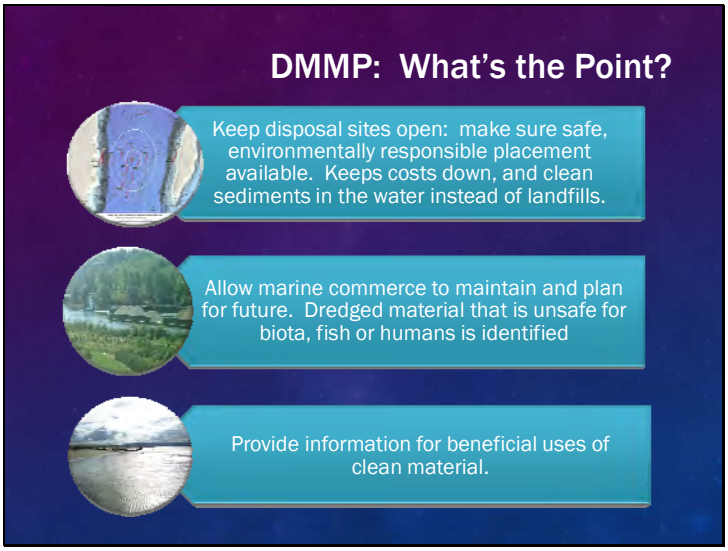

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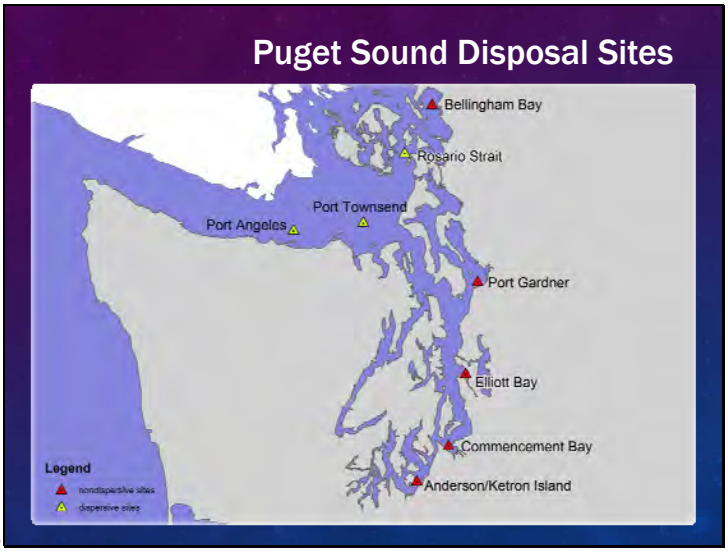

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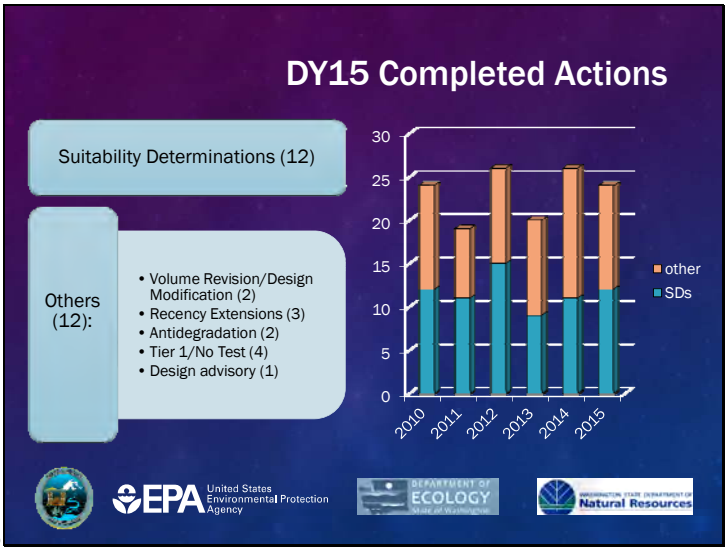

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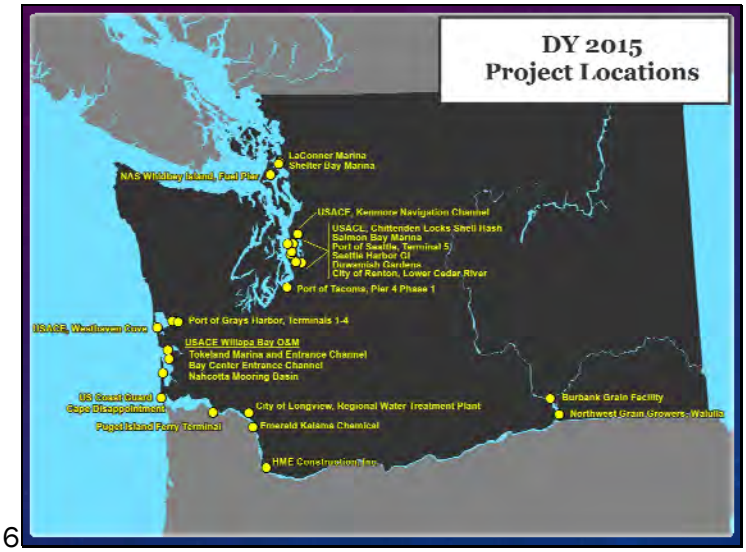

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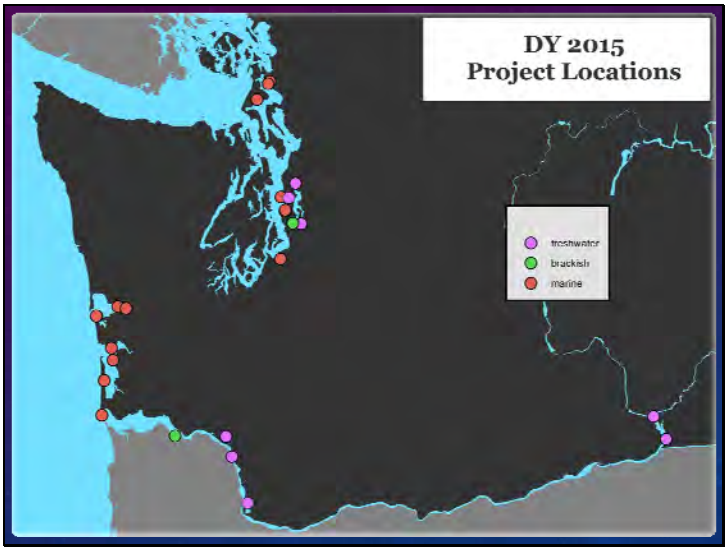

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DY15 Testing

- Out of 24 completed actions:
  - 14 projects - chemical testing
  - 10 projects - dioxin testing
  - 2 projects - bioassays
  - 5 projects – antidegradation testing
  - *No* bioaccumulation testing

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Projects with guideline exceedances (excluding dioxin)

PROJECT	CHEMICALS	COMMENTS
POT Pier 4	TBT (up to 50,000 µg/kg)	most tested material to CERCLA
Kenmore Nav. Channel	benzyl alcohol, benzoic acid	failed due to dioxins, so no bioassays
POGH Westport Marina	pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes	bioassays conducted
Shelter Bay Marina	benzyl alcohol	only exceedance, no bioassays
LaConner Marina	benzyl alcohol	only exceedance, no bioassays

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Benzyl Alcohol & Benzoic Acid

- Many projects with exceedances of ONLY these constituents
  - Can be due to decay of plant material and woody debris; anthropogenic sources include pharmaceuticals, soap, perfume and flavorings
- Have not required bioassay testing on case-by-case basis
- Need more info before programmatic change
  - Will require bioassays in future projects

Dioxin Testing DY15

All TEQs reported are calculated with U = ½ RL

Only 2 projects had failures due to dioxin:

- Westport Marina (1/17 DMMUs failed due to dioxin)
- Kenmore Federal Navigation Channel (all 30,000 cy of material failed due to dioxin)

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Dioxin Testing DY15, cont.

7 projects passed dioxin guidelines for ALL material:

- Puget Sound: Port of Seattle T5, Port of Tacoma Pier 4, Shelter Bay (Swinomish Channel)
- Columbia River: NWGG Wallula (antidegradation)
- Washington Coast: Port of GH Piers 1-4, Willapa Bay federal navigation projects, Westhaven Cove entrance channels

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Biological Testing DY15

Two projects had bioassay testing:

- Westport Marina
  - 2/5 DMMUs failed (amphipod and larval test hits)
- Kenmore Federal Navigation Channel
  - Bioassays only for antidegradation
  - Used new FW guidelines
  - All Z-samples passed; no anti-degradation

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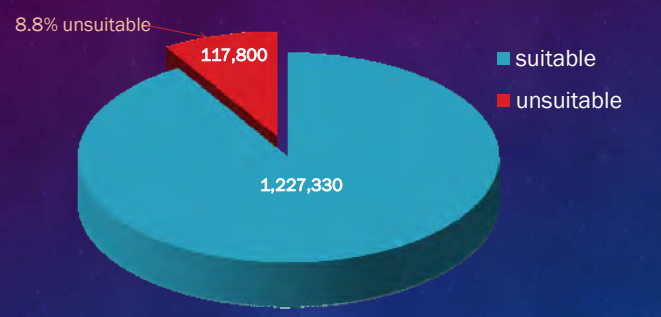
Projects with Unsuitable Dredged Material

PROJECT	SUITABLE (CY)	UNSUITABLE (CY)	REASON
POT Pier 4 Phase 1	11,000	47,000	riprap and TBT
Kenmore Nav. Channel	0	30,000	dioxins
POGH Westport Marina	204,200	40,800	PAHs, dioxins, bioassays

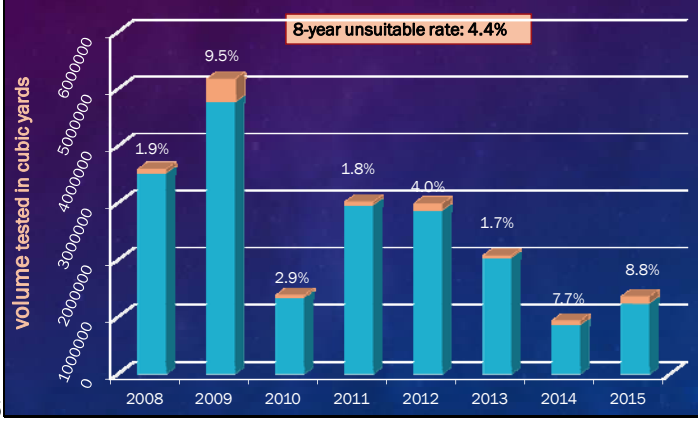
Slide 14

DY 15 Suitability of Volume Tested



Slide 15

Suitable/Unsuitable: 8 year Comparison



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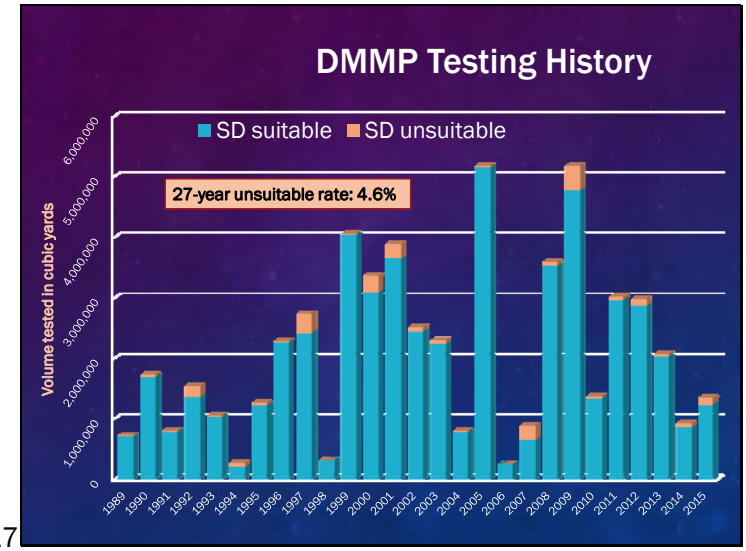

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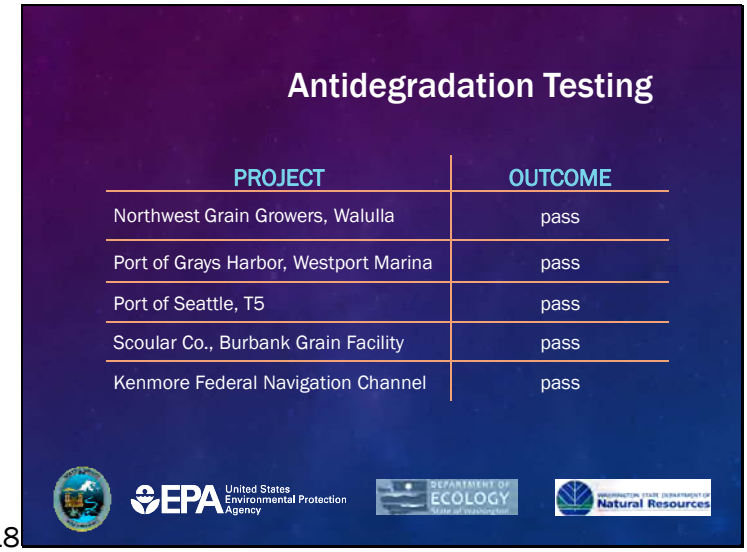

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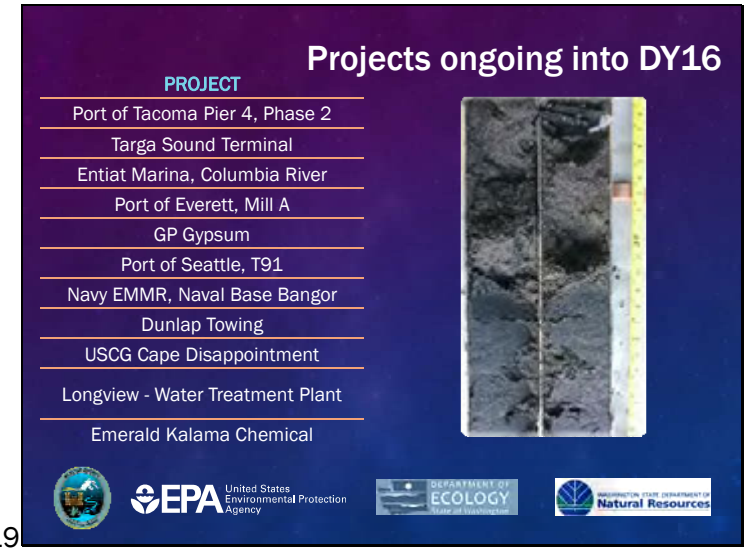

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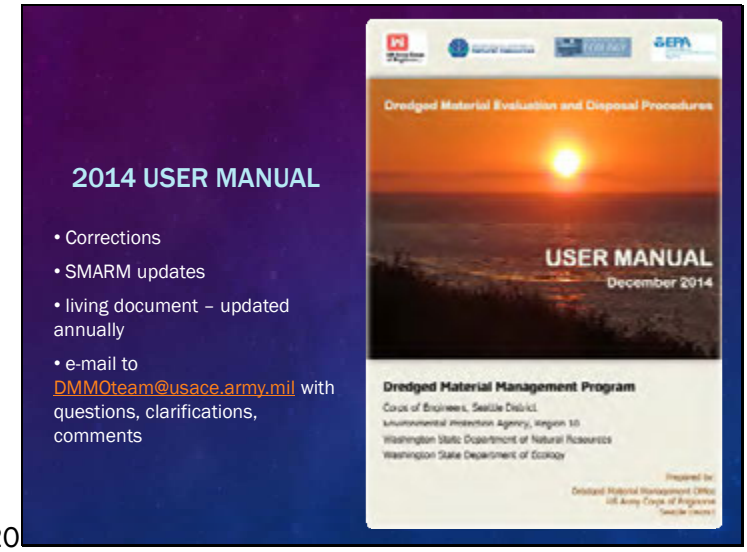


Slide 20

Slide 21

3. EPA Superfund Year-in-Review - Ravi Sanga, EPA

Summary

Ravi Sanga has been a Remedial Project Manager at EPA Region 10 for 14 years. He has worked on sediment sites including the Lower Duwamish Waterway, Harbor Island East Waterway, and Pacific Sound Resources. This presentation highlighted work done on Superfund sites in Puget Sound. Notes are included with slides where applicable, to add important detail.

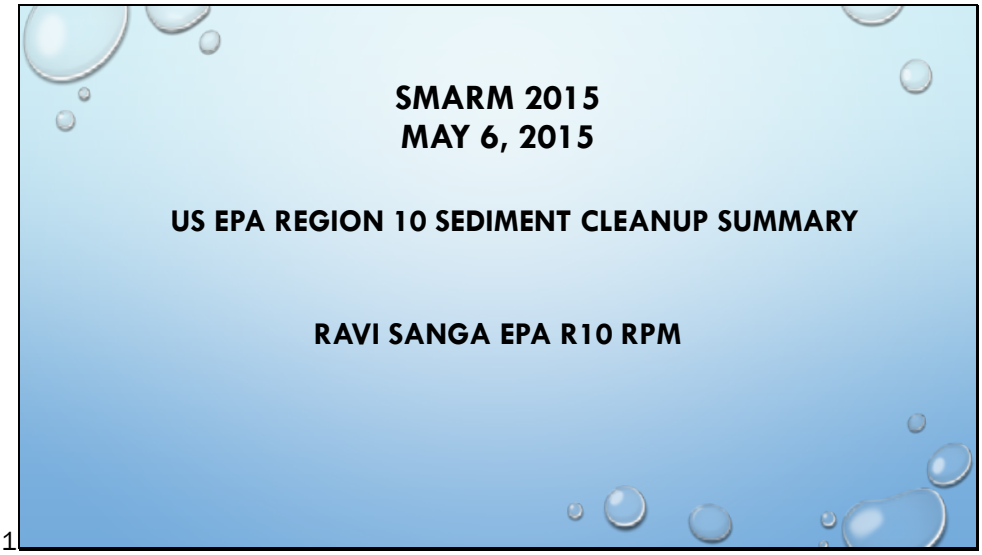
Discussion

Q: Linda Anderson-Carnahan (EPA) – Has the percent PCB loading from air sources been determined for the Lower Duwamish?

A: Ravi Sanga (EPA) – I don't think so.

A: Jim Pendowski (ECY) – I think that Ecology has funded some atmospheric source studies to determine this.

Slides



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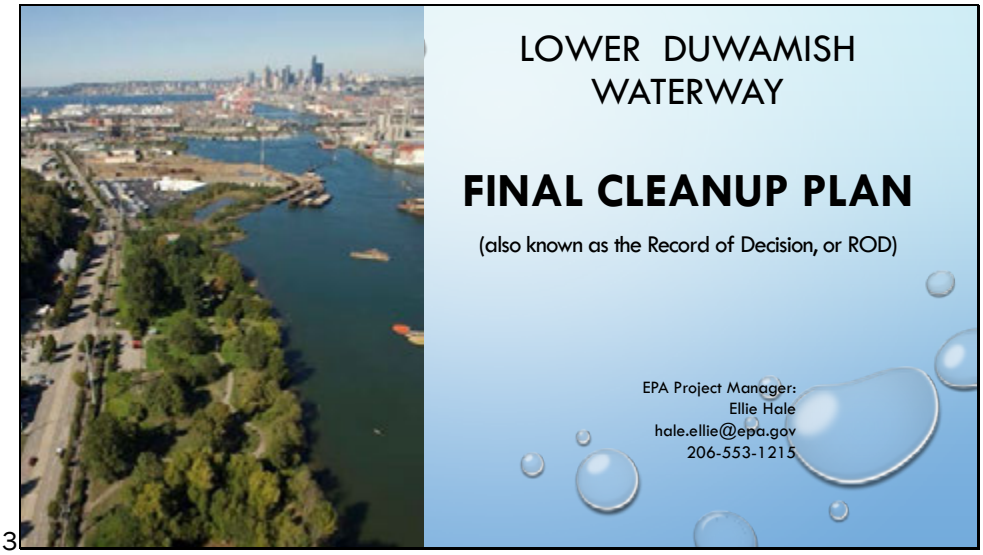
Slide 2

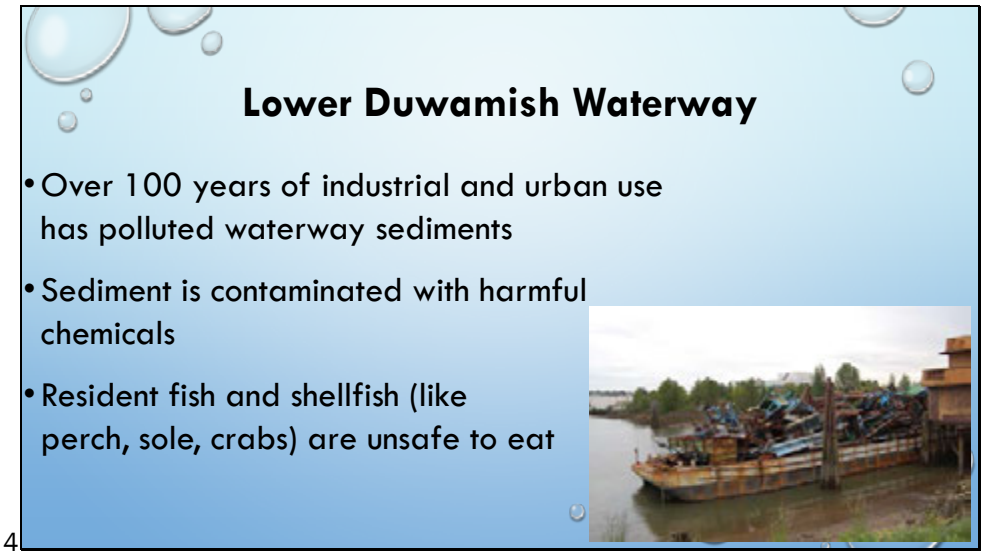


Slide 3

This presentation gives a broad overview of what's in the ROD, signed 11/21/14.

What is the Final Cleanup Plan or the Record of Decision or ROD?

- EPA's decision on how to clean up contamination in the in-waterway portion of the Lower Duwamish Waterway to protect human health and the environment
- Considers the technical information developed during the remedial investigation and feasibility study, and public comments on the Proposed Plan
- Significant milestone in the Superfund process – culmination of the previous 14 years of work
- Allows us to move forward with designing and implementing the remedy



Slide 4

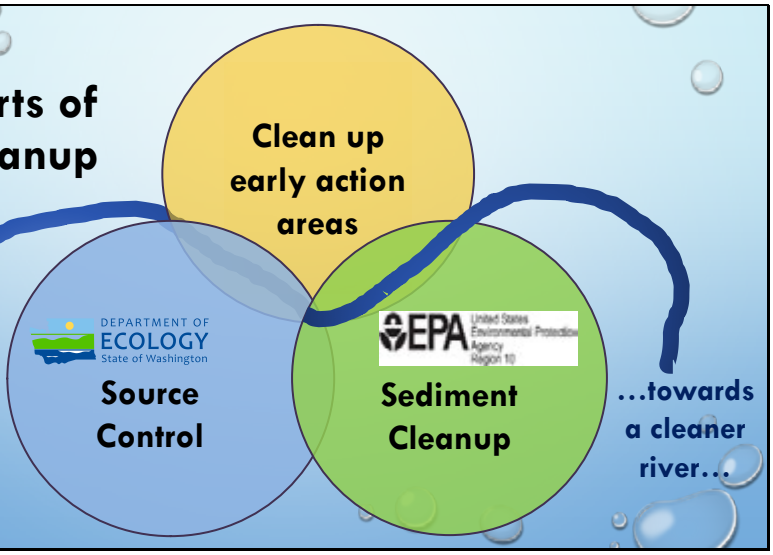
Cleanup Objectives (RAO's)

Reduce risks to:

1. People who eat resident fish and shellfish.
2. People coming into contact (skin contact and ingestion) with contaminated sediments.
3. Bottom-dwelling organisms, such as crabs and clams.
4. Fish, birds, and mammals.

Slide 5

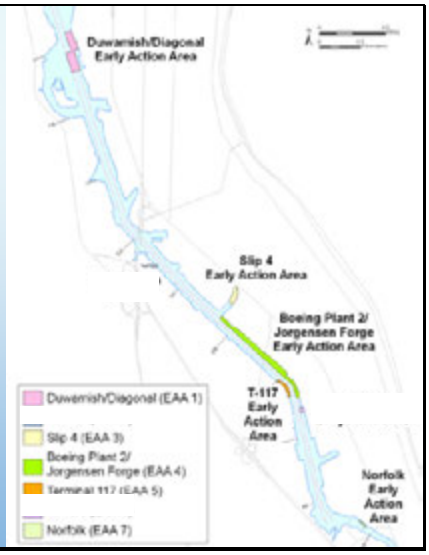
Key Parts of the Cleanup



Slide 6

Clean Up Early Action Areas

- Most completed by 2015
- Address 29 acres of the most contaminated areas in the waterway
- Remove approximately 280,000 cubic yards of contaminated sediments
- Projected to reduce surface sediment PCB concentrations by 50%



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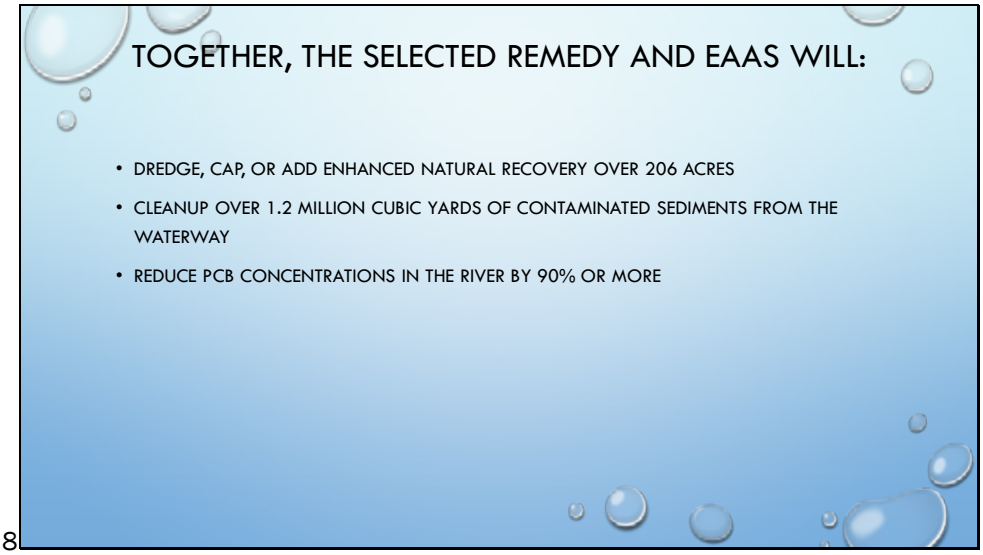

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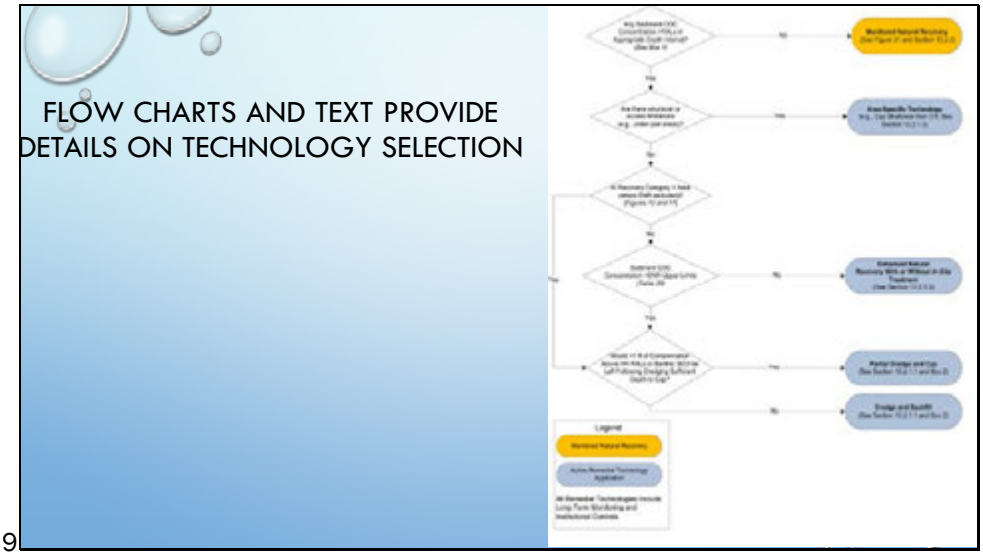
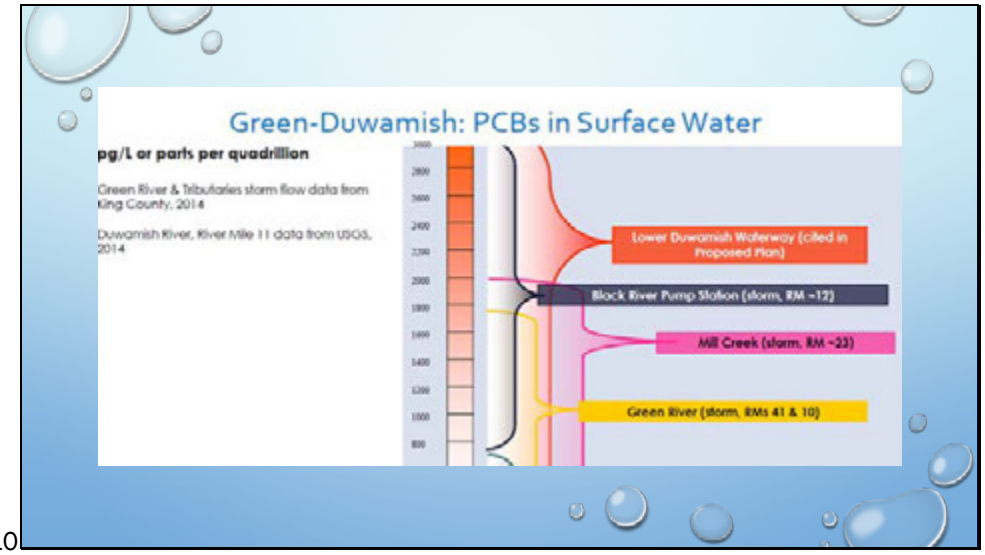


Slide 9

Major Components of the remedy are dredging, capping, ENR and MNR.

- "Monitored natural recovery" relies on the natural flow of sediment form upriver to cover contaminated sediments in the lower water, and includes long term monitoring. We considered this option for the Duwamish because a large amount of cleaner sediment from the Green River Watershed deposits in the Duwamish.
- "Enhanced natural recovery" uses a thin layer of sand to cover the contamination and speed up natural recovery.



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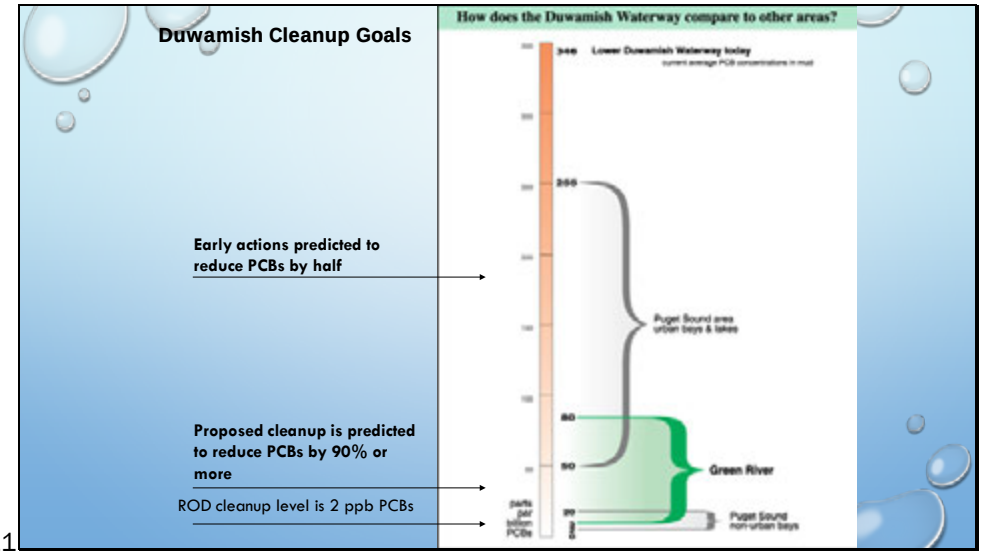
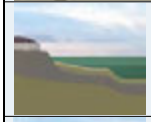
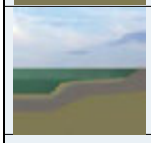


Slide 11

What will we achieve from the cleanup?

- Using PCBs as an example, we estimate the early actions will reduce PCB contamination in surface sediments by 50%.
- The goal of our cleanup plan after the EAA cleanups is to get the Duwamish as clean as non-urban areas in Puget Sound. We honestly don't know if this is achievable. We think our cleanup plan will at least get us 90% there, but there is much uncertainty beyond that 90% mark, because new sediments will continue to deposit from the Duwamish and Green River Watersheds, which cover more than 400 square miles.
- If we were to clean up the entire waterway to the 2 ppb goal – our long-term prediction is that concentrations would then increase over time to somewhere around the 90% mark.
- The increment between the "90% reduction" arrow and the "proposed goal" arrow is where the uncertainty lies.
- This is because at those concentrations the incoming sediments from the Green River will dictate the long-term concentrations in the waterway.
- As noted on this chart, it will take more than just cleaning up the contaminated sediment in the Duwamish to get the sediments clean in the long-term.
- How we use this watershed will have a big impact on the long-term health of the Duwamish.

- Our plan includes long-term monitoring and evaluation and consideration of whether additional work is needed if we don't achieve our goals. In the Agencies' view, the selected remedy provides the best balance of protectiveness, effectiveness and cost.
- Alternatives that remove less contamination – less permanence.
- Alternatives that remove more contamination - increased short-term impacts and cost, without much improvement in permanence.
- Best balance of minimizing short-term risks over a 7 year construction period, while reducing remaining contamination relatively quickly through MNR.
- Takes into consideration multiple future uses of the waterway: industrial/commercial, residential, recreational, and habitat.
- Over 90% reduction in concentrations of human heath contaminants of concern.
- Reach protective levels for wildlife and sediment-dwelling organisms.
- Safe for people coming into contact (skin contact and incidental ingestion).
- Safer for people who eat resident fish and shellfish.

Remedy	Area	Time	Cost	Follow-Up
Dredging	105 Acres	7 Years	**$342 Million**	
Capping	24 Acres			
 ***Enhanced Natural Recovery (ENR)***	48 Acres			
 ***Monitored Natural Recovery (MNR)***	235 Acres	10 Years		
	412 Acres	**17 Years**		

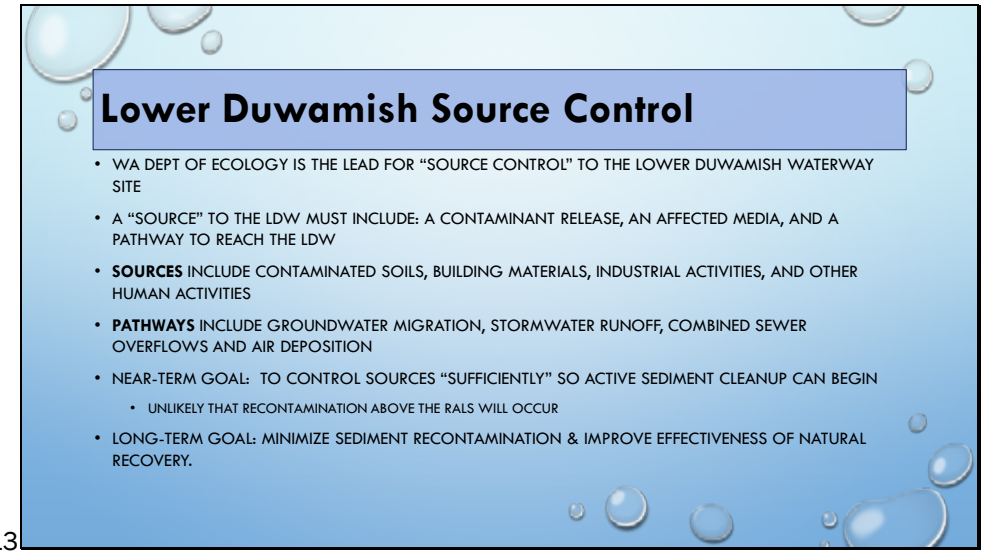
Slide 12

There are a total of 177 acres of *active* cleanup.

Dredge and cap are used in the most contaminated areas and those most susceptible to scour or erosion.

ENR is used in moderately contaminated areas. MNR is used only in areas with low levels of contamination and where potential for recovery is high

Why so much MNR? LDW contamination consists of hot spots with large areas of very low levels of contamination. Hot spots get more aggressive cleanup; lower levels get MNR, in-between get ENR.



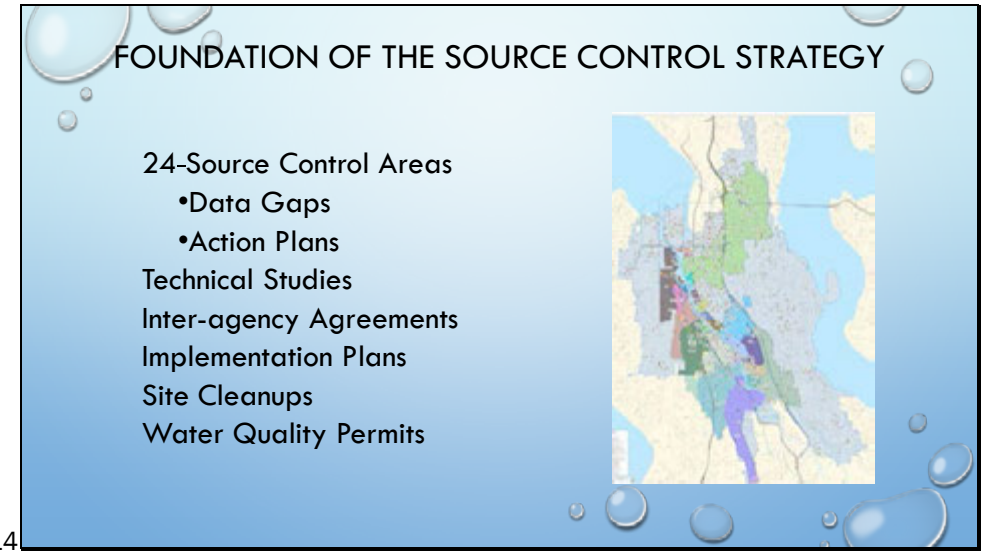
Slide 13

Note that Ecology is the lead for source control in the LDW, but not for the neighboring East Waterway and West Waterway sites. Examples of source control components:

- **Contaminated site**: Historical waste disposal via infiltration (the contaminant release) resulted in contaminated soil and groundwater (the affected media) and the groundwater is seeping into stormwater pipes through cracks (the pipe is the pathway to the LDW).
- **Stormwater runoff**: Historically allowed PCB-containing building materials, such as caulking and paints, are deteriorating (the contaminant release) and getting picked up in stormwater runoff (the affected media) which is then discharged to the LDW (the stormwater conveyance is the pathway to the LDW).

Source control activities focus on **controlling sources** and **pathways** of pollution to the LDW. LDW sediment cleanup will begin after EPA has entered into agreements with one or more parties, baseline and remedial design sampling has occurred, and sources are sufficiently controlled such that it is unlikely that sediments will become recontaminated above the RALs.

Over the long term, source control will help to minimize recontamination of sediments and will improve the effectiveness of natural recovery. Source control actions have already achieved significant reduction in contaminants entering the waterway.

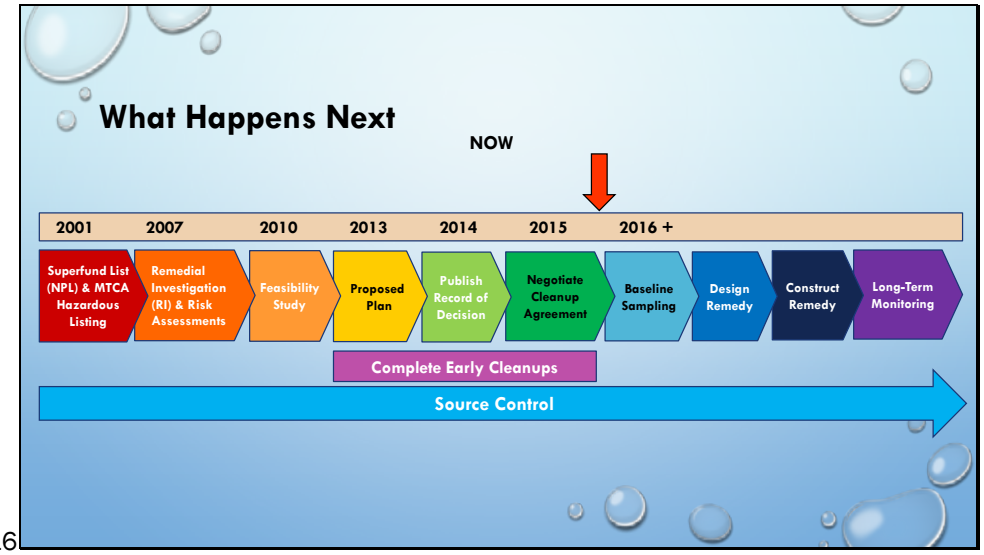


Slide 14

Foundation of the strategy is culmination of over a decade of work:

1. Extensive research in 24 source control areas generated data gaps reports and action plans with high, medium and low prioritized actions for each source control area. Ecology tracks action items in a database.
2. Technical studies and interagency agreements – most completed but some still underway -Examples of Technical Studies: Outfall inventory, SWPPP project, Industrial Facility Sampling, Green River Loading, Air deposition
3. IA's: Interagency agreements betweej TCP & local govts/quasi govts to leverage funds and accomplish timely and informed source control. Substantial amount of source tracing data collected over multiple years.
4. Implementation Plans: Source Control Work Group members are developing Implementation Plans to describe priorities and specific source control actions they will take over the next 5 years (City of Seattle, King County, Ecology, WDOT and EPA)
5. Site Cleanup: Ecology currently has 18 sites under Orders in the LDW (includes Ecology-led RCRA sites). At least fourteen more sites need cleanup orders. Ecology is also performing 195 site hazard assessments to determine if there are additional sites that need to be addressed.
6. Water Quality Permits: There are approximately 110 NPDES permits in the LDW source area (6 different types). CSOs are scheduled for control in accordance with federal Consent Decree requirements. Industrial stormwater is receiving more treatment and the most recent general permit includes additional requirements for data collection and line cleaning. Adaptive management efforts are underway for municipal stormwater. Ecology is also increasing their inspection resources for the Green-Duwamish watershed.

Slide 15



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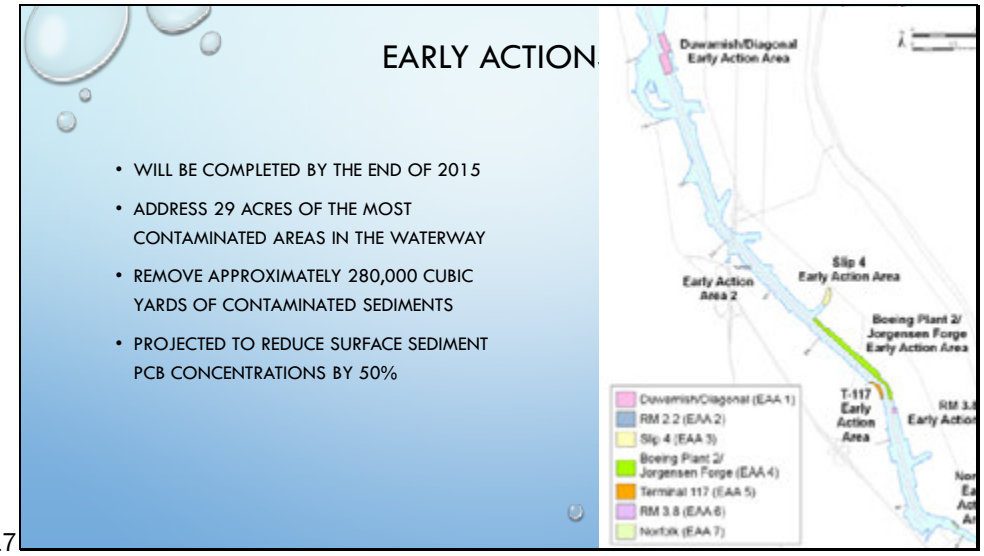

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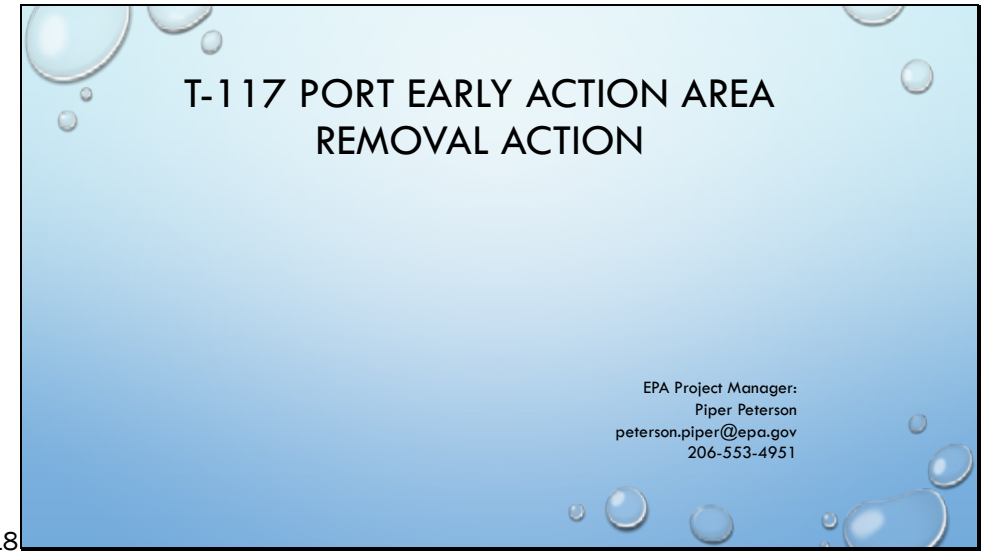


Slide 18

T-117 UPLAND SOILS/BANK REMEDIATION

- CLEANUP BY THE NUMBERS
  - 8,000 TONS OF DEMOLITION DEBRIS
    - 2,500 TONS REUSED/SALVAGED
    - 3,500 RECYCLED
  - REMOVED 57 CREOSOTE-TREATED WOOD PILES
    - REPLACED WITH 4 STEEL PILES AND A POLYETHYLENE DEBRIS DEFLECTOR

T-117 Riverbank Pre-construction

Slide 19

T-117 UPLAND EXCAVATION

- EXCAVATED 77,000 TONS (48,000 CUBIC YARDS) OF UPLAND SOIL
- ONLY 2 EXCEEDANCES (FOR DIESEL EXHAUST) AMONG ~180 DAYS (SHIFTS) OF AIR, NOISE, LIGHT MONITORING

Slide 20

T-117 UPLAND EXCAVATION

- PLACED 53,000 TONS (88,000 CY) OF BACKFILL
- 860 FEET RIVER BANK REPLACED

Slide 21

Slide 22

T-117 SEDIMENT

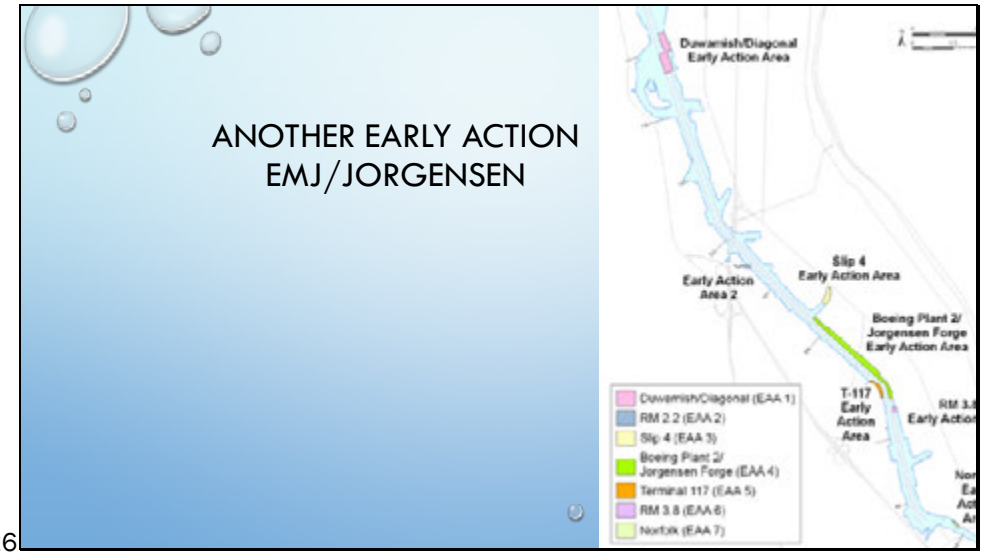
- 14,000 CY DREDGED SEDIMENTS OVER 64 DAYS OF WORK
- 25,000 TONS OF CLEAN SAND BACKFILL AND ARMOR STONE
- REMOVAL/BACKFILL FROM ADDITIONAL 25 FEET OF ADJACENT RIVER BANK

Slide 23

Slide 24

Temporary sheetpile wall will remain in-place until 2016, when habitat restoration is scheduled.

Slide 25



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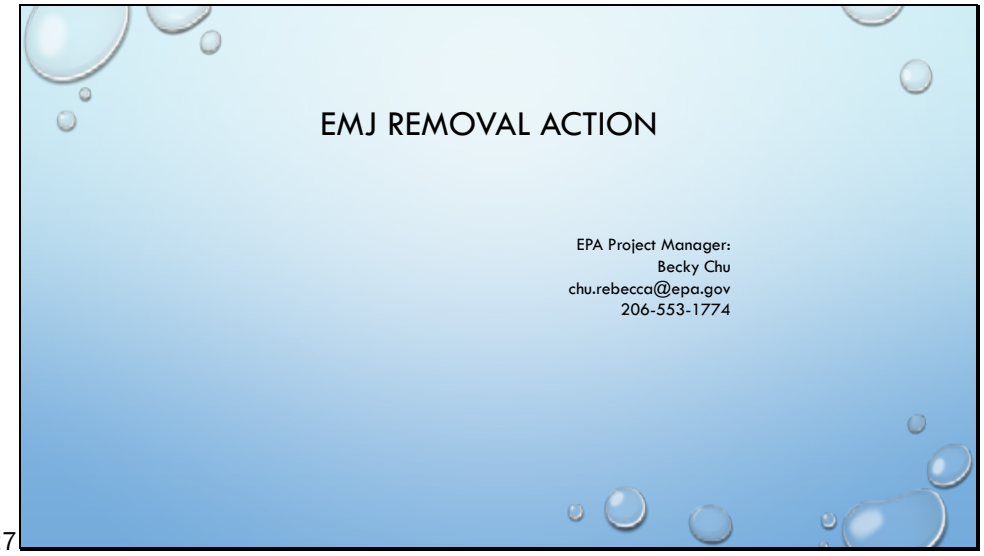

Slide 27

EMJ BACKGROUND

- EAA OF THE LDW- ADJACENT TO BOEING PLANT 2
- PRP-LED NTCRA(STARTED: 2003; EECA 2008-2011; REMOVAL ORDER: 2012)
- METAL FOUNDRY (FORMERLY BETHLEHEM STEEL)
- PRIMARY COCS: CO-LOCATED PCBS AND METALS (AS, CD, CR, CU, PB, HG, AG, ZN)
- SEDIMENT SITE: ~12000 YDS^3 SEDIMENT, 3000 YDS^3 BANK
- UPLANDS IS ECOLOGY MTCA SITE
- "24" PIPE" RUNS ALONG THE NORTHERN PROPERTY LINE WITH BOEING PLANT 2

Slide 28

EMJ BACKGROUND

Slide 29

EPA'S ACTION MEMORANDUM

- * COMPLETE EXCAVATION OF ALL BANK AND SEDIMENTS WITHIN EAA EXCEEDING RVALS;
- * STORMWATER MANAGEMENT;
- * LONG-TERM SEDIMENT AND GROUNDWATER MONITORING.

COC	RvAL (mg/kg)
PCBs	12 ppm OC
Cadmium	5.1
Lead	450
Chromium	390
Mercury	0.41
Silver	6.1
Zinc	410
Arsenic	51

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Slide 32

Problems at EMJ/Jorgensen:

- Overflowing cofferdam during dredging- so clearly that defeats the purpose of keeping the material out of the LDW.
- Didn't attach the silt curtain to prevent the bank material from getting in to the LDW.
- TSCA barge was leaking via the scupper. Realized it wasn't actual TSCA de-water leaking through scupper- but shut down the site until we had that- and many, many other problems- under control.

Slide 33

LOCKHEED WEST SEATTLE SUPERFUND

- RD/RA CLEANUP ACTIVITIES

EPA Project Manager:
Piper Peterson
peterson.piper@epa.gov
2Lynda <lpriddy@earthlink.net>06-553-4951

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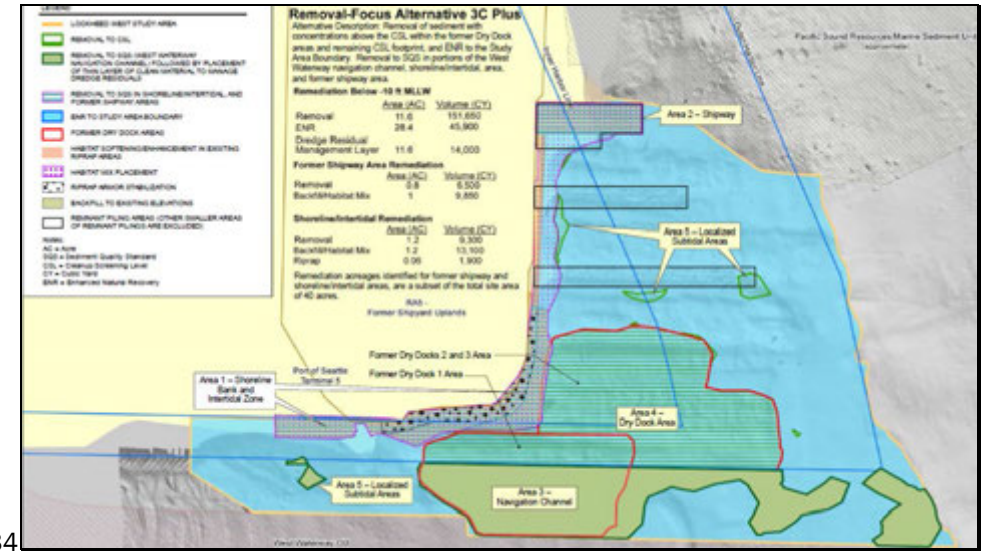

Slide 35

SITEWIDE REMEDIATION TOTALS

- DREDGING: 13.6 ACRES AND 167,450 CY
- BACKFILL SHORELINE AND INTERTIDAL AREAS: 2.2 ACRES AND 22,950 CY OF HABITAT MIX
- THIN COVER FOR DREDGE RESIDUALS MGM'T/ENR LAYER: 40 ACRES (ENTIRE SITE) AND 59,900 CY
- $ 47.7 MILLION, CAPITAL COST ($48.1 MILLION DISCOUNTED RATE)

NEXT STEPS

- UAO ISSUED MARCH 5, 2015
- UAO EFFECTIVE APRIL 13, 2015
- START RD/RA
  - NAME RD/RA CONTRACTOR 10 DAYS AFTER UAO EFFECTIVE DATE – TETRA TECH
  - RD WORK PLAN SUBMITTED 60 DAYS AFTER UAO EFFECTIVE DATE
  - PRELIMINARY DESIGN (30%) SUBMITTAL 60 DAYS AFTER SUBMITTAL OF THE PRE-REMEDIAL DESIGN DATA REPORT

Slide 36

EAST WATERWAY OPERABLE UNIT (OU) OF THE HARBOR ISLAND SUPERFUND SITE

EPA Project Manager:
Ravi Sanga
sanga.ravi@epa.gov
206 553 4092

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EAST WATERWAY OU

- SUPPLEMENTAL REMEDIAL INVESTIGATION
- CURRENTLY REVIEWING FEASIBILITY STUDY
- PROPOSED PLAN EXPECTED 2016
- ROD/CLEANUP DECISION 2018

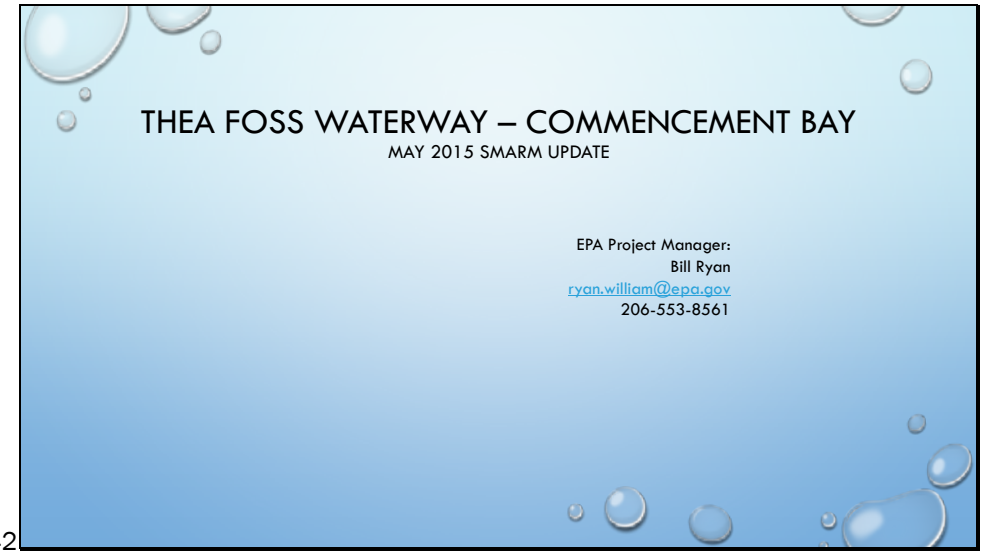
Slide 41

The PSR 5 year review completed at the end of Sept 2014. Remedy continues to be protective of the environment and human health.

Additional cap material was placed in late 2013 in subtidal areas where cap material was thinnest.

One of the issues identified with the 2005 capping project was the lack of accuracy in barge positioning during placement. In order to address this issue the Dredge Quality Management tool (DQM) was used to monitor the barge positioning during placements. The design called for the centroid of the barges to remain within a 50 ft radius of the target during placement.

Product continues to be removed. SPME analysis demonstrated that upwelling did not break through sediment cap.



Slide 42

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Bridge debris fell into the waterway.

THEA FOSS WATERWAY – COMMENCEMENT BAY

MAY 2015 SMARM UPDATE

- DISPOSAL
  - DREDGED MATERIALS WERE PLACED IN WATER-TIGHT CONTAINERS ON BARGE
  - CONTAINERS TRANSFERRED DIRECTLY TO TRUCK AND THEN TO TRAIN
  - TRANSPORTED TO ROOSEVELT LANDFILL FOR DISPOSAL
- POST-CONSTRUCTION MONITORING
  - CONCENTRATIONS WELL BELOW SQOS
- FINAL WATERWAY DEPTHS RANGED BETWEEN -6" TO +12" OF PRE-PROJECT DEPTHS

Slide 44

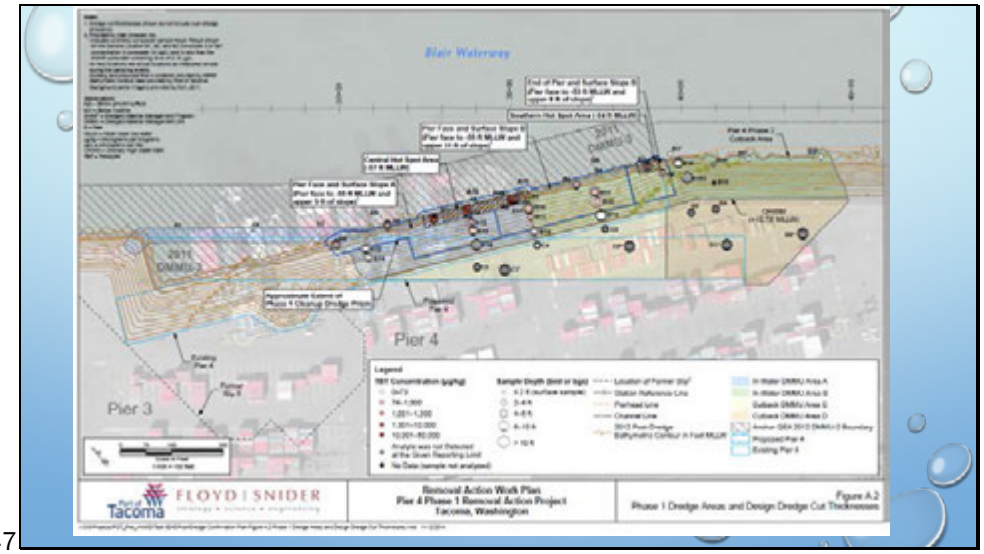
BLAIR WATERWAY TBT REMOVAL ACTION

- OSC KATHY PARKER
- PARKER.KATHY@EPA.GOV
- 206-553-0062
- PARKER.KATHY@EPAMAIL.EPA.GOV

Slide 45

Slide 46

Slide 47



Some of the highest TBT Concentrations in the world were found here. Nobody knows where it came from.

The TBT was discovered during the Port's regular sediment characterization work for DMMP as part of a permit for Pier 4 reconfiguration and reconstruction. The project now has two distinct work phases: The Phase 1 Removal Action which will first address 49,000 cy of overlying TBT-contaminated sediments, and Phase 2 which is in the permitting process as originally planned and includes reconfiguration of the pier and additional cutback and dredging of 500,000 cy. The project is planned to be completed over 3 years, with work scheduled to be conducted between 2015 and 2018.

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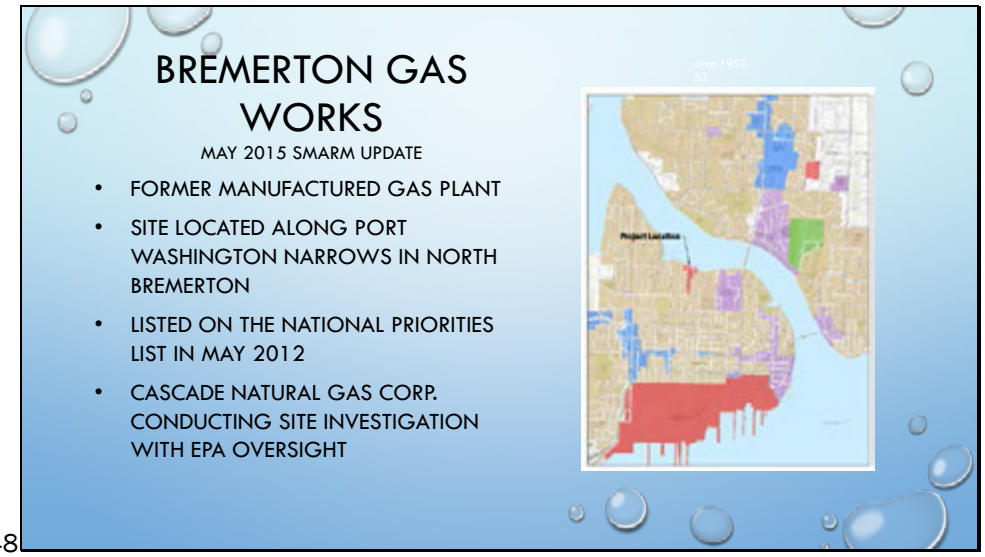

Example of continued investigation and listing by EPA of contaminated sediment sites.

BREMERTON GAS WORKS (CONTINUED)

MAY 2015 SMARM UPDATE

- 2 REMOVAL ACTIONS ON THE BEACH
  - NOVEMBER 2010 (PRE-LISTING)
  - OCTOBER 2013
- CONTAMINATION HAS BEEN FOUND IN UPLAND SOILS, GROUNDWATER AND SEDIMENTS
- PRIMARY CONTAMINANTS OF CONCERN
  - PAHS, METALS, BTEX

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BREMERTON GAS WORKS (CONTINUED)

MAY 2015 SMARM UPDATE

- RECENTLY FINALIZED RI/FS SCOPING MEMO (MARCH 2015)
- DRAFT RI/FS WORK PLAN CURRENTLY UNDER DEVELOPMENT – HOPE TO FINALIZE AND BEGIN FIELD INVESTIGATION IN LATTER PART OF 2015

EPA PROJECT MANAGER:

BILL RYAN

RYAN.WILLIAM@EPA.GOV

206-553-8561

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4. PAH Sediment Screening for the Protection of Fish: Lyndal Johnson, NMFS

Summary

Lyndal Johnson is a scientist with NOAA's Northwest Marine Fisheries Science Center. This paper is slightly updated from one that was presented at the RSET annual meeting in Portland in November 2014. Lyndal and her co-author, Jeremy Buck of the USFWS, are working on a white paper to develop recommendations to the DMMP and RSET on the effects on fish of PAHs in sediments. The present PAH guidelines are based on effects to benthic invertebrates.

Lyndal summarized the pathways for PAHs from sediments into fish, and described adverse effects and response of fish to exposure. No sediment PAH values were proposed, but NMFS and USFWS anticipate that this work, when finalized, may be considered for proposing new sediment PAH values.

Discussion

Q: Justine Barton (EPA) - Where is the white paper?

A: Lyndal Johnson (NMFS) - We'll put a link on DMMO's website.

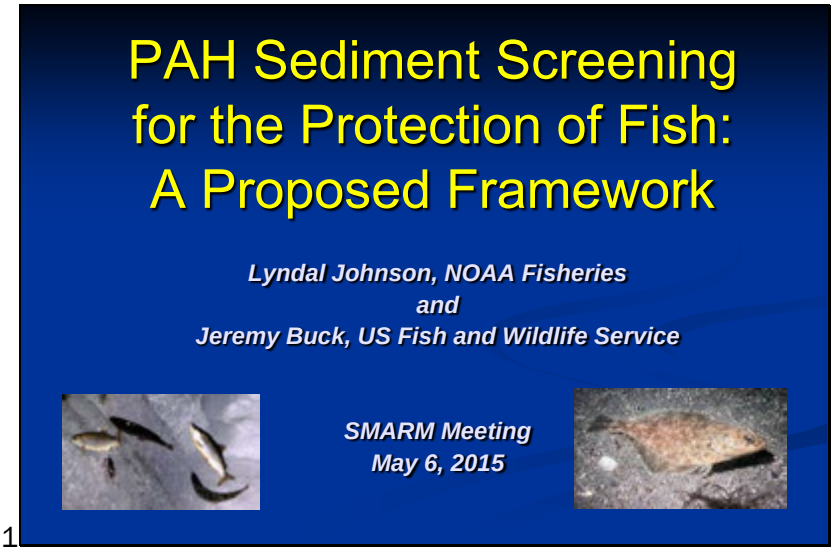
Q: Jennifer Sutter (ODEQ) – Most studies looked at TPAHs. Have you considered using other groupings of PAHs?

A: Lyndal Johnson (NMFS) - We could use other groupings. We looked at TPAH mostly because of the high correlation with various effects. We could separate LPAHs and HPAHs out and will consider doing this. Most endpoints have shown good correlation with totals, though.

Q: Kathy Godtfredsen (WindWard) – We've already submitted comments on this white paper. What's the next step? Will there be a formalized process before its recommendations are used?

A: Lyndal Johnson (NMFS) - We haven't seen your comments. There's been a change in the management group for RSET and perhaps your comments were lost in the shuffle. We'll track them down. *(Editor's Note: Comments had been e-mailed to RSET personnel but not noted by the recipients. They were recovered and added to the record.)*

Slides

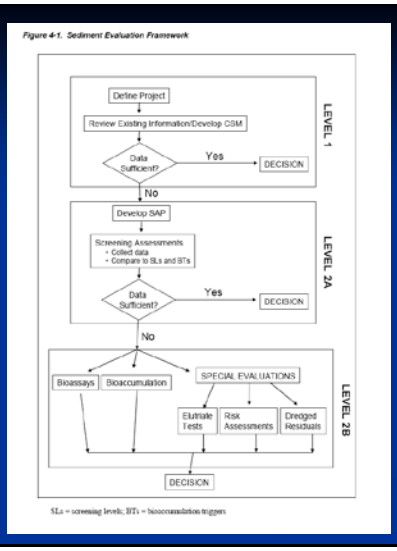


Slide 1

Contributors

Beth Horness
Laura Inouye
John Incardona
Dan Lomax
Jim Meador
Mark Myers
Rob Neely
Sandie O'Neill
Jennifer Peers
Jim West
Gina Ylitalo and NWFSC Environmental Assessment Program

Slide 2



Sediment Evaluation Framework (SEF 2009))

SEF Guidelines or Benchmarks:

- Sediment Screening Levels (SLs)
- Target Tissue Levels (TTLs) for Invertebrates and Fish, Wildlife, and Humans

Slide 3

Fish TTLs for Contaminants

- The Target Tissue Value approach has been applied for some major classes of contaminants, e.g.
  - PCBs for salmon (Meador et al. 2002)
  - DDTs for fish (Beckvar et al. 2005)
  - Methyl mercury for fish (Beckvar et al. 2005)
- Translating to sediment value – site specific BSAFs
- Many contaminants of concern for which values aren't available, but at least a viable approach
- Revised criteria based on human health concerns (e.g., new Ecology sediment standards) would protect fish for most compounds (lead, mercury, selenium, TBT, PCP pyrene, phenanthrene possible exceptions)

Slide 4

PAH SLs & TTLs for Fish: Problems and limitations

- Current SLs are based on synoptic field data combining chemistry with invertebrate bioassay and/or benthic data
- May be protective of fish prey base, but not direct effects on fish
- TTL approach proposed as alternative for protection of fish for bioaccumulative compounds
- Fish metabolize PAHs, so TTLs won't work; something different needed

Slide 5

Exposure Pathway/Assessment

- Direct correlation of sediment PAH levels with biological effects
- Alternatives to TTLs
  - Dietary effects thresholds
  - Metabolites of PAHs in bile of fish

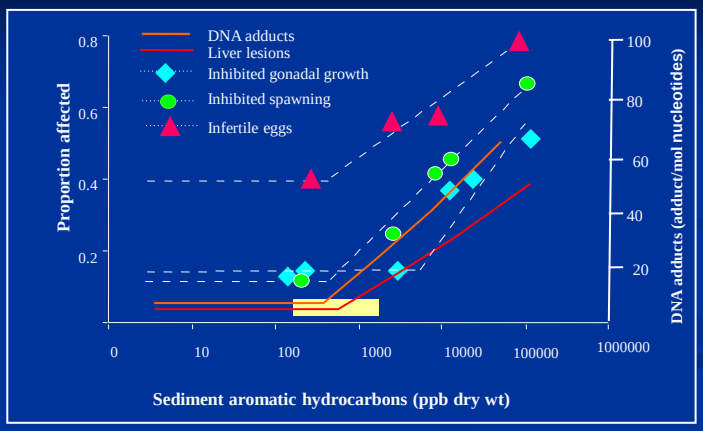
Slide 6

Exposure Pathway/Assessment

- **Direct correlation of sediment PAH levels with biological effects**
- Alternatives to TTLs
  - Metabolites of PAHs in bile of fish
  - Dietary effects thresholds

Slide 7

English sole injury vs. sediment PAH concentrations



Slide 8

Sediment ΣPAH concentration vs. biological effects in English sole

Biological Effect

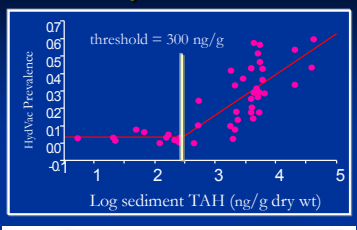
PAH (ppb dry wt)	Liver Lesions (%)	Gonad Dev (%)	Inhib. spawn (%)	Infertile eggs (% eggs)	DNA damage (nmol adducts per mol bases)	Reduced Growth (%change in wt per day)
50	0	15	12	38	5	1.1-1.2
100	0	15	12	38	5	--
1000	9	15	17	42	25	--
2000	18	15	25	48	36	--
3000	24	15	30	51	43	0.05-0.10
5000	31	18	35	55	51	--
10000	40	27	43	61	63	--
100000	71	58	69	80	100	--

Slide 9

Liver Lesions In Other Species

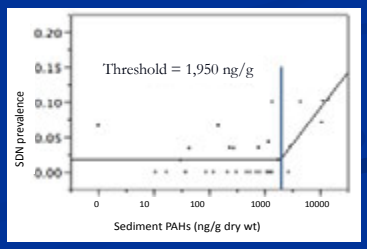
Winter flounder

Threshold for degenerative lesions
300 ng/g total PAHs



Starry flounder

Threshold for degenerative lesions
1950 ng/g Total PAHs



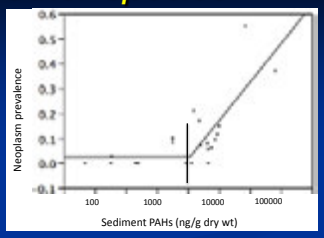
Slide 10

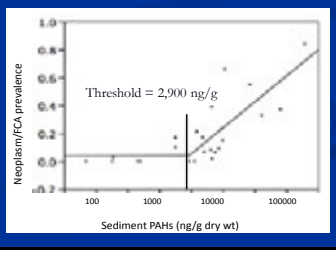
Liver Lesions in Other Species

Brown Bullhead

Threshold for neoplasms
3400 ng/g total PAHs

Threshold for FCA and neoplasms
2900 ng/g total PAHs





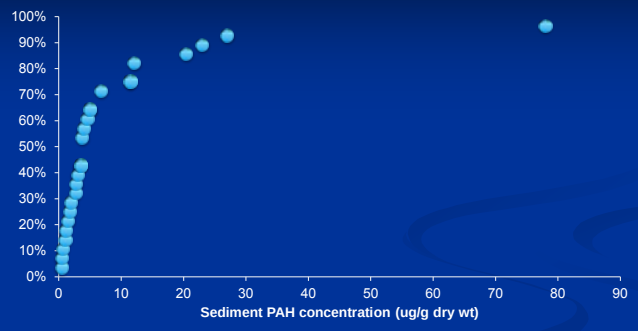
Slide 11

Additional Studies of ΣPAH concentration in sediments vs. biological effects

Species	Compound	Endpoint	Concentration	Reference
Pink salmon eggs	PAHs in weathered oil	Embryo mortality	2800 ng/g dry wt (LOEC)	Murphy et al. 1999
Pink salmon embryos	PAHs in weathered oil	Embryo mortality	2800-4600 ng/g dry wt (LOEC)	Heinz et al. 1999
Senegalese sole	PAHs in sediment	Degenerative liver lesions	1100 ng/g dry wt	Costa et al. 2009
Turbot	PAHs in sediment	Reduced growth; lipid depletion	2000-3000 ng/g dry wt (LOEC)	Kerambrum et al. 2012
White perch	PAHs in sediment	Altered stress response	3000-4000 ng/g dry wt (LOEC)	Hontela et al. 1995
Mummichog	PAHs in sediment (BaP only)	EROD activity in the intestine	3500 ng/g dry wt (LOEC)	Couillard et al. 2009
Mummichog	PAHs in sediment	Liver neoplasms	16000 ng/g dry wt (NOEC)	White paper
Zebrafish	PAHs in sediment	Developmental abnormalities	28000 ng/g dry wt (LOEC)	Raimudo et al. 2014
Zebrafish	PAHs in sediment	Mortality	78000 ng/g dry wt (LOEC)	Raimudo et al. 2014

Slide 12

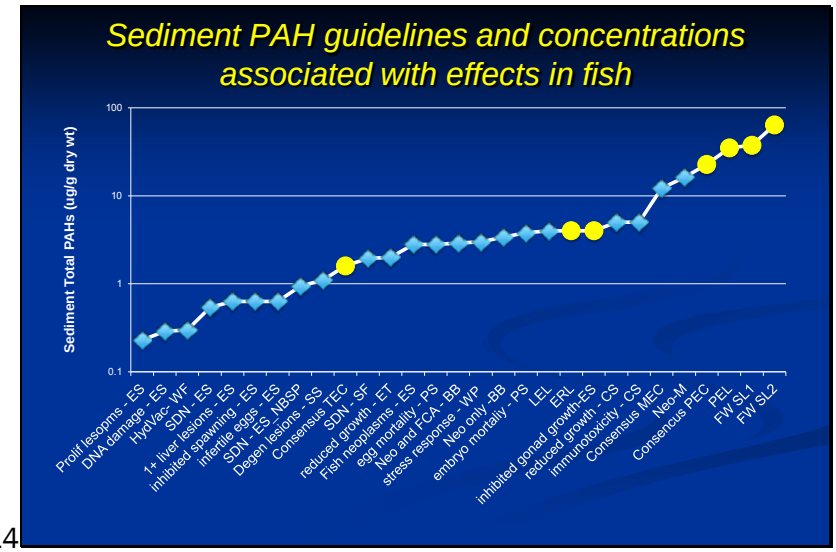
Cumulative Distribution for Sediment PAH studies



10% percentile: 0.9 ug/g dry wt 25% percentile: 1.9 ug/g dry wt

For liver lesion thresholds, PAH concentration where prevalence was 2x the background was used

Slide 13



Slide 14

Exposure Pathway/Assessment

- Alternatives to TTLs
  - Dietary effects thresholds
  - Metabolites of PAHs in bile of fish

Might be used to derive sediment guidelines to support SLs; or used for Level 2B testing

Slide 15

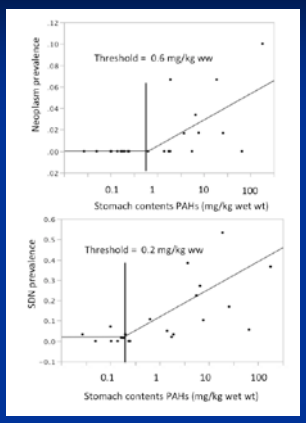
Exposure Pathway/Assessment

- Alternatives to TRVs
  - **Dietary effects thresholds**
  - Metabolites of PAHs in bile of fish

Might be used to derive sediment guidelines to support SLs; or used for Level 2B testing

Slide 16

PAHs in sole stomach contents vs. lesions



Threshold value of 0.2 mg/kg wet wt for specific degenerative necrosis (SDN)

Threshold value of 0.6 mg/kg wet wt for neoplasms

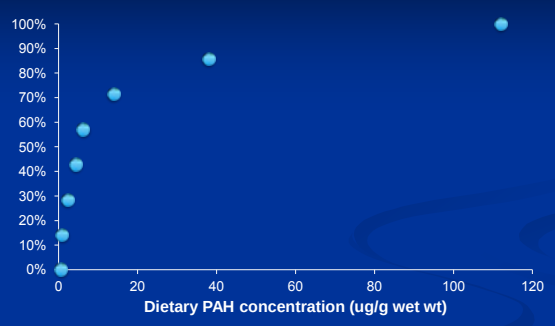
Slide 17

Dietary ΣPAH concentrations vs. biological effects

Species	Endpoint	Dose (ug/g fish wt/day)	Concentration in food (ug/g ww)	Reference
English sole	Degenerative lesions	-	0.2	2014 white paper
English sole	Neoplasms	-	0.6	2014 white paper
Pink salmon	Reduced growth rate	0.14	0.9	Carls et al. 1996
English sole	Reduced growth rate	0.12	2.3	Rice et al. 2000
Chinook salmon	Increased growth variability	0.7	3.8	Meador et al. 2006
Rainbow trout	Decreased disease resistance	0.66	4.1	Bravo et al. 2010
Chinook salmon	Changes in enzymes related to lipid metabolism	2.3	12	Meador et al. 2006
Chinook salmon	Changes in lipid content	6.1	32	Meador et al. 2006
Chinook salmon	Reduced weight	18	95	Meador et al. 2006

Slide 18

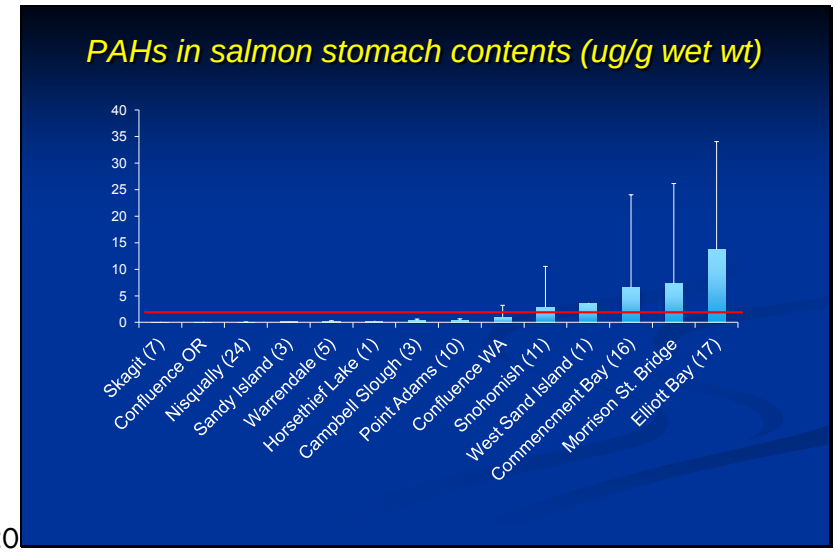
Cumulative Distribution for Dietary PAH studies



10% percentile: 0.825 ug/g dry wt 25% percentile: 1.95 ug/g dry wt

For liver lesion thresholds, PAH concentration where prevalence was 2x the background was used

Slide 19



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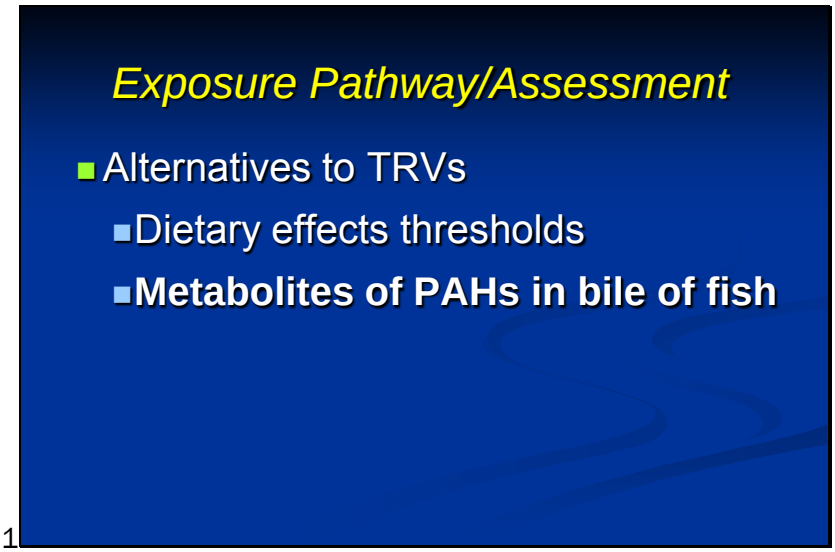

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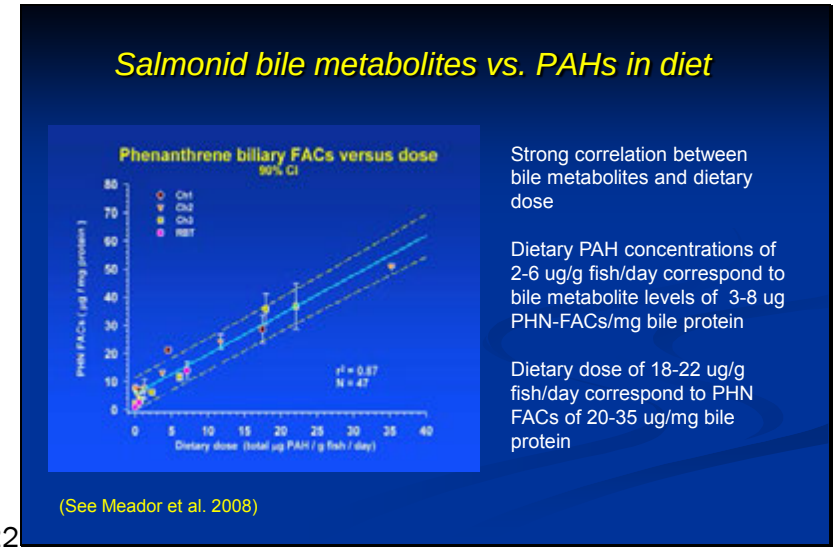
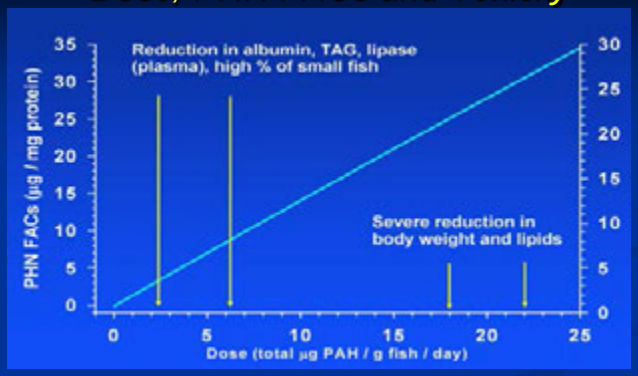


Slide 22

Dose, PHN FACs and Toxicity



Estimated no effect level of ~2 ug FACs-PHN/mg protein (Meador et al. 2008)

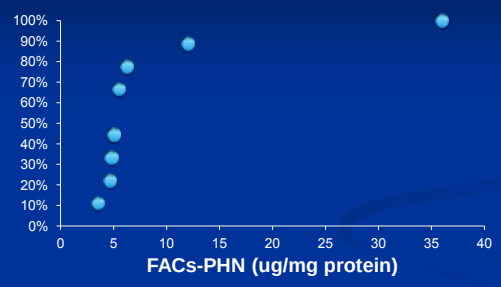
Slide 23

PAH metabolites in bile vs. biological effects

Species	Endpoint	Dose (ug/g fish wt/day)	FACs-PHN (ug/g bile protein)	Reference
English sole	Increased liver lesions prevalence (2-4 x)	-	5	PSAT 2007
English sole	Reduced growth rate	0.12	4.7	Rice et al. 2000
Pink salmon	Reduced growth rate	0.14	4.8	Carls et al. 1996
Rainbow trout	Decreased disease resistance	0.66	5.5	Bravo et al. 2010
Chinook salmon	Increased growth variability	0.7	3.5	Meador et al. 2006
Dolly varden trout	Reduced reproductive hormones	-	5	Sol et al. 2000
Chinook salmon	Changes in enzymes related to lipid metabolism	2.3	6.3	Meador et al. 2006
Chinook salmon	DNA damage in gill tissue	-	11	Kelley et al. 2011
Chinook salmon	Changes in lipid content	6.1	12	Meador et al. 2006
Chinook salmon	Reduced weight	18	36	Meador et al. 2006

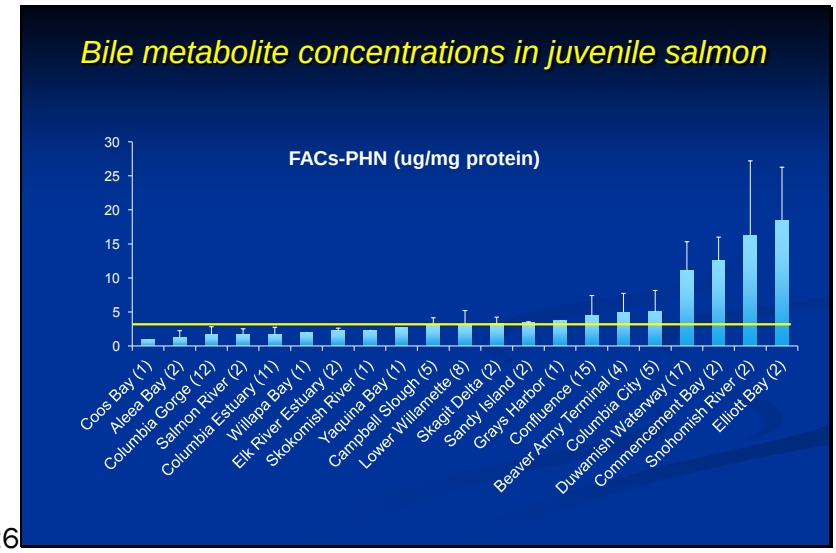
Slide 24

Cumulative Distribution for Bile Metabolite Studies



10% percentile: 3.5 ug/mg protein 25% percentile: 4.7 ug/mg protein

Slide 25



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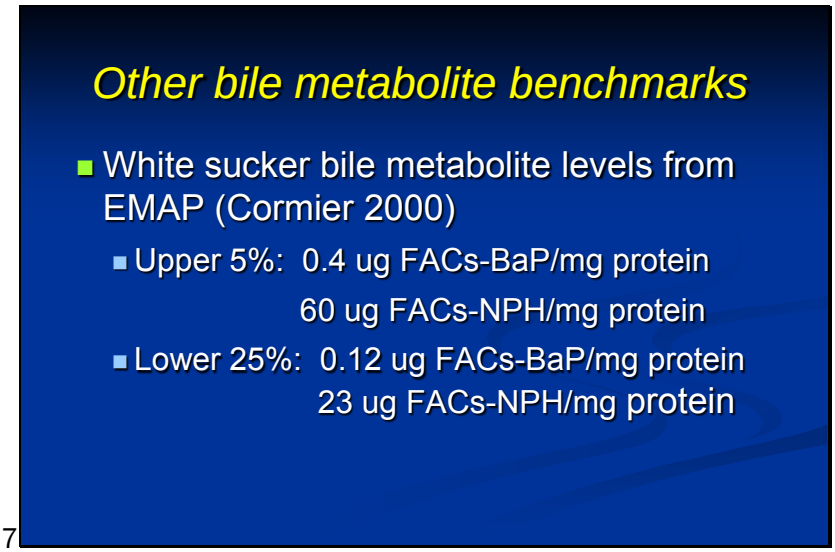

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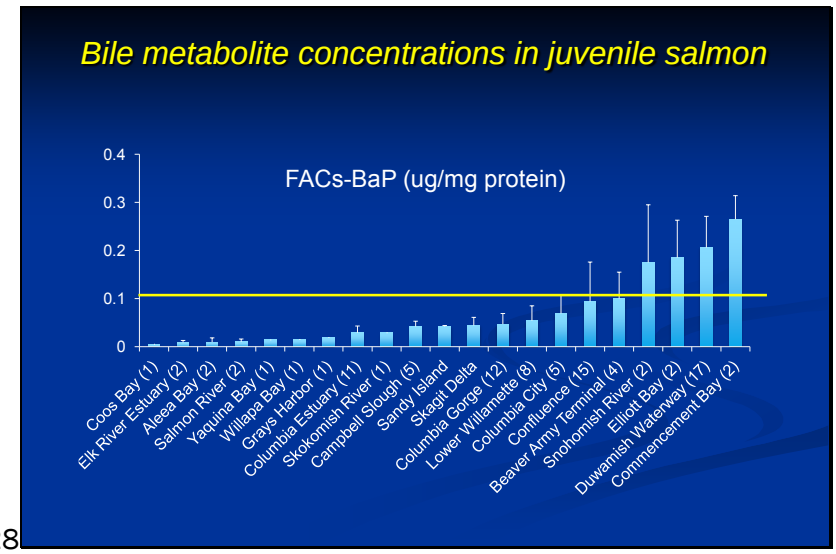


Slide 28

Summary of Findings

10th and 25th percentile values for PAHs or metabolites in sediment, diet and bile

- Sediment PAHs: 0.9 -1.9 ug/g dry wt
- Dietary PAHs: 0.83 – 1.95 ug/g wet wt
- Bile FACs-PHN: 3.5 - 4.8 ug/mg protein

Slide 29

Next Steps?

- Review sediment, diet, and bile data to determine appropriate screening guidelines
- Consider Conceptual Site Model to determine whether PAHs are an issue (e.g., compare with existing data to see if field caught fish from project area have biliary FACs above thresholds)
- Identify appropriate test-out options (e.g., bioassays, bioaccumulation tests, field risk assessments) when guidelines are exceeded
- Develop evaluation framework and incorporate recommendations into the SEF/DMMP

Slide 30

5. Freshwater Guidelines: Follow-up from 2014 - Laura Inouye, Ecology

Summary

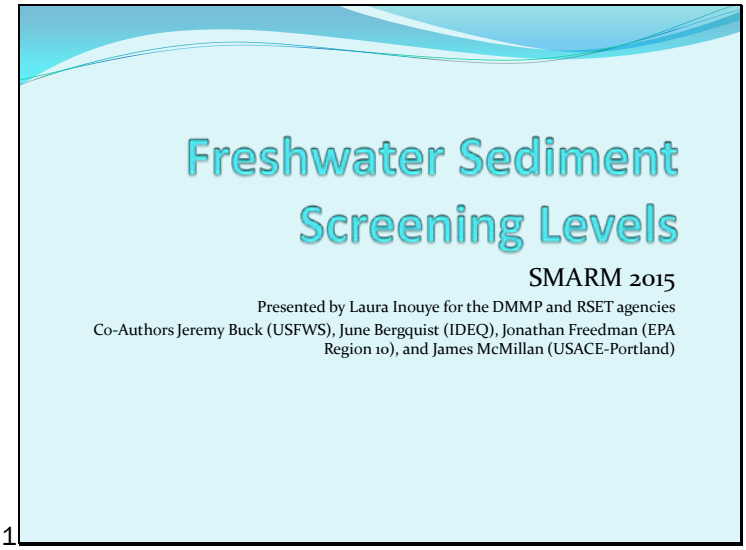
Laura Inouye discussed the adoption of two of the three parts of the freshwater guidance proposed last year. In 2014, RSET proposed adoption of part 1, the benthic freshwater SLs that were promulgated in Washington in 2014, part 2, the water-quality-based screening levels, and part 3, the background based approach for metals. No comments were received on parts 1 and 3, which will be adopted. Part 2 will continue to be developed, with emphasis on developing test-out procedures and application to new surface material.

Discussion

Q: Jennifer Sutter (ODEQ) – Could you clarify an issue with the application of these guidelines to new surface material? Is it only an issue if the new surface is higher than the original?

A: Laura Inouye (ECY) – At this time, the WQ-based SLs do not apply to new surface material, due to complicated issues on how they apply and test outs that are applicable to what we are trying to protect. We hope to work these out for the next presentation.

Slides



Slide 1

A Little History

2007: RSET and Ecology began a process for gathering more data to re-run the FPM method to develop freshwater screening levels

2010: Ecology decided to move forward with adopting the resulting values into rule

2013: In February, Ecology promulgated the values as freshwater benthic standards, which was one part of a framework for addressing contaminants

Slide 2

A Little History

2013: In November at the 2013 RSET annual meeting, an approach was informally outlined that included :

1. Washington State's freshwater benthic sediment standards
2. WQ-based sediment SLs, and
3. A background over-ride for metals.

2014: In May at the 2014 SMARM meeting the three approaches were formally proposed in a single paper. Public comments were received, and resulted in changes.

2014: In November, at the 2014 RSET meeting the paper was broken into three parts, and modified based on public comments. Further public comments were received on only one part of the paper, the WQ-based SLs.

Slide 3

Status

1. Comments and responses to comments will be available soon(both rounds of review comments included).
2. Proposing adoption of Parts 1 and 3, which had no public comments (freshwater benthic screening levels, background approach for metals).
3. The new benthic SLs will replace the interim values completely.
   - Same method used, new values used larger dataset
   - Please do NOT compare "old and new" SLs in sediment data reviews!

Slide 4

Status

4. Part 2, the WQ-based SLs, will continue to be worked on
    a. Defining elutriate testing methods
    b. Role of modeling
    c. Role in new surface material evaluation
        - Applicability
        - Porewater vs elutriate testing
        - Potential bioassay test outs

Slide 5

Other Moving Parts

1. Bioaccumulatives: Path forward available in Washington due to rule revision (but not sure how it applies to other states)
2. Other Ecological receptors: Fish Screening Levels (Lyndal Johnson, NOAA)

Slide 6

6. Freshwater Bioassay Interpretation - Laura Inouye, Ecology

Summary

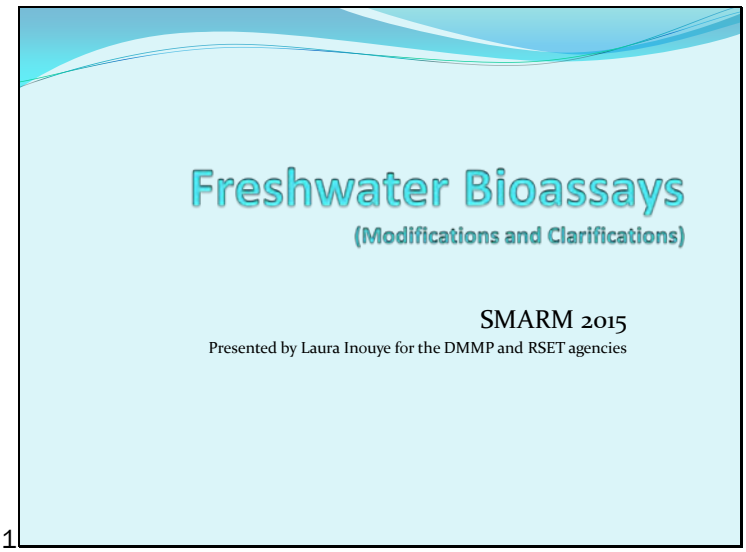
Laura Inouye discussed the differences in the history of marine bioassays and chemical criteria as compared to those for freshwater. These differences have led to the proposed dropping of one- and two-hit definitions for freshwater bioassays, as they were neither functionally or ecologically similar to the marine one- and two-hit definitions. For bioassays, SL1 or SL2 hit will result in material being unsuitable for in-water dispersive placement, and SL2 will primarily be used in antidegradation evaluations. No changes were made to bioassay requirements or the definition of what constitutes a hit, only how the hits were interpreted for in-water placement. Additionally, clarifications were made on application of reference bioassays.

Discussion

Q: Teresa Michelsen (Avocet) - I like consistency. Why not get rid of the 1-hit/2-hit designation semantics for marine as well?

A: Dave Fox (USACE) – We considered this but decided it would be too big of an effort for this SMARM. We would need to evaluate the ramifications for disposal site monitoring and the potential impact on suitability determinations.

Slides



Slide 1

Background

Sediment Management Standards (SMS) standards (chemical and biological)

- Marine standards adopted in 1995
- Freshwater standards adopted in 2013

Bioassays (marine and freshwater): bioassay test results **always trump** chemistry SL comparisons

Slide 2

Background

Marine bioassays:

- Implemented in 1988 for DMMP **before** the SMS rule was adopted in 1995
- DMMP guidance is more protective than rule in some cases.

Freshwater Bioassays:

- Developed side-by-side with the SMS rule.
- Freshwater bioassay and benthic numeric standards were promulgated as rule in February 2013; adopted **afterward** by DMMP in May 2014.
- One and two hit adopted into FW for consistency with marine guidance.

Slide 3

Background (marine bioassays)

In the DMMP's marine bioassay guidance:

A "one hit" designation results in a determination that the sediments fail for in-water placement.

- "one hit failure" is when test sediment results do not pass the bioassay-specific one-hit guidelines relative to negative control and reference for any bioassay

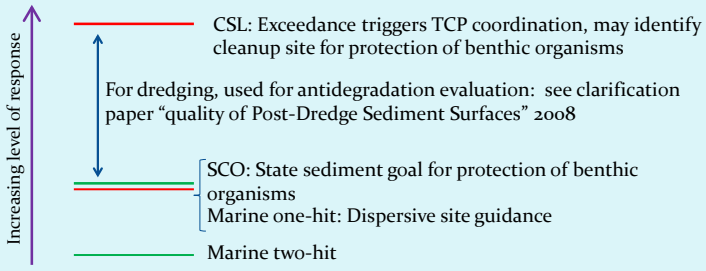
Sediments meeting the lesser "two hit" impact level require a second confirmatory "hit" in order to fail for open-water disposal.

- "two hit failure" is when test sediment results do not pass the bioassay-specific two-hit guidelines relative to negative control and reference for at least two separate endpoints

Slide 4

Background (marine bioassays)

Marine (DMMP guidance 1988; SMS 1995)



Slide 5

Background (freshwater bioassays)

In the DMMP's current freshwater bioassay guidance:

A "one hit failure" is when test sediment results do not pass the bioassay-specific one-hit guidelines (CSL/SL2) relative to negative control* for any bioassay

A "two hit failure" is when test sediment results do not pass the bioassay-specific two-hit guidelines (SCO/SL1) relative to negative control* for at least two separate endpoints

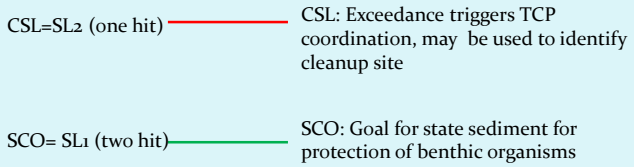
The 2014 adoption of the bioassays left it unclear how hits related to non-dispersive and dispersive disposal sites

*a reference sediment, if run, would be substituted for the control

Slide 6

Background (freshwater bioassays)

Freshwater (SMS 2013; DMMP/RSET 2014)



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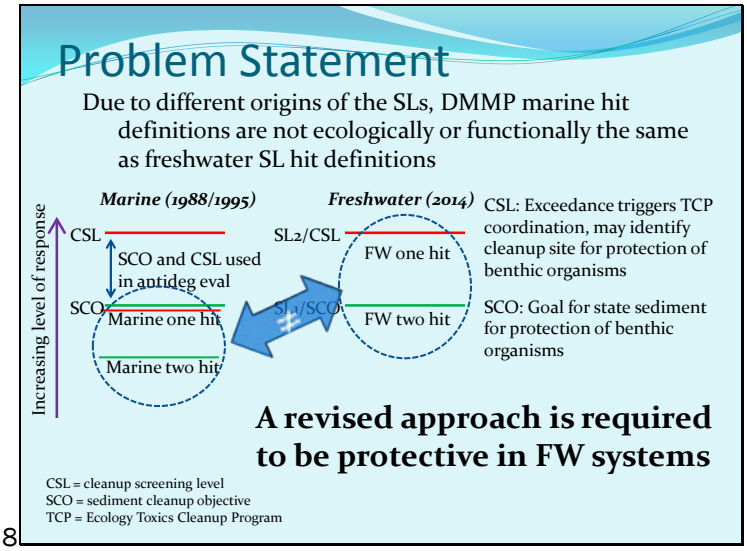

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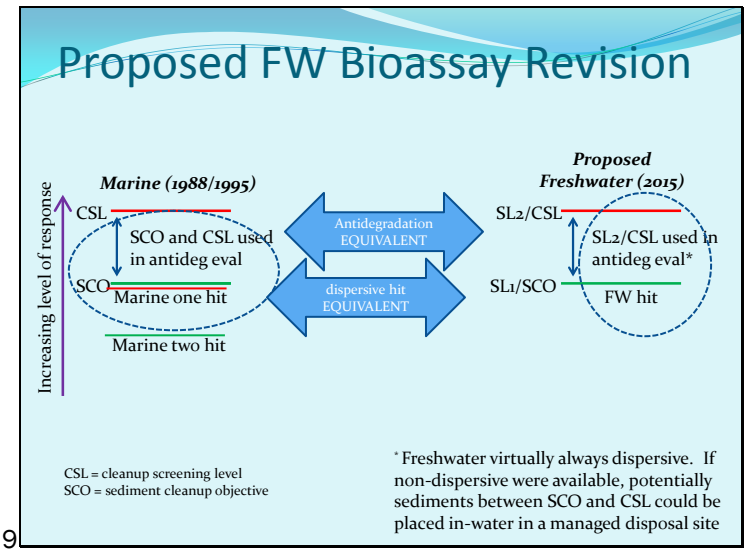
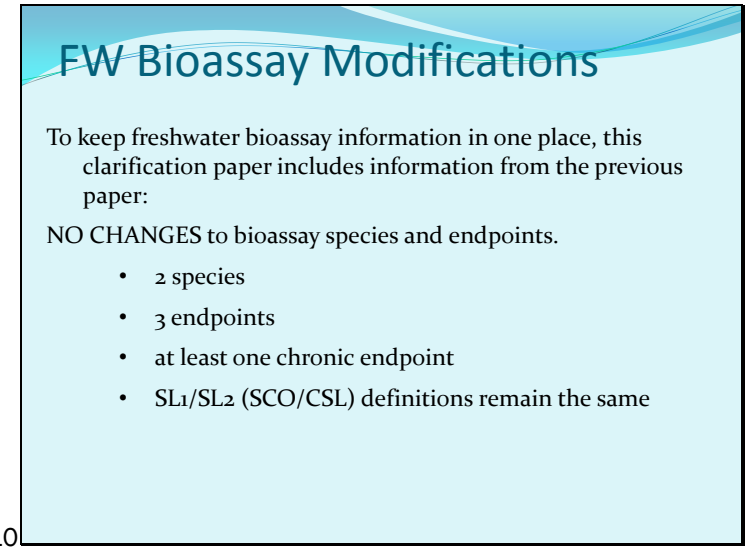


Slide 9



Slide 10

FW Bioassay Modifications

CHANGES to freshwater interpretive criteria.

- For freshwater, any hit will fail material
- "one hit/two hit" will no longer apply in freshwater sediments (unless disposal site is non-dispersive).
- Previously named "one hit" will become SL2/CSL
- Previously named "two hit" will become SL1/SCO

Slide 11

FW Bioassay Modifications

CLARIFICATION to freshwater interpretive criteria for comparison to control and/or reference.

When reference, control, and test sediments have similar physical characteristics, a hit occurs when:

- a test sediment response relative to the negative control and reference sediment exceeds the bioassay specific response guidelines, **AND**
- the difference from both the reference and negative control responses is statistically significant

Slide 12

7. Biomass Endpoint Development: An Update - Russ McMillan, Ecology

Summary

Bioassays serve as a surrogate for toxic effects to the benthic community. At present we have relatively few species with well developed bioassay protocols that are available during a large window of the calendar year, and with which our regional labs have reasonable experience.

Ecology received several recommendations to consider biomass as another endpoint during the public review of the freshwater sediment standards. Both ASTM & EPA protocols identify biomass as an additional endpoint and it has been used more on a project specific basis in recent years. The rule allows for additional tests to be proposed for use on a site-by-site basis.

This work was built on the same data set used to develop the SMS freshwater sediment criteria. As the work moves forward, it will be reviewed by 5 national experts on freshwater sediment bioassays as well as other agencies. There will also be public review before a new proposal is made for addition to the SCUM II manual.

Discussion

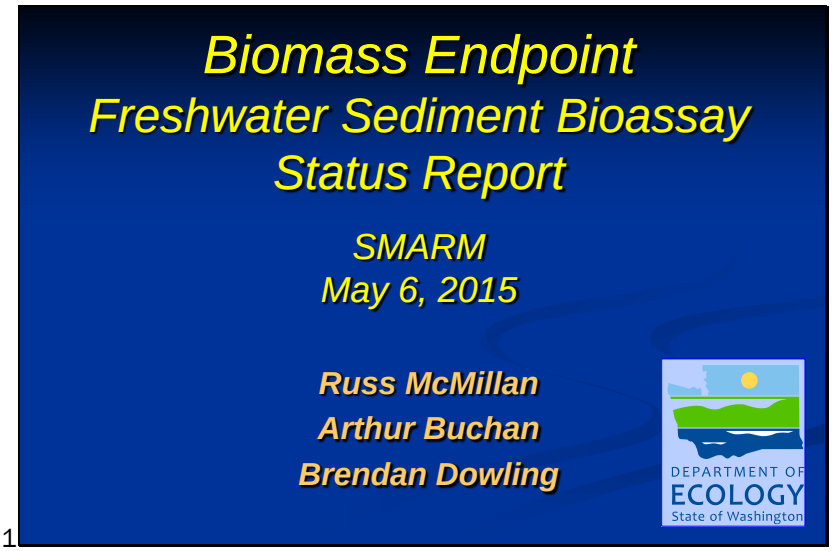
Q: Gary Lester (EcoAnalysts): Why evaluate dry mass for *Hyalella* but ash-free dry weight for chironomids?

A: Russ McMillan (ECY) - Chironomids are sediment-ingesting organisms that take in sand grains plus organics, so the gut content contributes a lot to total weight. If we only measured dry weight, the data would be confounded by gut sediment. *Hyalella*, on the other hand, targets organics so its gut isn't full of inorganics.

Q: Erika Hoffman (EPA) – Has a similar analysis been done on the biomass endpoint with *Neanthes*?

A: Russ McMillan (ECY) - We haven't done this but biomass measurement, generally, is not new. ASTM and EPA include this in their protocols and there's a growing body of biomass data in the U.S. But growth and mortality are still the dominant endpoints.

Slides



Slide 1

Biomass Endpoint Goals For Today

- Why bother with Biomass?
- Provide an update on the Biomass Endpoint development.
- Touch on what comes next.

Slide 2

Freshwater Sediment Bioassays

- Limited Options Compared to Marine
  - 2 Species
  - Endpoints
    - Mortality
    - Growth

Slide 3

What is the Biomass Endpoint?

- Takes into account both survival and growth but normalizes to initial count.
- Calculated as:

$$Biomass = \frac{Weight\ of\ Surviving\ Organisms}{Number\ of\ Initial\ Organisms}$$

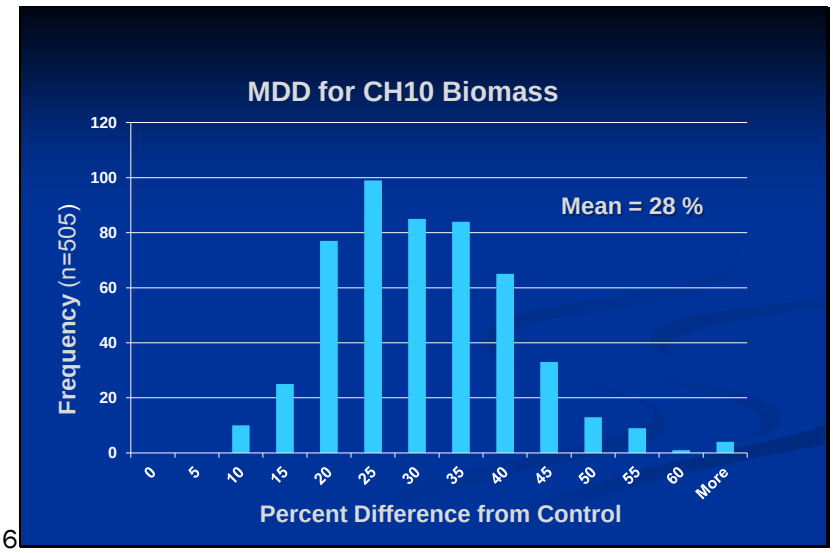
Weight = Dry weight for *H. azteca*; Ash-free dry weight for *C. dilutus*

Slide 4

Biomass Methods

- Used same data as FW criteria in SMS.
- Paired the Growth & Mortality data.
- Used Biostat to discern statistical difference.
- Minimum Detectable Difference.

Slide 5



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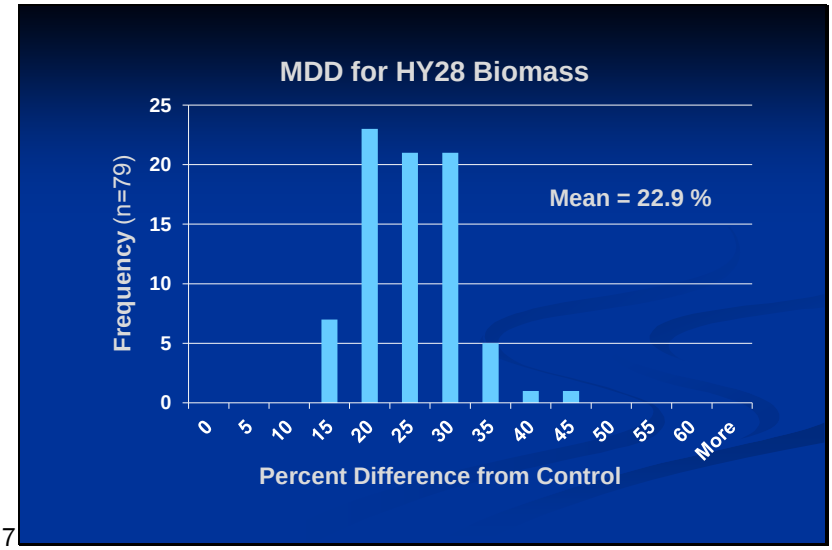


Slide 7

Next Steps

- Develop Interpretive Criteria
  - Allow comparison to Growth & Mortality.
  - Review
    - Ecology Experts
    - RSET
    - Sediment Technical & Policy Workgroup
    - National Experts

Slide 8

Next Steps

- Collect additional data
- Reexamine performance
- Propose final interpretive criteria
- How to Integrate into SMS bioassay suite
  - External Review/Public Comment
  - Clarification Paper at SMARM
  - Update SCUM II Guidance

Slide 9

Statistical methods for comparing test sediment to control

Outcome of Shapiro-Wilke's Test	Outcome of Levene's Test	Statistical Test of Experimental Hypothesis
Normal Distribution	Variances Homogeneous	Student's t-test
Normal Distribution	Variances Heterogeneous	Approximate t-test
Non-Normal Distribution	Variances Homogeneous	Mann-Whitney test
Non-Normal Distribution	Variances Heterogeneous	Rankit Analysis

Slide 12

Freshwater Biological Standards

- Bioassay suite to include at least:
  - 2 Species
  - 3 Endpoints
  - 1 Chronic Test
  - 1 Sublethal Endpoint
- Interpretation
  - SQS: Single SQS level hit
  - CSL: 2+ SQS level hits; 1+ CSL level hit

Slide 13

Freshwater Biological Standards Technical Considerations

- Objectives in development of biological standards.
  - Protect functions and integrity of a benthic community - Multiple species/sensitive life-history stages.
  - Discern a range of effects bounding minor adverse effects levels.

Slide 14

8. DNR Disposal & Monitoring Update - Celia Barton, DNR

Summary

The Anderson/ Ketron dredged material disposal site was the focus in 2015 as we prepare to apply for another Pierce County Shoreline Permit to continue operation at the site. The US Army Corps of Engineers (USACE) conducted a Fate and Transport Modeling study. Three numerical models were used to accurately simulate the fate of material placed at the site. Real data from actual disposals of material were used in the simulation. This work concluded the site is acting as described in the siting study PSDDA (1989); 95% of the material settles within the site boundary within 2 hours; half of the remaining material settles within the site boundary within 48 hours; the remaining 2-3 % remains within bathymetric boundaries at depths deeper than 300 feet. Additionally high resolution multibeam hydrographic surveys show sandwave formations within the Nisqually River delta area which dissipate at the 60 meter depth contour. These are the results of strong currents, historic Lahar flows, and co-seismic subsidence. The data suggests there is no active conduit for bedload transport between the disposal site and the sandwaves.

USACE also directed an update of information on the biological community studied in the 1987 Siting Feasibility which includes the Nisqually Reach area. The original 29 stations are revisited with 9 new stations added to better characterize the disposal site. Using similar methodologies will allow comparisons between the current and historical data, where available and appropriate. Field sampling is scheduled to conclude May 2015 with the report sometime later in the summer.

Our first visual images of this disposal site came from the Washington Department of Fish and Wildlife (WDFW) ROV survey which duplicated the beam trawl stations as closely as possible. WDFW worked with the trawl study design team from early in the project. These results will be compared to the beam trawl data and evaluated for future alternatives.

The Puget Sound DNR managed disposal volumes continue to decline. This is the expected trend as large volume beneficial use projects are getting ready to receive clean dredged material. The Grays Harbor DNR managed disposal volumes are showing an increasing trend, primarily Port Terminal dredging.

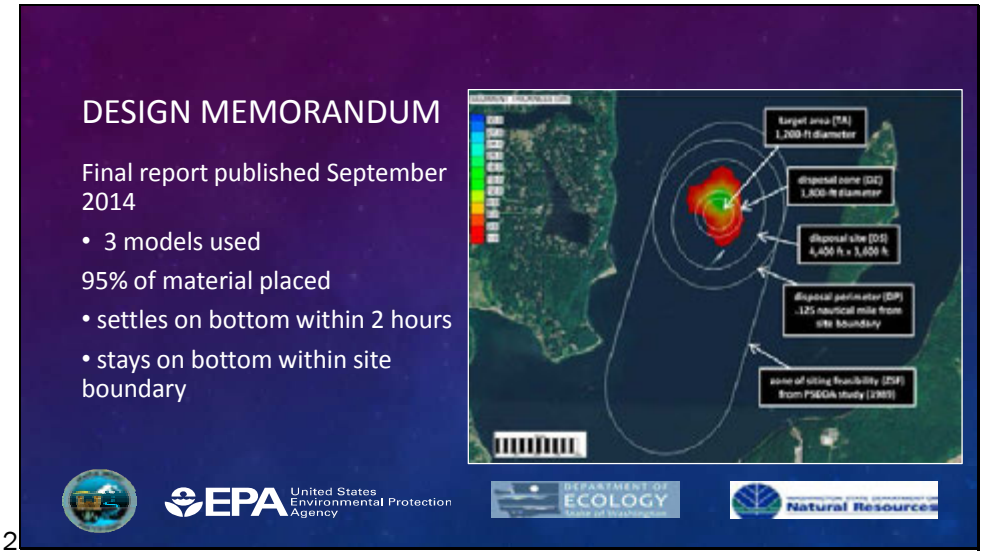
All of our disposal sites require Shoreline Permits from a local jurisdiction. The Anderson/Ketron site is in Pierce County. This disposal site was established 26 years ago and is identified in Statute as "essential to the commerce and well-being of the citizens of the State of Washington" (RCW 79.105.500). In 2012 DNR created the Nisqually Reach Aquatic Reserve which allows for operation of the disposal site under oversight of DMMP. The Pierce County Council voted to amend their proposed Shoreline Master Program to prohibit disposal of dredged material within the Nisqually Reach Reserve, in spite of the Reserve Management Plan's approval. There will be an opportunity to submit comments to Department of Ecology sometime this summer regarding this restriction on use of a disposal site. The contact person is Ms. Kim VanZwalenburg kvan461@ecy.wa.gov (360) 407-6520.

Discussion

Q: Gary Lester (EcoAnalysts) – After the organisms are processed, are they tossed overboard or lowered to depth?

A: Celia Barton (DNR) - Some are immediately tossed over, and some have their swim bladders pierced (with a needle) so that they can be lowered. We also delay their return to the water to deter predation by seagulls.

Slide 1



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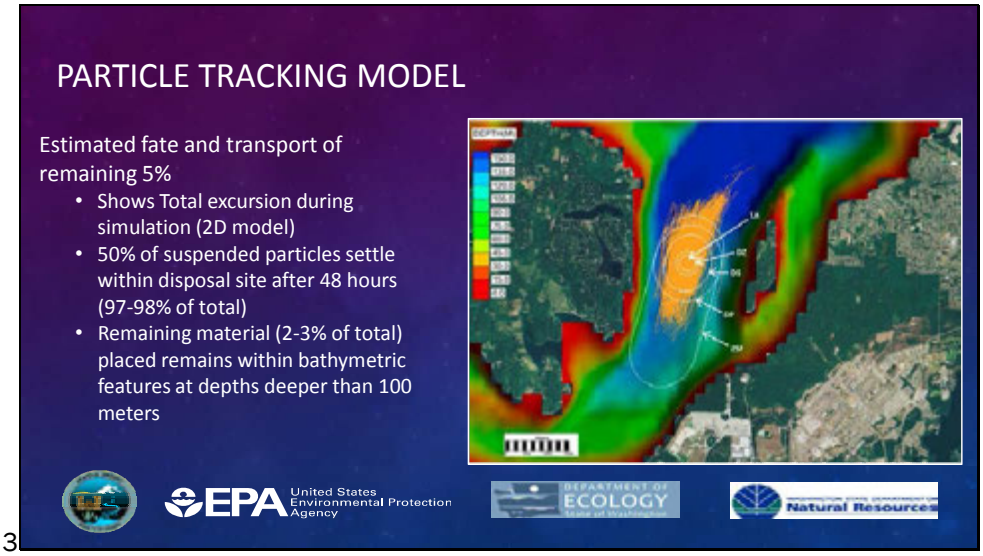


Slide 3

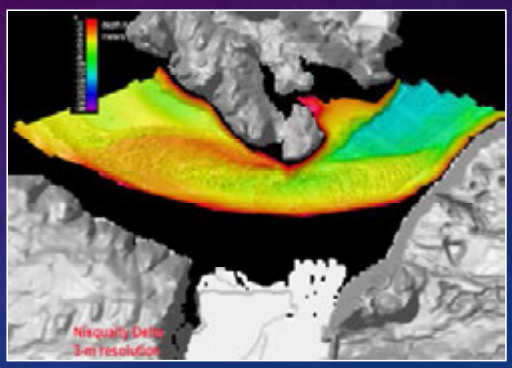
SITE RELATIONSHIP WITH NISQUALLY DELTA

Multibeam hydrographic surveys

Strong currents develop sand wave bedforms
- dissipate at the 60 m contour

Disposal site outside of Delta area (and picture here)
- depth exceeds 100m

Suggest no active conduit for bedload transport between the 2 areas



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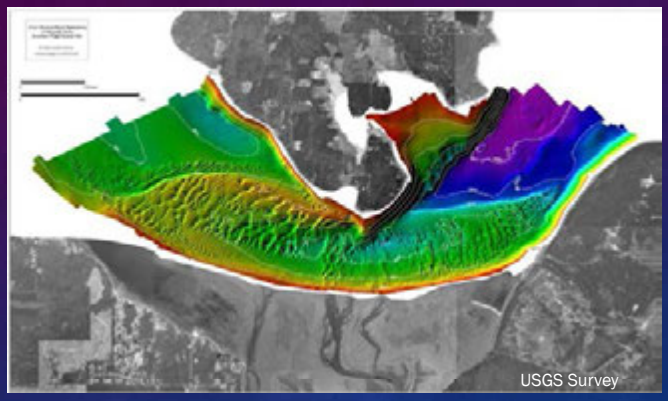
CONCLUSIONS

Model results confirm that the assumptions used during the original siting of the disposal site were accurate and that the site is acting as described in PSDDA (1989)

Slide 5



Slide 6

SITE MONITORING TRAWL SURVEY

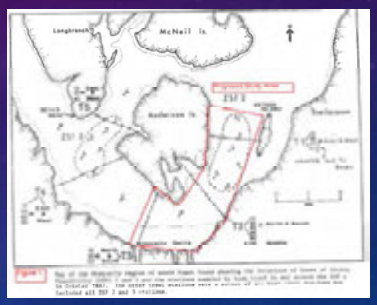
SMARM 2015

Slide 7

ANDERSON/KETRON DISPOSAL SITING STUDY

Corps directed study
- Herrera and Newfields
- Interagency crew – WDFW, EPA, Corps, Ecology, DNR

Duplicate 1987 Siting Study
- 26 year time span



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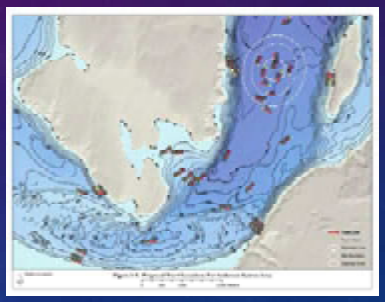
STUDY INCLUDES DISPOSAL SITE AND SURROUNDING AREAS

Species diversity and abundance
- compare 1987 to 2014/2015
- On and around disposal site



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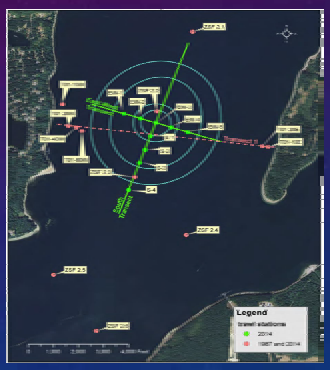
ANDERSON/KETRON DISPOSAL SITE

29 stations revisited throughout the study area

9 new stations added
- emphasis on the disposal site and immediate area outside of disposal site



Slide 10

NISQUALLY RIVER AREA

Study will duplicate original siting transects in Nisqually Reach

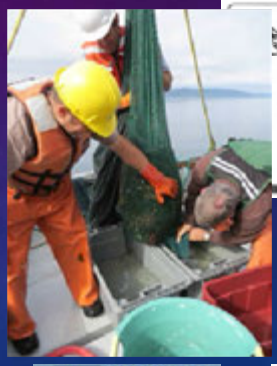
Provide wealth of information and 26 year comparison

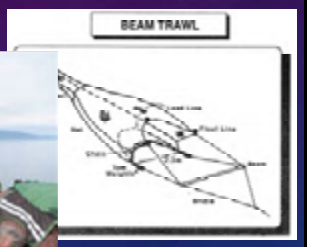
Slide 11

FOUR SEASON BEAM TRAWL SURVEY

Direct comparison to 1987
- vessel, Skipper, trawl

July 2014, October 2014, February 2015, May 2015





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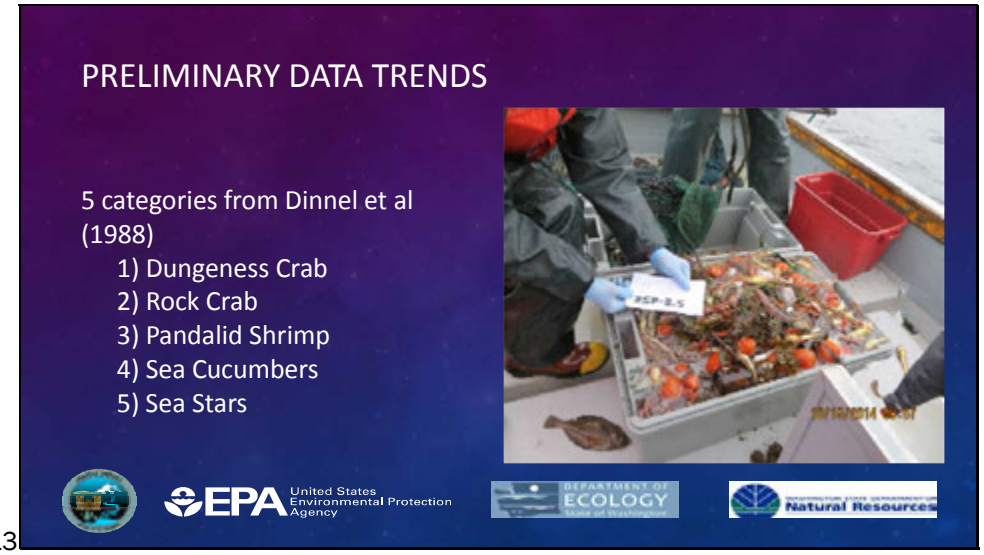

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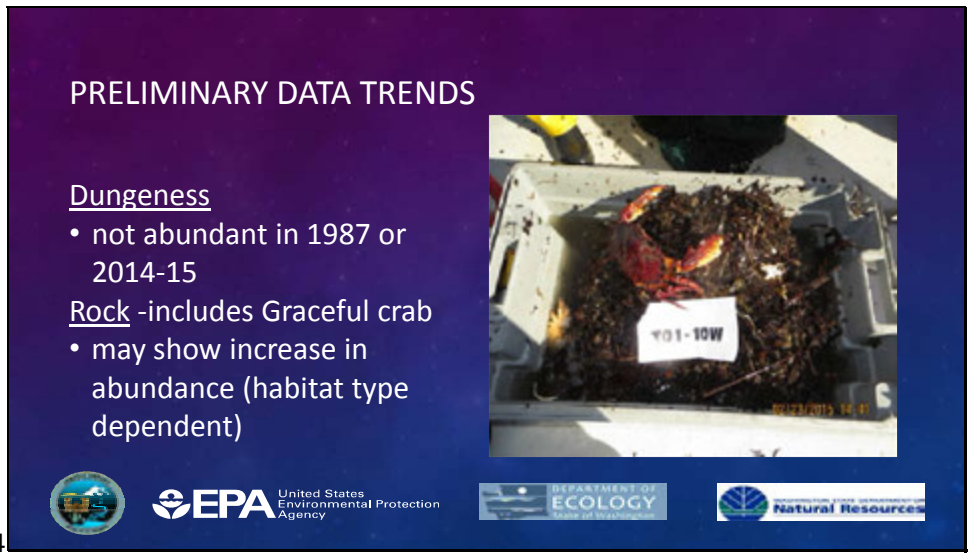

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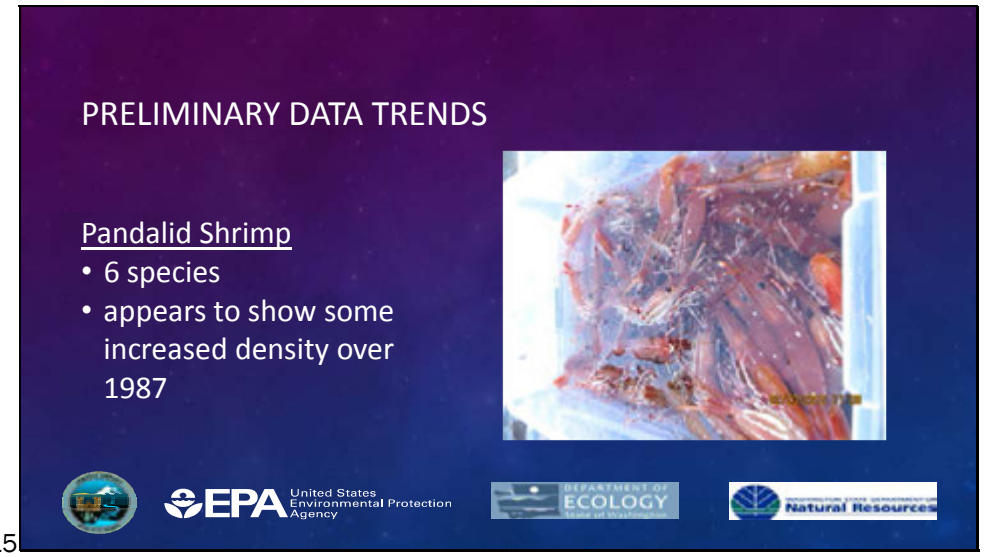

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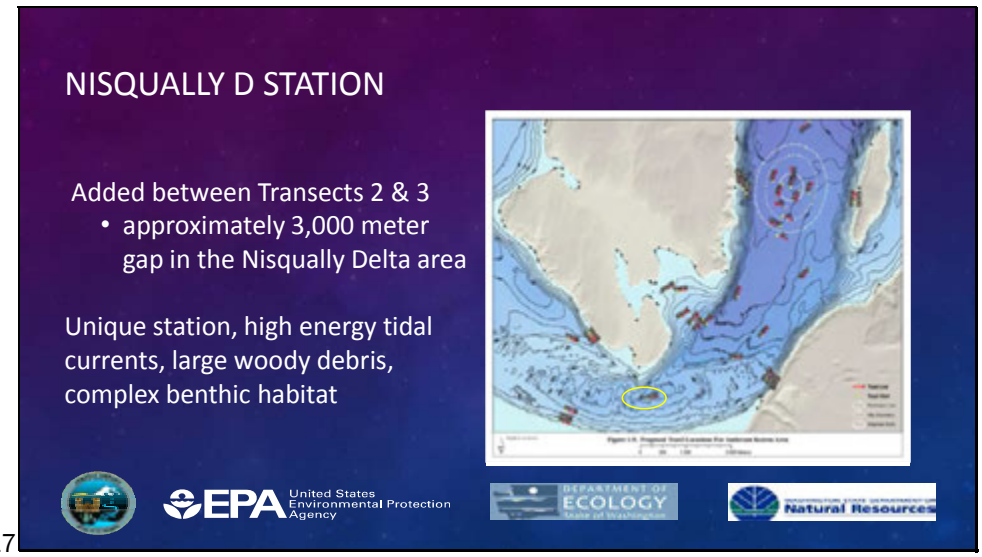

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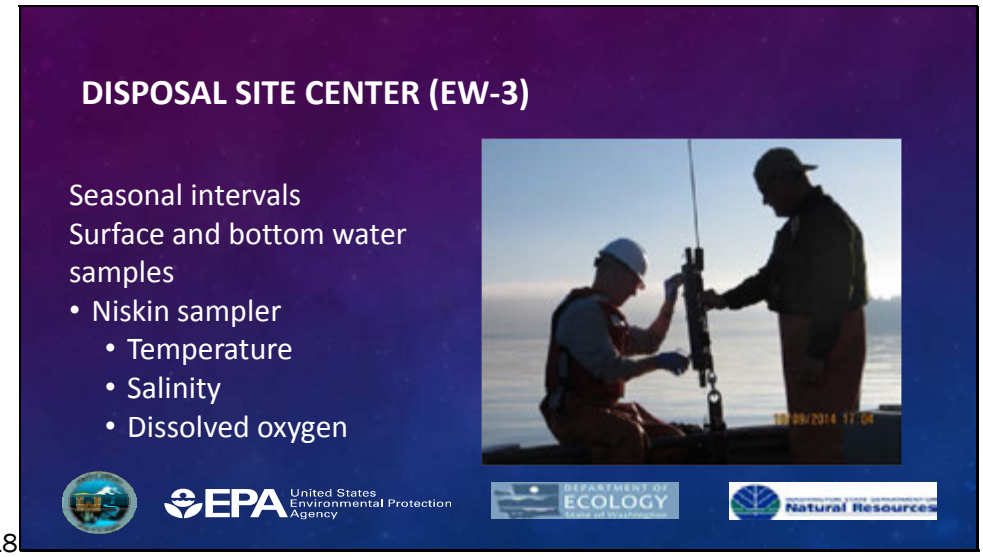


Slide 18

WHAT TO EXPECT

Data report characterizing the existing demersal fish, crab, and shrimp resources

Comparison of these results to the 1987 study results where available and appropriate

Slide 19

ANDERSON/KETRON WDFW'S ROV SURVEY

SMARM 2015

Slide 20

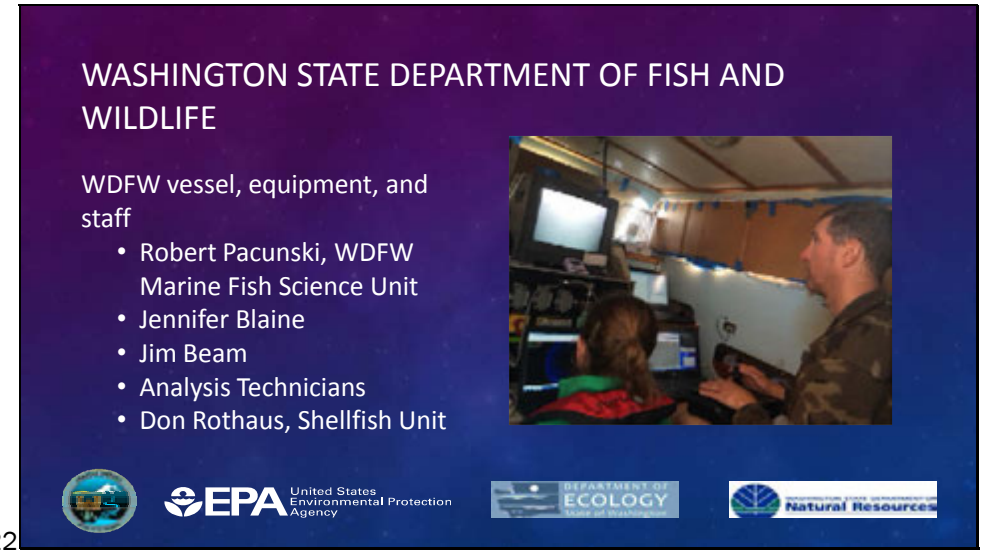
WASHINGTON STATE DEPARTMENT OF FISH AND WILDLIFE

Purpose

- Duplicate beam trawl stations as much as possible
- Compare results for future alternatives

WDFW Participated from early design of Corps Trawl project

Slide 21



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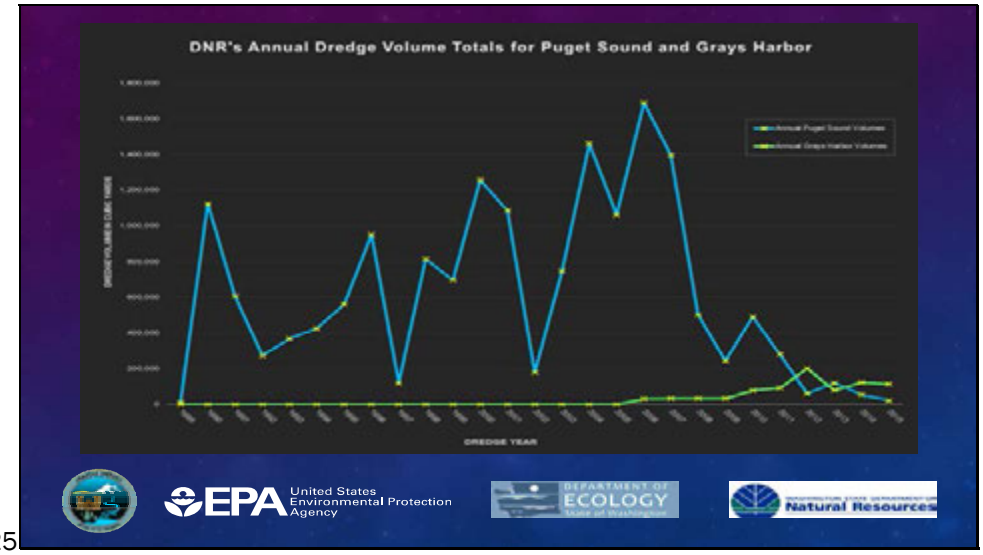

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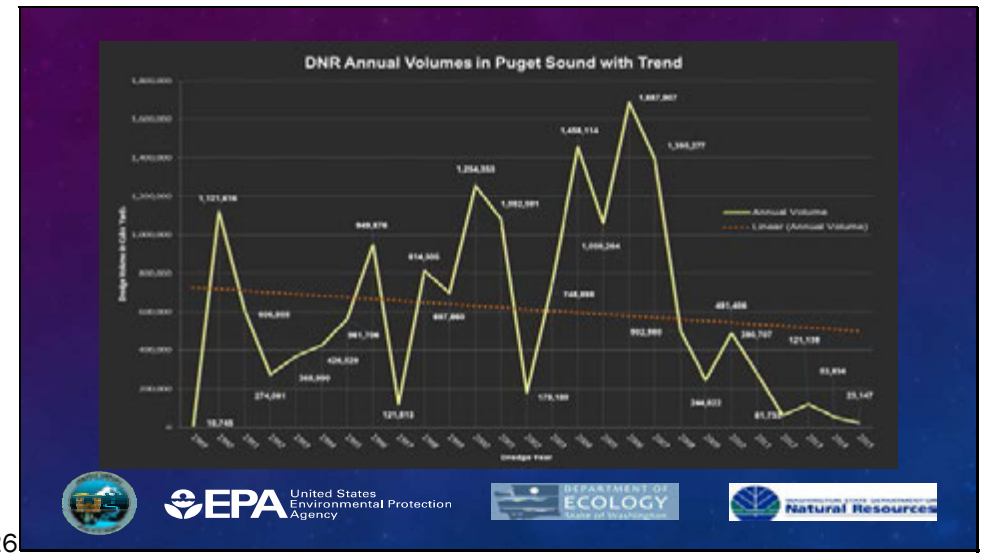

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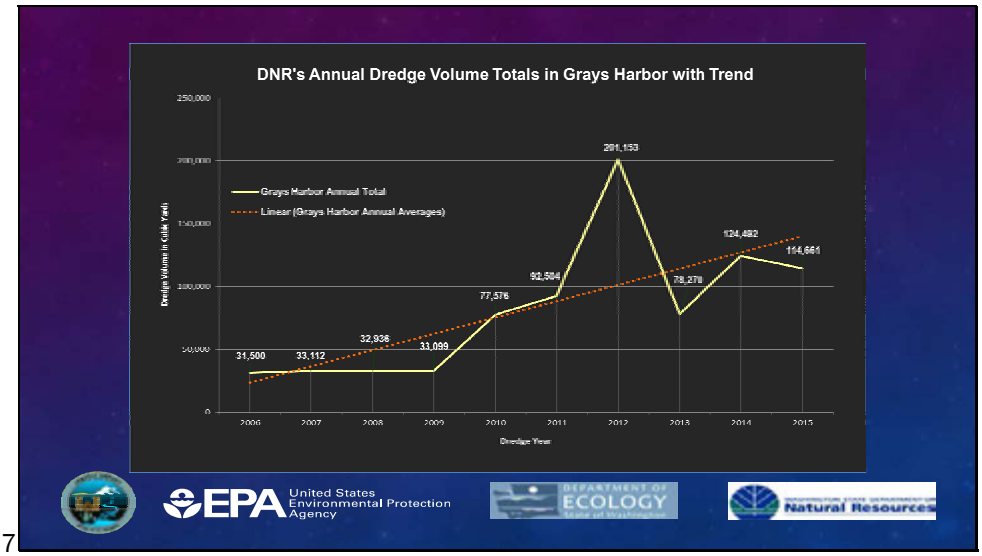

Slide 27

Shoreline Permit Update

Disposal Site	Jurisdiction	Expiration date	Term	Permit Fee
Anderson/Ketron	Pierce Co	Sept 30, 2014	Application Pending study results & SMP modification	Expect $9,000 fee
Port Gardner	City of Everett	Dec 15, 2014 (1 x 5 yr ext possible)	Second extension requested	$2,000 (1999)
Commencement Bay	Pierce County	Sept 13, 2015	Extension requested	$2,205 (2009)
Willapa	Pacific Co	Jan 31, 2016	5 yr	$790 (2010)
Port Townsend	Clallam Co	Feb 2, 2016	5 yr (1 yr ext)	$1125 (2010)
Port Angeles	City of Port Angeles	May 24, 2016	5 yr	$750 (2010)
Grays Harbor	Grays Harbor Co	Dec 7, 2016 (1 x 5 yr ext possible)	10 yr (2x 5 yr ext)	$200 (2001)
Elliott Bay	City of Seattle	May 2, 2021	10 yr term	$3,311 (2010)
Rosario	Skagit Co	Sept 26, 2021	10 yr	$2,400 (2010)
Bellingham Bay	Whatcom Co	expired		$1,745 (2001)

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ANDERSON/KETRON DISPOSAL SITE

Anderson/Ketron Disposal site established in 1989

- 26 years of scientific monitoring
- Historically used on average – once every 3 years

Slide 29

ANDERSON/KETRON DISPOSAL SITE

DNR established Nisqually Reserve in October 2011

- DNR will evaluate new uses within the Reserve
- Disposal site is an approved use in Reserve Management Plan

Slide 30

Pierce County Shoreline Master Program

Shoreline Permits from local jurisdictions required for use of all disposal sites.

Proposed Pierce County Shoreline Master Program was written to allow for dredge disposal under DMMP.

However - late revision to proposed program – Page 30 of Exhibit G added:
1. The following activities **are prohibited**:
   d. Disposal of dredged material within the Nisqually Reach Aquatic Reserve.

Slide 31

Public Comment Window

Ecology will review Pierce County Proposed Shoreline Master Program

Open for public comment early summer – around June?

Opportunity to submit comments to Ecology regarding this restriction on use of the Disposal Site

Slide 32

Contact Washington Department of Ecology

Get on the list to receive notice of opportunity to comment

Kim VanZwalenburg
kvan461@ECY.WA.GOV
(360) 407-6520

Slide 33

9. Debris Management - Erika Hoffman, EPA

Summary

Erika Hoffman discussed the proposal to require projects dredging sediments for open-water disposal to pass dredged material through a 1-ft by 1-ft screen. Currently, debris greater than 2-ft by 2-ft in any dimension is prohibited at the disposal sites, as is anthropogenically-derived waste of any size. Recent disposal site monitoring has identified large-sized debris and anthropogenic waste at two of the DMMP's non-dispersive sites, indicating that the current approach of visual identification and removal of debris is not effective. The DMMP agencies proposed clarification is for all projects to use a screen to remove debris unless they meet exemption criteria indicating a low reason to believe that debris is present. Reduction of the screen size from 2x2-ft to 1x1-ft is proposed to provide a more effective removal of both debris and anthropogenic waste as well as to align DMMP requirements with those in other West Coast EPA regions. Implementation of this screening requirement would begin in the 2017 dredging year.

Discussion

Q: Heather Trim (Futurewise) - The exemptions for using a screen are generous. Are they the same as in California?

A: Erika Hoffman (EPA) - While exemptions are not explicit in California, they *are* applied to California projects. They don't have an issue paper process like we do via the SMARM. When a screen is not required, they document those decisions in the permit process. One important difference is that California doesn't allow native sediments to go out for open-water disposal, due to the cohesive nature of native formations, which remain consolidated in "chunks" even after disposal. In Hawaii there is ancient coral in native sediments that also remains chunky and requires screening.

A: John Hicks (USACE) - During USACE dredging near the Spokane St. Bridge, debris became an issue. When the contractor encountered debris, they documented it with photos in order to get a change order and more compensation for resulting delays. Unfortunately, the contractor took the debris to the Elliott Bay disposal site. The USACE spent almost $100,000 documenting where the disposed debris landed. This is one line of evidence indicating a need for change in the DMMP's screening requirements.

Q: Kym Anderson (Port of Seattle) - But because of one project, everyone has to screen? Will there be project-specific considerations (i.e., for Port berth projects that are frequently dredged)? Wouldn't an errant chain that made it into the barge just get covered by the next disposal event?

A: John Hicks (USACE) –Elliott Bay isn't the only site with debris. A recent Anderson-Ketron site evaluation indicated the presence of debris as well.

A: Erika Hoffman (EPA) – Yes, BPJ will be used for each project.

A: Laura Inouye (ECY) - We've heard from dredgers that once debris hits the barge, it is hard to get it out of the barge.

A: Celia Barton (DNR) - Disposal volumes are low these days so one can't assume that debris will be quickly covered with more dredged material. Also, our program has already said that debris is not allowed at the disposal sites.

Q: Jeff Stern (King County) – Isn't it disingenuous to not require it of the USACE? Why not require everyone to do it once? Otherwise you are making assumptions of debris presence/absence without evidence.

A: Erika Hoffman (EPA) – The exclusion policy wasn't written to favor the USACE. The USACE will be required to use a screen if they don't meet the criteria just like any other project. Why require screening in low reason-to-believe situations? We've seen marina debris. We do have proof.

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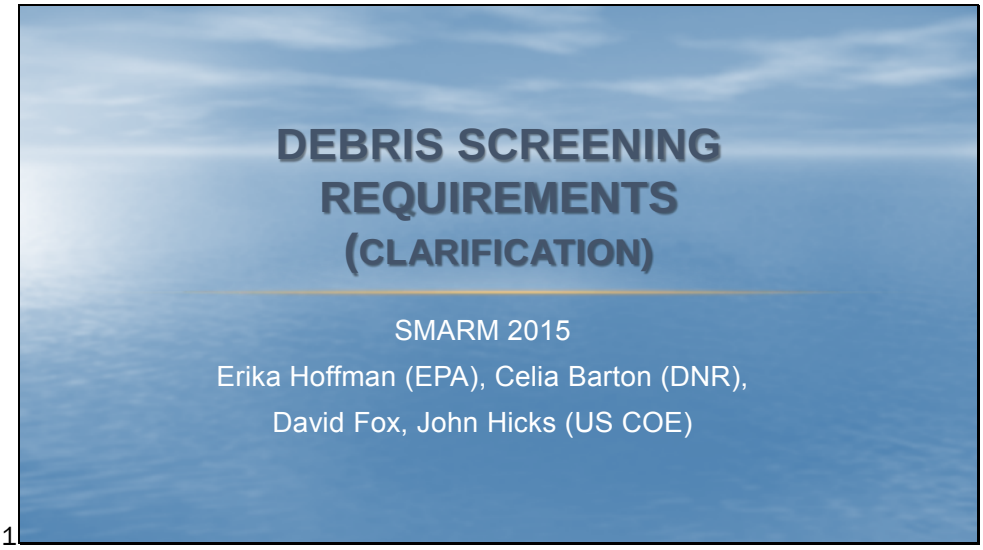

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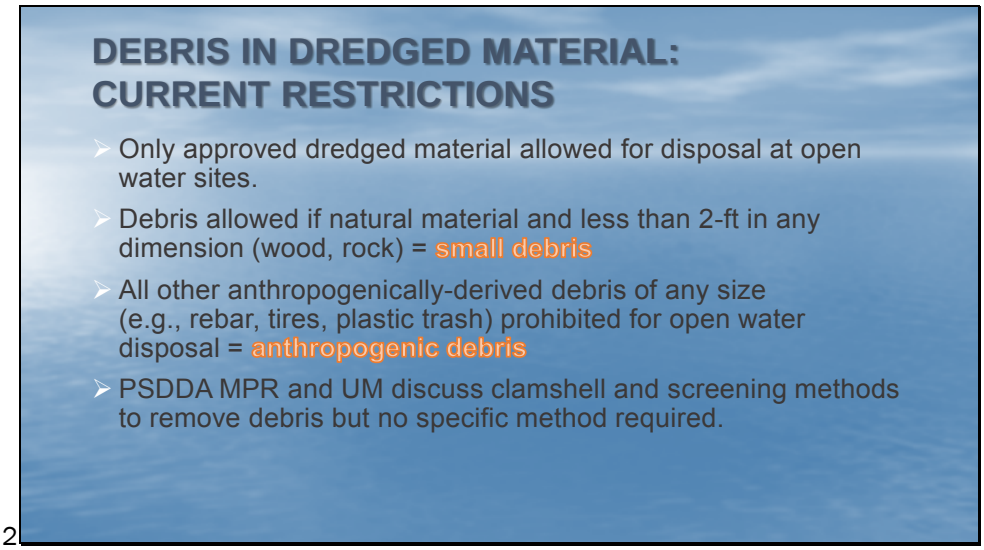


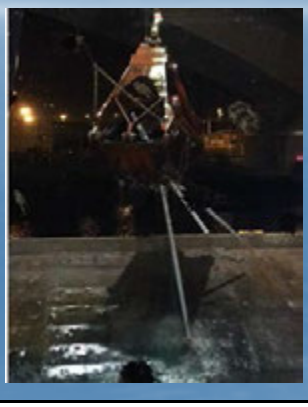
Slide 2

DEBRIS REMOVAL USING CLAMSHELL

- In Washington State – debris removal typically triggered based on visual observation of dredging process
- Debris greater than 2' x 2' removed from dredge barge using bucket and segregated for upland disposal

Slide 3

DEBRIS REMOVAL USING CLAMSHELL



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DEBRIS REMOVAL BY SCREENING

- Steel mesh ("grizzly") recommended in COE national guidance
- Covers part or all of scow. Can be (re)movable
- Heavy-duty chain or inflexible steel construction
- 1' x 1' mesh grizzly required for most projects in California
- Grizzlies rarely used in Puget Sound and Grays Harbor projects

Slide 5

Slide 6

Slide 7

Slide 8

DEBRIS IN DREDGED MATERIAL PROBLEM STATEMENTS

- **Large debris observed at Puget Sound disposal sites**
  - May change habitat quality at sites
  - Interferes with site monitoring equipment
- **Anthropogenic debris of all sizes seen at sites**
  - May change habitat quality at sites
  - May introduce contamination into the aquatic environment

Slide 9

DEBRIS AT ELLIOTT BAY SITE (2014)

Slide 10

DEBRIS IN DREDGED MATERIAL PROBLEM STATEMENTS (CONT.)

- **UM definition of "debris" doesn't distinguish between allowable and prohibited types of debris**
  - Creates confusion on what is allowed and what isn't
  - Could erode public acceptance of open water disposal
- **Inconsistent debris screening requirement between West Coast EPA Regions**

Slide 11

PROPOSED CLARIFICATION

1. **All projects must use a screen to remove debris unless they meet one of exemption criteria:**
   - Dredging most native sediments
   - Dredging of frequently maintained navigation channels, away from berths and shorelines
   - Dredging in non-urban areas removed from marina/industrial/shipping activities
   - Evidence from previous rounds of dredging with screen shows no debris

Slide 12

PROPOSED CLARIFICATION (CONT.)

2**. Maximum size of size of wood and rock debris allowable for open water disposal is reduced to 1-ft in any dimension**
   - Material must be screened using 1'x1' grid
   - Provides for more effective removal of both anthropogenic debris (e.g. tires) and large woody/rock debris
   - Aligns DMMP debris management guidelines with those in place in California

Slide 13

IMPLEMENTATION

- Screening and 1-ft size limitation requirement begins 2017 dredging year (June 2016)
- Requirement for grizzly will be documented in DMMP Suitability Determination
- Applicable to all areas covered by DMMP: Puget Sound, Grays Harbor, Willapa

Slide 14

IMPLEMENTATION

Costs associated with new requirements:

- Additional scow and offloading equipment for debris
- Offloading & disposal of debris
- Cleaning and repairing the grizzlies
- Moving the grizzlies
- Potential reductions in production rate

Many dredging companies working in Washington State have been successfully using 1'x1' grizzlies for dredging projects in California for over a decade

Slide 15

COMPLIANCE ENFORCEMENT

- Site inspections
- Fines for failure to use grid when required
- Disposal site monitoring may be required (costs borne by dredging contractor)

Slide 16

10. Modifications to Ammonia and Sulfide Triggers for Purging and Reference Toxicant Testing for Marine Bioassays - David Fox, Corps

Summary

David Fox (Corps) presented a summary of proposed revisions to the 2013 SMARM clarification paper. The 2013 paper included updated ammonia/sulfides purging and reference toxicant triggers (these will not change); pre-bioassay testing and monitoring of overlying water (instead of porewater) during purging to reduce the volume of sediment needed for sacrificial beakers; and purging of the larval test by aeration only, with no renewal of overlying water.

Post-SMARM comments were received in 2013 from two teams of consultants/laboratories. While insightful, the comments were sometimes conflicting. Both teams agreed that ammonia/sulfides should be measured in porewater for bedded sediment bioassays, with the exception of *Ampelisca*, which is a tube-building amphipod and not directly exposed to porewater. The teams differed in their recommendations regarding who should do the pre-bioassay testing, the analytical or bioassay labs.

Data gaps were identified and four federal navigation projects in 2013-2015 were used to answer four basic questions regarding ammonia/sulfides measurements. Other recommendations made by the consultants and laboratories were also evaluated.

The additional ammonia/sulfides testing demonstrated that both bulk and porewater ammonia concentrations were stable during storage, prior to running bioassays. However, bulk and ammonia concentrations were not highly correlated. Therefore, bulk measurements were not predictive of ammonia concentrations in the exposure medium for bedded sediment bioassays. Porewater measurements of sulfides were found to be of little value because sulfides were largely undetected.

Another experimental finding was that the process of compositing sediment samples did not appear to result in a significant loss of sulfides due to volatilization.

Side-by-side testing was conducted for two ammonia purging methods for the larval development bioassay, an aeration-only method and an alternative method using both aeration and water renewal (developed by Ramboll-Environ's environmental lab in Port Gamble). The latter method was run on "combined" beakers to reduce the loss of suspended sediment. The aeration-only method proved to be more effective overall. While both methods reduced ammonia levels in overlying water, only the aeration method reduced ammonia levels in porewater. Sediment loss was measured for the aeration/renewal method; loss of solids was only 0.04%. Pre- and post-purging chemical analyses (semivolatiles and metals) were performed for both purging methods. There was no apparent contaminant loss from either purging method.

Northwestern Aquatic Sciences (NWAS) provided a graphic showing a significant reduction in ammonia levels due to dilution during bioassay set-up.

Conclusions drawn from ammonia and sulfides testing for federal projects, along with the observations made by NWAS, were summarized. These conclusions and other factors were considered in developing the recommendations included in the 2015 clarification paper. Recommendations included analyzing sulfides on composites instead of individual cores; pre-bioassay procedures to determine the need for purging; and continuation of water renewals for bedded sediment tests during bioassays if needed.

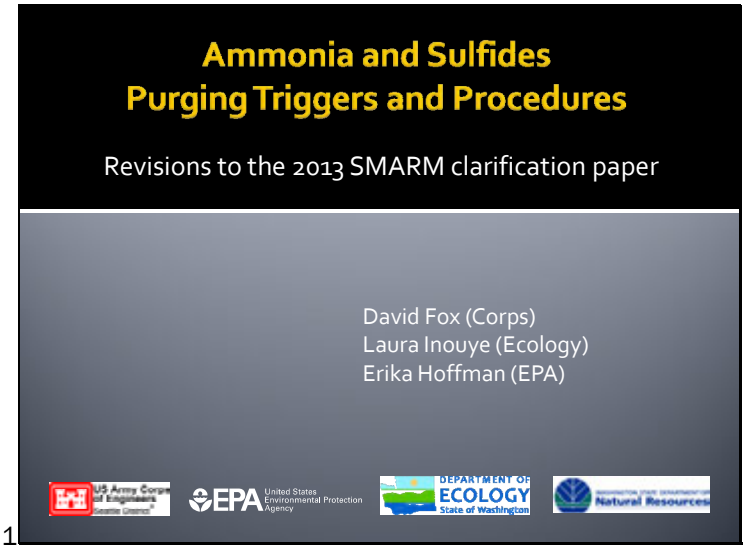
Discussion

Q: Roger McGinnis (HartCrowser) – The lack of correlation between hydrogen sulfide in bulk sediments and porewater is not surprising because most sulfide in anoxic sediment is chemically

bound up as insoluble iron(II) sulfide and is not bioavailable. The acid extraction used for sediment total sulfides analysis converts these insoluble metal sulfides into hydrogen sulfide, which is then measured.

A: David Fox (USACE) – Acknowledged.

Slides



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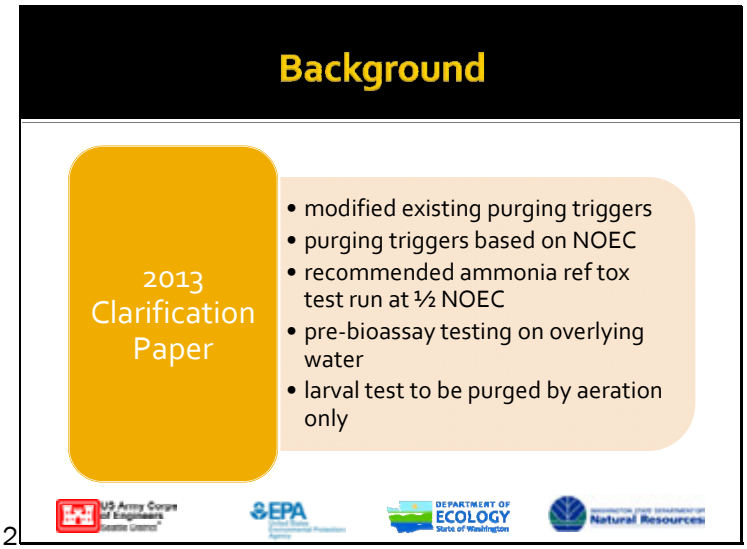


Slide 2

Purging and Ref Tox Triggers

Trigger	Bedded sediment tests				Larval tests	
	Neanthes	*Ampelisca*	*Eohaustorius*	*Rhepoxynius*	*Bivalve*	*Echinoderm*
Unionized Ammonia (mg/L) Ref Tox	0.23	0.118	0.4	0.2	0.02	0.007
Unionized Ammonia (mg/L) Purge	0.46	0.236	0.8	0.4	0.04	0.014
Hydrogen Sulfide (mg/L) Purge	3.4	0.0094	0.122	0.099	0.0025	0.01

Slide 3

Comments Received

NewFields
Bill Gardiner
Brian Hester

NWAS/SEE
Dick Caldwell
Tim Thompson

Insightful but sometimes conflicting comments

Slide 4

Comments Received

NewFields

- measure porewater for bedded sediment tests
- bioassay labs should do the pretesting, not the analytical labs
- alternative method proposed for purging larval test
- continued purging during bioassay may be necessary

NWAS/SEE

- porewater is more relevant than overlying water for *Eohaustorius*, *Rhepoxynius* and *Neanthes*
- pre-bioassay testing will increase costs; have analytical lab do more of the pretesting
- have analytical lab measure both bulk and porewater
- measure sulfides on composite, not individual core

Slide 5

Data Collection

- Additional ammonia/sulfides data were collected for four federal projects to answer the following questions:
  1. For sediment stored for bioassays, would bulk measurements taken after several weeks of storage be different from measurements made when the sediment first gets to the analytical lab?
  2. Would it be useful to have the analytical labs measure porewater concentrations in addition to, or instead of, bulk concentrations?
  3. How well do concentrations measured by the analytical labs match up with concentrations measured by the bioassay labs?

Slide 6

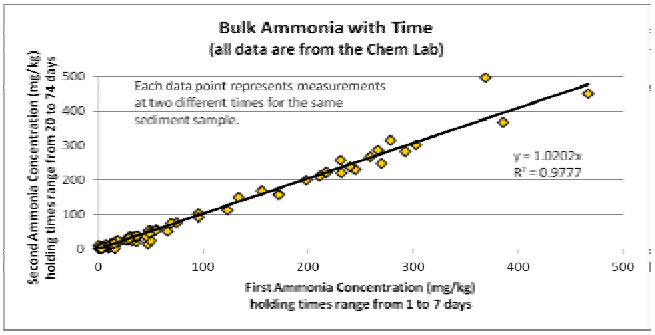
Data Collection

4. Would measurements of bulk sulfides on composites be better than our traditional way of measuring on samples from individual cores?
5. How well does the purging method suggested by NewFields for the larval test compare to the aeration-only method?
6. How much sediment is lost using the NewFields method?
7. Does either purging method result in a loss of contaminants?

Slide 7

1. Experimental Findings

Bulk ammonia stable with time (as measured by analytical lab)



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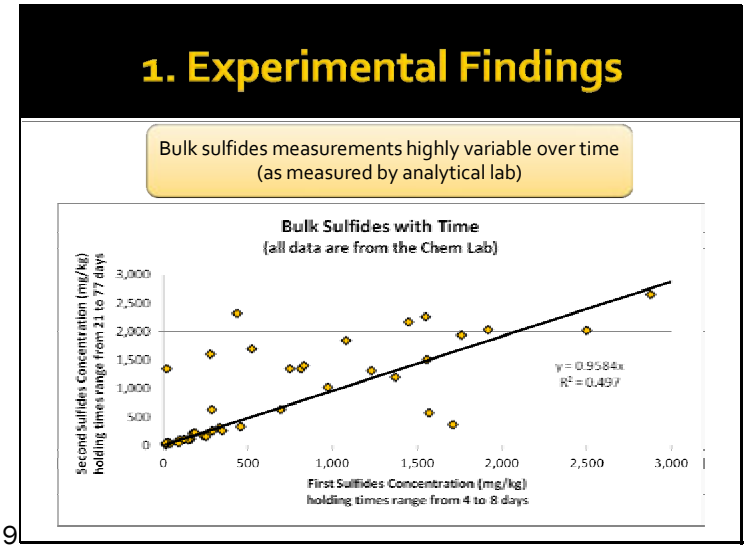

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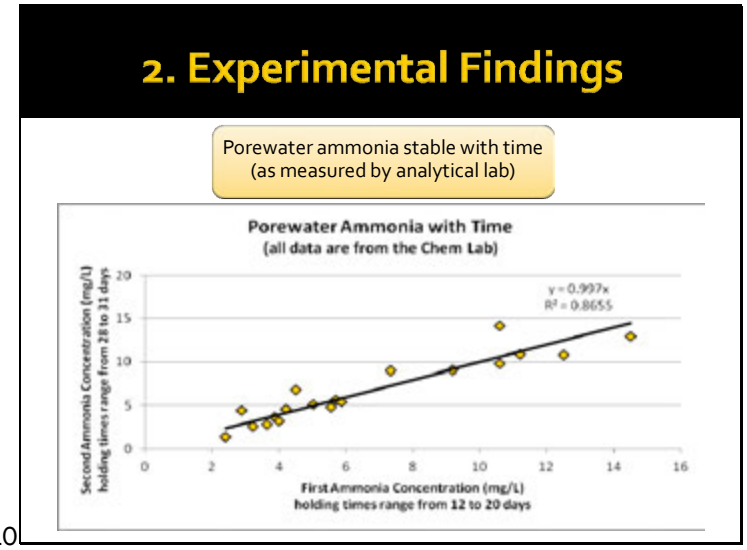

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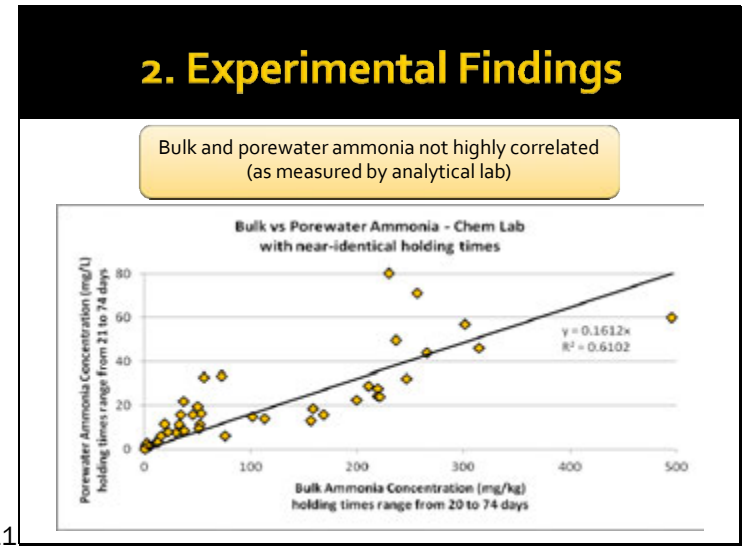


Slide 11

2. Experimental Findings

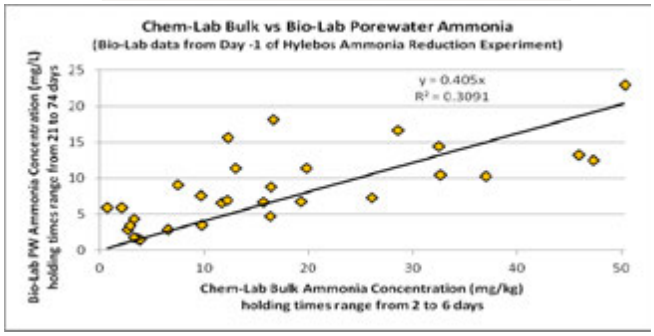
Porewater sulfides mostly undetected
(as measured by analytical lab)

- porewater sulfides were measured at two different times for only one of the projects (Hylebos) so determination of stability was only possible for a single project
- Hylebos bulk sulfides were as high as 4,300 mg/kg for single cores and 2,500 mg/kg for composites, but porewater concentrations were mostly non-detects
- of all the porewater measurements made for the four projects, only 15 out of 90 had detected concentrations even though there were a lot of high bulk sulfides concentrations

Slide 12

3. Experimental Findings

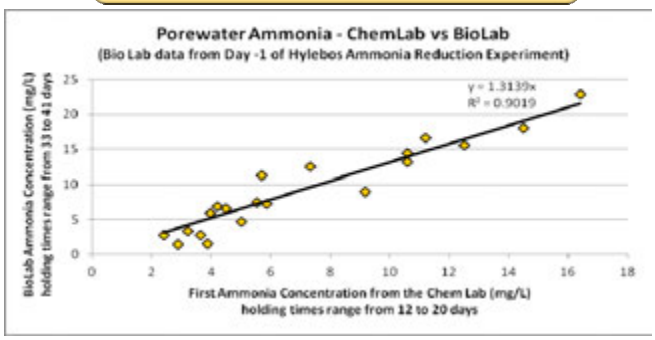
Bulk ammonia by analytical lab not highly correlated
with porewater ammonia by bioassay lab



Slide 13

3. Experimental Findings

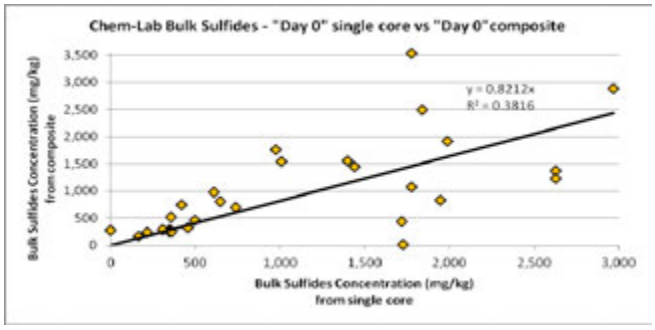
Porewater ammonia by analytical lab
predictive of porewater ammonia by bioassay lab



Slide 14

4. Experimental Findings

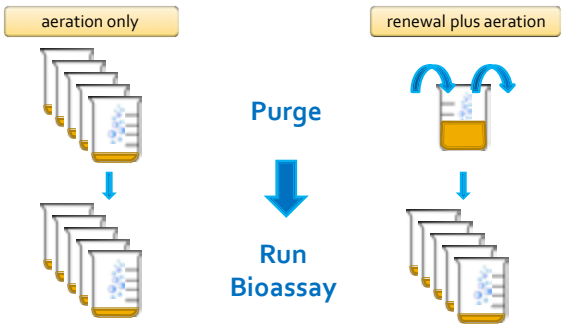
Bulk sulfides from single core not well-correlated with bulk sulfides from composite



Slide 15

5. Experimental Findings

Purging the Larval Test



Slide 16

5. Experimental Findings

Comparison of Purging Methods

- 12-day purging period
- 18 g/beaker for aeration-only method
- 200 g in 'combined' beaker for renewal/aeration method
- both methods reduced overlying NH_3
- only aeration method reduced porewater NH_3
- sulfides data difficult to interpret

Slide 17

6. Experimental Findings

Sediment Loss During Renewal Method

- all removed water from one treatment was filtered
- the sediment remaining on the filter was weighed
- loss of solids was only 0.04% of the total wet-weight mass

Slide 18

7. Experimental Findings

Contaminant Loss from Purging
Hylebos Waterway Sediment Samples

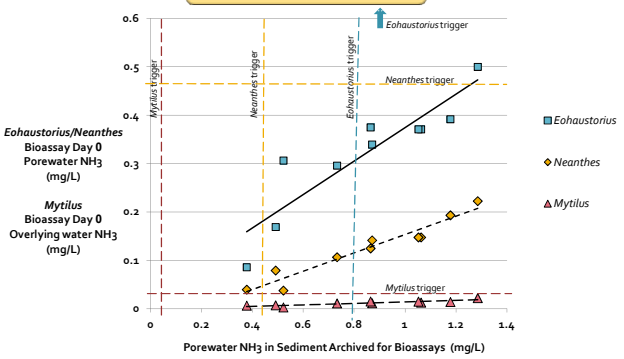
- post-purge sediment concentrations compared to pre-purge concentrations
- aeration-only; renewal/aeration; unpurged
- semi-volatiles and metals
- no apparent contaminant loss from either purging method

Slide 19

NORTHWESTERN AQUATIC SCIENCES

Richard Caldwell and Gerald Irissarri

Dilution during bioassay set-up may eliminate need for purging



Slide 20

A Few Conclusions…

Conclusions

- ammonia is stable during storage, so no need for more than one measurement by the analytical lab
- porewater ammonia measurements by the analytical lab better predict porewater measurements by the bioassay lab than do bulk measurements, but…
- it's difficult collecting enough sediment for porewater testing by the analytical lab AND for sacrificial beakers for purging
- composited sediment is a better analogue of sediment stored for bioassays than samples from single cores

Slide 21

…And Several More

Conclusions

- the renewal method for purging the larval test appears to be less effective than aeration-only
- contaminant loss from purging doesn't appear to be a problem, at least for the chemicals and sediment samples tested for the Hylebos experiment
- the bioassay set-up itself reduces the concentrations of ammonia and sulfides, especially for the larval test, and may obviate the need for purging to begin with
- we don't have all the answers (imagine that) so…provide consultants/labs flexibility

Slide 22

Developing Recommendations

Factors Considered

- input from labs and consultants
- conclusions from Corps testing
- experimental results provided by NWAS
- logistics required – keep it simple
- volume of sediment required

Slide 23

Slide 24

Recommendations

2015 Clarification Paper

- bulk sulfides on composites, not individual cores
- for DMMUs requiring bioassays:
  - set up single amphipod/*Neanthes* beaker for pretest; measure NH_3 and sulfides in porewater after 24 hours; compare to purging triggers
  - set up single larval beaker; measure NH_3 and sulfides in overlying water after 4 hours (also applies to *Ampelisca*); compare to purging triggers

Slide 25

Recommendations

2015 Clarification Paper

- if renewal method of purging is proposed for the larval test, the NewFields method of purging a "combined" beaker must be used
- continue water renewals for bedded sediment tests (not the larval test) during bioassays if necessary

11. DMMP Clarifications and Updates (U/J flags, TBT, EIM, PAHs, Puget Sound SRM) - Kelsey van der Elst, Corps

Summary

Kelsey van der Elst presented on two DMMP clarification papers and several program updates. The first clarification paper provides examples of how to use data qualifiers for summed concentrations such as total chlordane, total PCBs, etc. The second clarification paper proposes changing the measurement basis for tributyltin (TBT) from porewater to bulk sediment analysis. DMMP program updates included summaries of use of the EIM database and use of the Puget Sound Sediment Reference Material, an update on the status of PAH and cPAH guidelines and a reminder that all project must investigate the presence of invasive aquatic species within their project area and comply with standard operating practices for equipment decontamination when working in area of extreme concern for invasive species.

Discussion

Q: Roger McGinnis (HartCrowser) – Which cPAH background value is being used and does it apply to all disposal sites? Was it from the Bold study?

A: Kelsey van der Elst (USACE) – We are just using Ecology's Port Gardner Regional Background value.

Q: Kathy Godtfredsen (WindWard) – cPAH issue is a big topic to put in grab bag presentation. Will there be a process for broader discussion of cPAHs and dredged material management?

A: Kelsey van der Elst (USACE) – This presentation is not meant to propose any guidance, just to let you know that we know there is an issue and that it will be addressed in the near future. Since we don't have any proposed PAH guidelines (we're working on these right now) the interim approach is to use Regional Background if available. There will be many opportunities for input and discussion as we move forward towards an actual proposal on PAHs.

Q: Kathy Kreps (TestAmerica) – Do grab-bag issues have associated papers that we can read and comment on?

A: Kelsey van der Elst (USACE) – First two issues have clarification papers associated with them on the website. The rest are status updates, with no papers, but the presentations will also be posted. You are welcome to comment on any of the presentations or papers.

Q: Clay Patmont (Anchor) – Regarding TBT, were you able to correlate bulk sediments with tissue?

A: Kelsey van der Elst (USACE) and Erika Hoffman (EPA) – No, we haven't been able to see a correlation. The West Waterway data set is the most definitive evaluation of that question and they didn't see a strong correlation. Remember, the rationale for making this clarification isn't that bulk is better correlated. Rather, it's because we feel that bulk is a better 1st tier measurement.

Q: Clay Patmont (Anchor) – Regarding dioxins, what happens when Regional Background for dioxin is different from 4/10 guidelines?

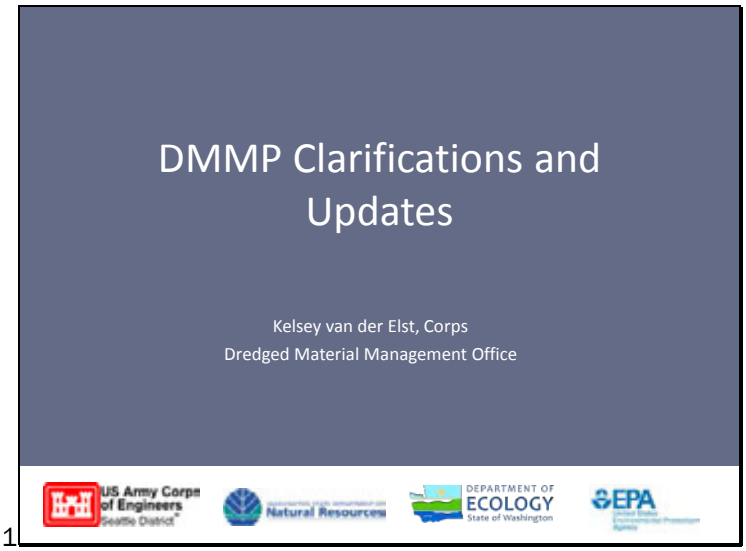
A: Kelsey van der Elst (USACE) – We don't have answers for that question yet. We're just starting to grapple with those kinds of issues.

A: Laura Inouye (Ecology) – The Port Gamble cleanup project came up just as the state Pt. Gardner regional background for cPAHs was determined. In the absence of DMMP policy on new state guidelines, we took the conservative stance on this particular project and did not allow material from the cleanup with cPAHs over regional background. This does not mean that we will be requiring

cPAH analysis for all dredging projects. We see a path forward that involves a holistic approach to looking at PAH levels that include protection of fish. We hope to have a proposal soon.

Q: Deborah Williston (King County) – cPAH values are related to human health risk, but that's not what's relevant at disposal sites. We have found that risk values for carcinogenic compounds are higher than background. Recommends further consideration of this point.

Slides



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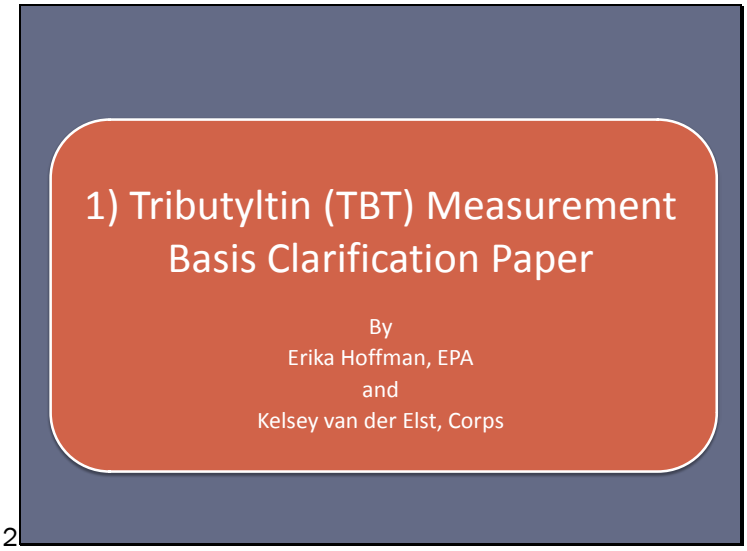


Slide 2

TBT Measurement Basis

Current DMMP standard

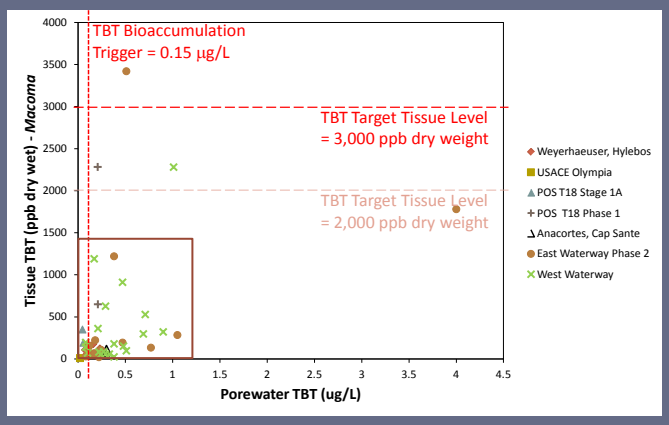
- Porewater TBT analysis

Problems

- Holding time constraints
- Difficulty collecting sufficient porewater in sandy and consolidated samples
- Analytical challenges of TBT extraction and analysis
- No clear relationship between porewater TBT concentrations and tissue concentrations
- Inconsistent with freshwater standards

Slide 3

TBT Measurement Basis



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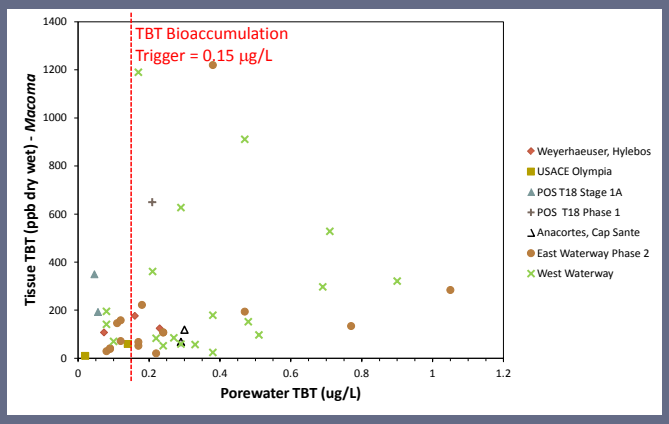
TBT Measurement Basis



Slide 5

TBT Measurement Basis

Proposed Clarification

- Bulk TBT analysis
- BT = 73 µg/kg

Special cases

- Porewater TBT analysis will be considered on a case-by-case basis
- BT = 0.15 µg/L

Slide 6

2) Clarification Paper on Summations with U/J Flags

by Kelsey van der Elst, Corps

Slide 7

Applying qualifiers to summed values

- Summed parameters include:
  - PAHs
    - Total LPAHs
    - Total HPAHs
    - Total PAHs
  - Total Chlordanes
  - Total PCBs
  - Total DDT
  - Total Benzofluoranthenes

When all constituents are non-detect (U-flagged)

Sum is reported as the highest non-detect value and U-flagged

Chemical	Result	VQ
4,4' DDD	4.3	U
4,4' DDE	2.7	U
4,4' DDT	1.8	U
Total DDT	4.3	U

Slide 8

Applying qualifiers to summed values with mixed U/J qualifiers

When all constituents are detected and any number are J-flagged

Sum is J-flagged

Chemical	Result	VQ
4,4' DDD	4.3	J
4,4' DDE	2.7	
4,4' DDT	1.8	J
Total DDT	8.8	J

When some constituents are non-detect (U-flagged) and the rest are detected or J-flagged

Sum is J-flagged and the non-detect values are not included

Chemical	Result	VQ
4,4' DDD	4.3	J
4,4' DDE	2.7	
4,4' DDT	1.8	U
Total DDT	7	J

Slide 9

3) EIM Update

All projects are required to submit project data in EIM format to DMMO

DMMP-specific instructions on entering project data in EIM spreadsheets are available from DMMO

- Please ask for most recent version!

Slide 10

4) Puget Sound SRM Update

Slide 11

4) SRM Update

- Updated request form on DMMP website
  - Include which analyses will be conducted
  - Be sure project name is **unique** and **consistent** with project name used on laboratory CoC forms and data reports

Slide 12

4) SRM Update

DY	Bottles Requested	# of Projects	Projects from	Data received
2012	5	3	1 DMMP 1 EPA 1 Ecology	2/3
2013	38	21	11 DMMP 3 EPA 7 Ecology	13/21
2014	15	10	7 DMMP 1 EPA 2 Ecology	3/10
2015	30	22	24 DMMP 3 EPA 3 Ecology	8/22

Slide 13

4) SRM Update

- Required PS-SRM data deliverables:
  1. Electronic data
     - ARI: ask for SRM EDD when requesting cost estimate
     - Other labs: DMMO will work with them to produce acceptable EDD
  2. Data validation report for SRM
     - Stage 2B required, Stage IV recommended
  3. SRM sample data report
     - Required items are listed in SRM guidance document
       - As appendix to sediment characterization report preferred

Slide 14

5) Update on status of PAH/cPAH guidelines under DMMP

Slide 15

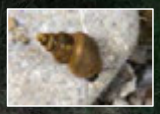
5) PAH/cPAH Status Update

cPAHs	PAHs
• Not currently on COC list • Cannot accept cleanup material above regional background at any DMMP disposal site • Will be addressed as part of the PAH work	• In the process of developing guidelines for PAHs that will be consistent with state standards

Slide 16

6) Aquatic invasive species

- SAPs must document check for presence of New Zealand Mud Snail in project area



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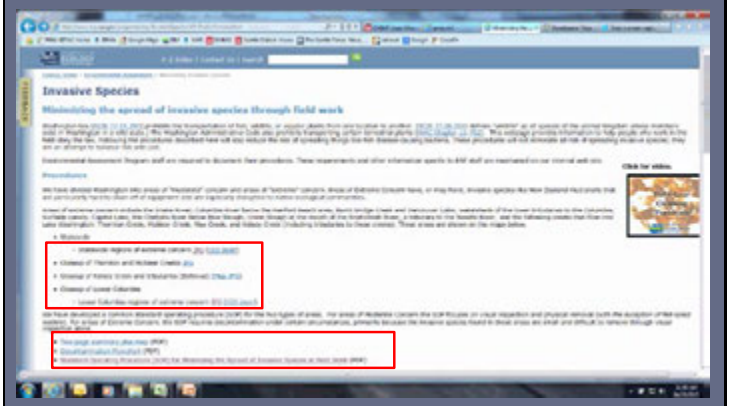
http://www.ecy.wa.gov/programs/eap/InvasiveSpecies/AISPublicVersion.html



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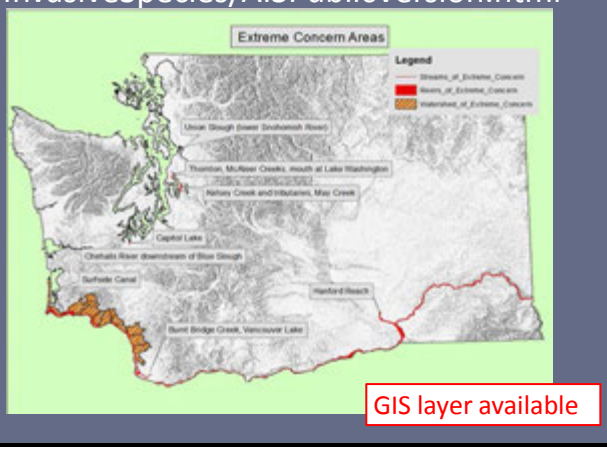

GIS layer available

Slide 19

Deadline for comments:
June 6th, 2015

Mail to:
- DMMO
  Seattle District – Corps of Engineers
  P.O Box 3755
  Seattle, WA 98124

E-mail to:
- DMMOTeam@usace.army.mil

Slide 20

APPENDIX 1

Meeting Announcement

Corps of Engineers, Seattle District
May 6, 2015

2015 Sediment Management Annual Review Meeting

HOSTED BY:

Dredged Material Management Program (DMMP) and the
Washington Department of Ecology Sediment Management Standards (SMS)

SMARM is an annual meeting to provide stakeholders information and to allow engagement on sediment management issues in the state of Washington. Any interested party is invited to attend.

Where: Seattle District Corps of Engineers Headquarters, Salish Sea Conference Room, 4735 East Marginal Way South, Seattle, Washington, (**see below for directions & important security information).**

For DMMP: This meeting serves as public notification of proposed changes and clarifications to the DMMP program. Changes can be minor or substantive, but they all are presented at the meeting, with a chance for stakeholders to ask questions and make comments. Comments are accepted on proposed DMMP program modifications at the meeting and until at least 30 days subsequent to the SMARM.

For SMS: This meeting serves as an opportunity to inform and engage the public on proposed technical, scientific, or policy changes and clarifications surrounding cleanup of contaminated sediment. This may include proposed changes to guidance, process, or policy. Comments are accepted at the meeting and until at least 30 days subsequent to the SMARM.

Public Participation: an important aspect of this meeting is holding a portion of the agenda open for stakeholders to present proposed modifications to the DMMP and/or SMS programs. You are invited to submit program-related issues, ideas & suggestions for consideration and discussion at the meeting. Submissions for these public issue papers or presentations will be accepted through Friday, May 1, 2015, and should include:

- A clear statement of the issue/concern/topic
- Why the topic is relevant and important to the DMMP and/or SMS programs and stakeholders
- Alternatives or suggestions for topic resolution

Poster Session: Technical posters are encouraged for display at the meeting. Posters should be relevant to sediment management. Please notify the DMMO if you plan to bring a poster so that appropriate display space is made available (e-mail to DMMOteam@usace.army.mil).

More: Draft papers outlining issues identified by the DMMP agencies and SMS program for discussion and potential implementation are posted on the Seattle District's website, at http://www.nws.usace.army.mil/Missions/CivilWorks/Dredging.aspx (go to "SMARMs and Program Updates" page).

Security procedures at this federal government facility include presentation of photo identification and proceeding through a metal detector. Allow plenty of time for parking and security. Directions and security information are attached.

US Army Corps of Engineers® | Washington State Department of Natural Resources | EPA United States Environmental Protection Agency | Department of Ecology State of Washington

Corps of Engineers, Seattle District
May 6, 2015

2015 Sediment Management Annual Review Meeting

Directions: 4735 E. Marginal Way South Seattle, WA 98134

From the north: From I-5 south, take Exit 165A toward James Street. Take an immediate right onto Columbia St. and follow through town to merge on to the viaduct/Hwy. 99 South. Hwy. 99 South becomes E. Marginal Way S. The Federal Center South (Building 1201) will be on your right; a large visitor parking lot will be across the street on your left.

From the south: From I-5 north, take Exit 162 (on left) to Corson/Michigan St. Stay straight on Corson Ave S. and get into right lane. Take the first right onto S. Michigan St. and go ½ mile. Turn right onto E. Marginal Way S./Hwy. 99. Go 1.3 miles. Federal Center South (Building 1201) will be on your left; a large visitor parking lot will be across the street on your right. Area and building maps are attached.

Parking and Security: Visitors can park in the large parking lot across the street from Federal Center South (FCS). Pedestrians cross E. Marginal Way S/Hwy. 99 at the pedestrian crosswalk at the light.

All visitors are subject to security screening and must sign in at the main entrance of the FCS Building 1201 to gain access to the new Corps Headquarters Building 1202. All attendees **must have picture identification** (a drivers license is suitable; a Government furnished ID or Passport are also acceptable). Attendees will then proceed to Building 1202 where they will be directed to the Salish Sea Conference Room located on the first floor.

Access Assistance: Guests who need special assistance accessing the building may be allowed in the secure gate near Building 1202. This requires at least 24 hours prior notice to allow coordination with the security office. Contact the Dredged Material Management Office for assistance with this process.

International Guests: All guests are welcome at the meeting regardless of nationality. International guests may use their own government-issued picture identification to gain access to FCS. We ask that international guests RSVP to the DMMO prior to meeting day so that security personnel can be advised.

For more information, contact the DMMO:

Mailing Address
U.S. Army Corps of Engineers, Seattle District
Dredged Material Management Office
PO Box 3755
Seattle, WA 98124-3755
E-mail DMMOteam@usace.army.mil
Phones 206-764-6083
206-764-6945
206-764-6550

US Army Corps of Engineers®
Washington State Department of Natural Resources
EPA United States Environmental Protection Agency
Department of Ecology State of Washington

APPENDIX 2

Agenda

Corps of Engineers, Seattle District
May 6, 2015

2015 Sediment Management Annual Review Meeting

8:30	**REGISTRATION AND COFFEE**	
9:00	Welcome	Moderator, Justine Barton, EPA
9:05	Opening Remarks	LTC Andrew Park, Deputy Commander, Seattle District Corps of Engineers
Session 1		
9:15	SCUM II & Regional Background Updates	Chance Asher, Ecology
10:15	DMMP Project & Issue Summary	Lauran Warner, Corps
10:30	**BREAK** (15 minutes)	
Session 2		
10:45	EPA Superfund Year-in-Review	Ravi Sanga, EPA
11:30	PAH Sediment Screening for the Protection of Fish	Lyndal Johnson, NMFS
12:00	**LUNCH** (60 minutes)	
Session 3		
1:00	Freshwater Guidelines: Follow-up from 2014	Laura Inouye, Ecology
1:20	Freshwater Bioassay Interpretation	Laura Inouye, Ecology
1:40	Biomass Endpoint Development – An Update	Russ McMillan, Ecology
1:55	**BREAK & POSTER SESSION** (20 minutes)	
Session 4		
2:15	DNR Disposal & Monitoring Update	Celia Barton, DNR
2:35	Debris Management	Erika Hoffman, EPA
2:55	Modifications to Ammonia and Sulfide Triggers for Purging and Reference Toxicant Testing for Marine Bioassays	David Fox, Corps
3:15	DMMP Clarifications and Updates (U/J flags, TBT, EIM, PAHs, Puget Sound SRM)	Kelsey van der Elst, Corps
3:35	Public Issues and Discussion:	Stakeholders invited to submit proposals for program-related issues
4:00	**SUMMARY AND CLOSING**	

Comments on DMMP Proposals accepted through June 5, 2015

2015 Sediment Management Annual Review Meeting
POSTER SESSION

Analysis of SVOCs in Food-Grade Storage Bags used for Sediment Bioassay Samples
Cheronne Oreiro, Analytical Resources, Inc. and Tim Thompson, Science & Engineering for the Environment, LLC

Beneficial Reuse of Dredged Marina Sediment
David Pischer, P.E., Landau Associates, Inc.

> Stabilization of approximately 47,500 cubic yards of fine-grained sediment dredged from the Port of Bellingham's Squalicum Outer Harbor for future use as the low-permeability soil component of the final cover system at the former Cornwall Avenue Landfill site.

Biomass Endpoint Development – An Update
Arthur Buchan, Washington State Dept. of Ecology

Coelution of Contaminant Drivers at Cleanup Sites and the Role of Consilience
Janet Knox and Laura Johnson, Pacific Groundwater Group (PGG) and Sue Dunnihoo and Van Spohn, Analytical Resources, Inc.

> The poster discusses typical coelution/quantification problems in analytical chemistry, and gives an example of how quantitation errors can lead to spatial analytical errors and thus errors in cleanup decisions.

Development of Standard Methods and Approaches for the Use of Passive Samplers in Assessment and Management of Contaminated Sediment
Tim Thompson, Science & Engineering for the Environment, LLC

Emerging Contaminants - Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)
Karla S. Buechler, TestAmerica Laboratories, Inc.

APPENDIX 3

List of Attendees

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APPENDIX 4

SMARM Comments and DMMP Responses to Comments

1. Revised Freshwater Sediment Screening Levels (from 2014)
2. Reporting Summed Concentrations with J and/or U Flags
3. Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites
4. Tributyltin (TBT) Measurement Basis

1. Revised Freshwater Sediment Screening Levels (from 2014)

- Avocet Consulting (Teresa Michelsen) – letter dated June 5, 2014
- Port of Portland in response to DMMP paper – letter dated June 16, 2014
- Port of Portland in response to RSET paper – letter dated February 5, 2015

10/9/2015: Responses to these comments will be added at a later date. Only parts of the paper without comments have been implemented, per the SMARM 2015 presentation by Laura Inouye, Ecology.

Avocet Consulting

June 5, 2014

RE: Comments on **"DMMP Issue Paper: Implementation of Revised Freshwater Sediment Screening Values"**

To whom it may concern:

Please accept these comments on the above-referenced paper presented at the 2014 SMARM meeting. I appreciate the opportunity to provide these comments on my own behalf. While I normally don't comment on SMARM topics, I am concerned enough about the proposed approach to do so in this instance. Included are a number of comments divided into regulatory, technical, and implementation areas, as well as recommendations for an alternative approach to protection of higher trophic levels.

Regulatory Issues

Legal Authority. The paper should present a clear statement of RSET's legal authority to develop and implement new water and/or sediment quality standards. It is my understanding that RSET/DMMP is a clearinghouse for effective decision-making that implements the existing laws and standards of its member agencies, but does not itself have the authority to develop new criteria. However, this paper appears to do exactly that with water quality-based sediment screening values and discusses the intent to do so for bioaccumulation-based sediment screening values in the future. Simply calling them screening values does not change their essential nature – they are values intended to be applied to every project in a tri-state area for regulatory decision-making – and they are placed in a table alongside promulgated values and used in the exact same manner.

RSET/DMMP frequently makes technical, scientific, and engineering updates to their programs and policies through SMARM; however, they are explicitly provided the authority to do so through the Sediment Management Standards (SMS) and other rules that provide the ability to update and use "latest science" without promulgating each individual change by rule. However, standards and criteria meant to be applied on a consistent basis state-wide are in another category. In Washington State, it is required by case law that any such values be promulgated by rule. The fact that there are overrides does not mitigate this requirement, as the marine and freshwater benthic standards also have overrides, and both the standards and their overrides are promulgated in rule. Thus, in order to develop and use any new water quality or sediment standards in the DMMP/RSET programs, it may be necessary to promulgate them as part of the Water Quality Standards (open for revision shortly) or Part III of the Sediment Management Standards, following all public review and comment and Administrative Procedures Act requirements.

Having been through this process myself, I will say that it is long and arduous, and requires a great deal of technical documentation, peer review, public review, and validation of the criteria, which I am not finding in the current proposal. While I am not a fan of process for process' sake, it may be an appropriate check and balance on values that can quickly get set in stone otherwise.

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Title and Regulatory Structure. The title of the SMARM paper is misleading, as it would lead most people to believe that this is mainly about adopting the recently promulgated freshwater sediment standards. Consideration of any one set of standards or criteria should be entirely separate from another set of standards with a different receptor population. Protection of benthic receptors is independent from protection of fish or humans. Each set of standards should be considered and adopted (or not) on its own merits, as getting standards in place for one set of receptors would still be an improvement over the current status, even if another is not yet completed. For clarity to the regulated public, each "overlay" or topic should be in its own paper.

The marine benthic standards are just as lacking in protection of fish and higher trophic levels, as is evidenced by NOAA's marine values for PAHs and PCBs for protection of fish being much lower than the AETs. Yet, a similar set of marine water quality-based sediment criteria was not developed. This gives the appearance of a desire to "modify" the freshwater benthic standards specifically, despite the long public process engaged in, before adopting them. If water quality-based standards and bioaccumulation-based standards are required for the RSET/DMMP program, they should be developed for both marine and freshwater environments, entirely independently of the benthic criteria. Any other approach is difficult to justify and lacks protectiveness, as it continues to delay having freshwater benthic criteria in the manual while rushing other criteria through the process.

Freshwater Sediment Standards. The interim values for freshwater sediments <u>must</u> be removed from the manual in their entirety, regardless of whatever else is decided. Those values never rose to the level of guidance in WA and were in a technical report that was an interim report along the way to calculating final values. We knew at the time that they were not completed and did not have a large enough data set or chronic tests included. Freshwater sediment standards for WA have now been finalized and promulgated, and only those values should be included and used for WA. The SMS rule is also very specific that due to the method used to calculate them, they are to be used as a set and not mixed and matched with or replaced by other values. There is a process provided in the SMS to develop alternative values on a site-specific basis, but this is not likely to be relevant to dredging projects and does not allow substitution of other criteria sets.

While Part III of SMS is technically applicable to water quality and dredging projects, Part III was not open for revision during the recent updates. If it had been, the same values would have been placed there. The same narrative standards are stated in both sections and the entire history of our rule and program indicates that the same levels were designed to be used for cleanup, water quality, and dredging. While alternative values could technically be placed in the DMEF, it would be difficult to justify how they meet the narrative intent of the SMS rule for use in WA. Other states may make their own decisions, but DMMP/RSET should honor each state's standards and rules in their manuals without alteration. All of the agencies and public had the opportunity to comment during the rule revision process, and only Ecology has the authority to revise the standards.

Public Process. The introduction describes how the bioaccumulation-based sediment values were delayed due to concerns about public participation expressed at the RSET conference call. However, just as much concern was expressed about the elutriate-based values, except that no-one knew what they were or were designed for at that time. In addition, it seems strange to have presented them at SMARM, when Seattle District is arguably the district among the three with the fewest freshwater projects. Were stakeholders in the other two districts given sufficient notice that freshwater issues would be discussed? Is it reasonable to expect them to travel to Seattle? Implementation of these

elutriate values should wait until there has been an opportunity for the districts most affected by freshwater standards to fully evaluate them and participate in discussing alternative approaches.

Problem Statement. The problem statement does not actually identify a problem to be solved. Simply because one set of standards does not address a receptor population it was not designed to address does not indicate an environmental problem. The lack of freshwater benthic standards in the manual is definitely a problem, as is the lack of bioaccumulation-based standards. Everything we know about sediments and risk to both lower and higher trophic level receptors indicates that these are two important pathways of concern that cause actual harm to the environment and human health. These are the areas on which DMMP/RSET should be focusing.

However, there is no evidence I am aware of that in-place sediments cause water quality problems sufficient to harm fish, particularly the types of sediments potentially suitable for open-water disposal. Nothing in the history of the program has indicated that this is a particular issue that needs addressing. No data are provided showing actual water quality exceedances above disposal sites or leave surfaces. This is not normally how DMMP proceeds – if there is a concern like this for which there is a lack of data, there is usually a year or so of data collection to confirm the need for such an action. I expect to see evidence of an actual problem prior to implementing a tri-state set of criteria and override testing requirements that apply to all projects. When DMMP/RSET did its impact analysis and found none, might that not have triggered reevaluation of whether these criteria were actually needed? They will have impacts on non-DMMP projects and potentially on cleanup projects that appear not to have been considered (see implementation section below).

Even for active dredging and disposal, there is no evidence cited that contaminants partitioning from sediments into surrounding water in a dissolved form are likely to cause harm to fish, particularly ESA species. Biological opinions in the region prepared by the resource agencies and the Corps have concluded otherwise. For example, the BiOp for Post Office Bar in the Willamette River (within the Portland Harbor Superfund Site) states that short-term increases in chemical concentrations, *if any*, *could* theoretically result in behavioral changes, increase in stress, and reduced fitness of juveniles. However, it does not provide any studies or other evidence supporting this statement. At the same time, the BiOp concludes that adult fish will swim away from the turbidity and juveniles tend to migrate along the shoreline, minimizing exposure to turbidity and resulting in a lack of measurable changes to the pelagic fish community (USACOE 2008). The same arguments would suggest very limited exposure to chemical releases during dredging, since they would be associated with the same areas in which short-term turbidity would occur. In fact, the BiOp concludes with the statement that "Very few salmonids, if any, would be exposed to the areas disturbed by dredging due to their habitat preferences and by timing the activity during a period of low abundance." This statement and others in similar BiOps highlight the fact that we already have regulatory controls in place to protect fish during dredging and disposal and that the resource agencies seem to feel these are adequate.

Technical Issues

Equilibrium Partitioning-Based Values are Not Applicable to Bedded Sediment. The most significant problem with the proposed approach is that sediment values back-calculated using K_{oc}s from water quality criteria would only be applicable to sediments in the water column, not to bedded sediments. To make this leap you would have to make one of two unlikely arguments, either 1) fish live in sediments, or 2) the entire water column has the same chemical concentrations as porewater in sediments. Even as a screening approach, these are untenable arguments. These equations originally came from elutriate

testing and are designed to predict possible water concentrations during disposal of sediments through the water column. They were never intended to apply to bedded sediments, and thus should not be applied to leave surfaces or as a measure of whether sediments may cause water quality impacts once placed at an open-water disposal site (i.e., whether they are suitable for open-water disposal). Not to mention that any contaminants soluble enough to conceivably be a problem at an open-water disposal site would be stripped during the dredging and disposal process – the very reason why ammonia and sulfides standards are not included in dredged material assessments.

Taking each of the propositions above one at a time – first, using sediment concentrations to calculate porewater concentrations (or vice versa) is unnecessary. The only population of receptors that is exposed to porewater is the benthic community, for which we already have both marine and freshwater standards. Water quality standards for protection of fish are not applicable to porewater or within sediments, for obvious reasons. State water quality standards need to be applied in the manner described in rule, not to another medium or set of receptors for which they were not intended and are not legally applicable.

Second, the suggestion that porewater concentrations could be used as screening levels for overlying water concentrations is unlikely at best. There are at least two processes that would have to occur for a porewater contaminant to reach the vicinity of a fish in the overlying water. First, the contaminant would have to diffuse out of the porewater into the layer of water just above the surface of the sediments. This can be hastened or slowed by various site-specific features and processes, including the presence of a nepheloid layer, organic matter, the type of sediment, and presence or absence of natural or artificial turbation. Next, the contaminant concentration that reaches the water is subject to dilution by the overlying water. In any tidally influenced or river system, that dilution will be large. Ecology has water quality models that could give a general sense of the amount of dilution that would occur in Puget Sound. In a riverine environment, flow models could be used to get a sense of the magnitude of dilution. However, this is almost unnecessary, as it is apparent from Table 1 that not much dilution would be required before these values would fall below the freshwater benthic values and be less protective in any case.

All of the above assumes that contaminants go only one way – from the porewater into overlying water. As these are contaminants that partition strongly onto sediments, the actual case is that more of the contaminants move into sediment from the water than the reverse, with the sediments acting as sinks for these contaminants.

In summary, there is no technical or theoretical basis for using these equations in this manner. For DMMP/RSET to imply that sediment porewater can be used as a screening approach for water quality impacts is highly problematic. Individuals with regulatory authority who are not as well versed in sediment transport and partitioning may not realize how unlikely this is and think that it is perfectly reasonable to apply in other contexts as well (such as cleanup evaluations and associated permitting).

Equilibrium Partitioning is Unlikely to Accurately Predict Water Quality during Dredging and Disposal. Even for the activities for which these equations and elutriate tests were designed, i.e., in-water dredging and disposal activities, these simplistic equilibrium partitioning equations are unlikely to be predictive. Dredging and disposal of sediments through the water column violates all assumptions of equilibrium and while it is convenient to ignore this, it is not appropriate (DMMP pays close attention to partitioning issues in bioaccumulation testing, for example). Below are just a few of the non-equilibrium processes that would affect whether the predictions of these equations are accurate:

- When disposing of sediments through the water column, sediments may not have time to equilibrate with the surrounding water sufficiently for contaminants with long equilibration times to partition off of sediments
- However, sediments are continually moving into cleaner water as they fall through the water column, increasing the concentration gradient and possibly increasing contaminant release
- Sediments of different particle sizes may fall to the bottom at different rates, increasing or decreasing the time in contact with surface water
- Dilution effects also apply during dredging and disposal
- Most sediment contaminants released during dredging or dredged material disposal are not released in dissolved form, but rather on fine particulates or organic matter to which they are tightly bound

This last consideration is likely the most important. We know from projects throughout North America that concentrations of highly hydrophobic chemicals such as PCBs and dioxins/furans tend to increase in fish tissues after dredging. Given their very high K_{oc}s and long partitioning half-lives, it is unlikely that these chemicals were released in a dissolved state. Sediment contaminants in general partition strongly into sediments or organic matter and are more likely to be found in these compartments in the water column as well as in sediment. This is an important risk to consider, but cannot be estimated through these equations.

In summary, equilibrium partitioning equations should not be used in an attempt to predict patently non-equilibrium processes, particularly when contaminants may remain in a non-dissolved state while moving through environmental compartments. It is also a concern that these equations most likely would not predict the actual effects observed from highly hydrophobic chemicals being released into the water on particulate or dissolved organic carbon and subsequently being ingested by fish, since these are not K_{oc}-based processes.

More Technical Backup and Validation are Needed. Although I disagree with use of these equations for the reasons described above, if they were to be used, much more technical backup would be needed to allow the public to evaluate the proposal. These appear to be essentially back-of-the-envelope basic equilibrium equations with almost no description of where the parameters in the equations came from. Referencing the previous SEF is not sufficient to demonstrate that these equations can or should be applied to these situations. It should be noted that the Bioaccumulation Workgroup considered use of the EqP method for assessing risks from sediment contaminants to fish and rejected it. It may be worth reading that section as a reminder of why this was not considered a useful approach. While it could be argued that this is water quality vs. bioaccumulation, there is really no difference between the two. The issue is potential impacts to fish from sediment contamination, and the real pathway of concern is through the food web, not through dissolved concentrations of highly hydrophobic chemicals in water. NOAA's past research bears this out, linking effects on fish to contaminants in stomach contents.

If the agencies choose to continue with this effort, a technical backup memorandum or report should be developed providing independent support for using these equations for this purpose, comparing this to other possible approaches, justifying the default parameters, providing similar parameters for marine environments, and describing how the default parameters can be modified for site-specific conditions. Clearly, in freshwater environments, many of these default values for parameters may vary and some will also in marine systems. In addition, the agencies should describe why they did not use the biotic ligand model for metals and whether that represents latest science.

In addition, prior to definitively adopting these values, DMMP/RSET should do as it has in the past and gather data on their accuracy in predicting actual water quality exceedances in all three areas in which they are proposed for use – leave surfaces, disposal sites, and during dredging/disposal activities. The benthic criteria for both marine and freshwater sediments have known reliability, and this should be an equally important requirement for any new values proposed for use in a tri-state area (or even a one-state area).

Regulatory Considerations

Scope of DMMP/RSET Decision-Making. For the reasons described in the technical section above, I do not believe it is technically defensible to use this approach to assess the suitability of sediments for open-water disposal. By that I mean specifically the effects that these sediments would have once placed at the disposal site, answering the question of whether they would cause the disposal site to exceed Site Condition I. It is really not within the scope of DMMP/RSET to address water quality issues, which are programs delegated to the state water quality programs and implemented through water quality certifications. This again gets back to whose function it is to do what. It is the states that develop sediment and water quality guidelines and enforce them in various ways. EPA also has that authority, but it is delegated to WA and OR (not sure about ID). DMMP/RSET should not, from the top down, dictate to states how to handle their water quality programs or certifications. Instead, states will communicate their standards and requirements to DMMP/RSET and add them to permits as appropriate. It may even be that different states will have different standards and preferences in that regard. DMMP/RSET needs to more carefully separate decisions that need to be made to evaluate the suitability for open-water disposal from other regulatory functions.

Impacts to other Projects. While DMMP evaluated the impacts to its own past projects, it did not look at potential impacts on other related projects. Sediments that project proponents believe may be suitable for open-water disposal are more likely to pass these and other criteria than sediments from more contaminated areas. While technically these values would presumably apply only to DMMP/RSET projects, in practice, we all know that such values get widely circulated and used for a variety of purposes. This is not so bad if the values are accurate and representative of actual environmental harm, but it does create an unnecessary regulatory burden if the values are too low or simply unrepresentative of the pathways present, as seems to be the case here.

Specifically, DMMP did not look at how these values might impact dredging projects that are not intending to go to open-water disposal, such as many projects in the Willamette or in more contaminated waterways in Washington. Because DMMP/RSET has extended these values beyond suitability for open-water disposal to regulation of leave surfaces and the potential for impacts during dredging, it could affect all of these projects. It could also affect the ability to get permits for cleanup of contaminated sites, which is of great concern to me. These projects already face enough regulatory hurdles, more and more each year. Yet meanwhile, these sites sit unremediated due in part to increasing difficulties with permitting. Please consider the possible unintended consequences of attempting to back-calculate water quality criteria to sediments, rather than just using the WQC directly.

Permit Conditions. The paper does not describe all of the things that could happen if it is determined that these screening values are exceeded. How does a cleanup or navigational dredging project get a permit to dredge if it is determined that these screening levels are exceeded? These projects are necessary activities and some thought needs to be given to what measures beyond those already

included in permits would be required. Again this gets back to unintended, or at least uncertain, consequences.

Perception Problems. I am concerned with the perception this creates that 1) porewater is a good way to screen potential impacts to overlying water, and 2) in-place sediments cause water quality problems. With doctoral training in contaminant fate and transport and a 20-year career in cleanup and dredging projects, I believe these are serious mischaracterizations of reality that could do real harm if individuals without this experience came to believe that either of these were true. DMMP/RSET should (and generally does) strive to present and use best available science in its programs and help educate each new generation of scientists and regulators.

In my experience, in-place sediments rarely result in water quality problems, and I cannot think of a case where when it did, it was due to equilibrium processes as represented by these equations. Some examples of real cases I can think of include free-phase petroleum moving through sediments (e.g., Eagle Harbor), highly contaminated groundwater moving through porous sediments (e.g., ASARCO), and conventional contaminants generated by wastes in sediments (wood waste, fish waste). None of these result from typical sediment contaminants partitioning out of sediments, into porewater, and then into the overlying water. That just isn't realistic. Let's not create problems that don't exist – we have enough to handle with the ones that do. If DMMP/RSET believes this situation is a real concern, please provide the data to back that up before imposing a new overlay on an already complicated regulatory process.

ESA and Benthic Species. Table 2 should be revised to remove ESA consultations from the override process for the benthic standards. There are no ESA benthic organisms in WA or OR, or to my knowledge in ID in areas that are dredged. Absent listed species, the federal resource agencies have no jurisdiction over these resources, which are trust resources of the States.

Alternative Approaches

Here are the approaches I would recommend for the issues outlined in this paper:

- **Adopt the freshwater benthic criteria in parallel to the marine criteria, as shown in the SMS rule.** Getting these standards in place provides protection for one set of receptors that is not currently available in the manual and is one step forward.

- **Use the tools already available to evaluate the potential for water quality impacts during dredging and disposal.** I recommend against adopting sediment values, which will have little technical validity. There is no actual need to back-calculate to sediment quality values since you already have water quality standards in rule. If you are concerned that a given project may have water quality impacts, conduct an elutriate test, use one of the available water quality models for dredging, and/or measure water quality concentrations. Over time, you may be able to develop an empirical relationship between sediment concentrations and measured water quality impacts that would be more defensible than the equilibrium equations – or find that this is not an issue for most chemicals. I would focus on potential releases of bioaccumulative contaminants on DOC or POC as the most pressing concern, since this is what has been observed nationally. This issue does not lend itself to K_{oc}-based approaches, and we may need to brainstorm a bit on the best approach. Consider whether this is something that belongs in the DMMP/RSET manuals or is a water quality certification issue.

- **I recommend against setting water quality-based sediment standards for leave surfaces or disposal sites until and unless you have actual evidence of a problem.** This imposes a regulatory burden, misapplies water quality criteria, creates an inaccurate perception of how contaminants move in the environment, and could have unintended consequences for other dredging and cleanup projects. If the agencies believe this pathway needs to be further evaluated, collect data in the water column above the disposal sites and/or leave surfaces to see whether water quality criteria are exceeded. If they are, you will have justification for deriving values and an empirical relationship between water quality and sediment quality that could be used to derive more defensible values. If not, we can focus on the more important bioaccumulative pathways.

- **Consider Using the SEF Approach for Bioaccumulatives.** This is by far the more pressing need to work on, and an approach for proceeding is already outlined in the SEF. Rather than developing region-wide bioaccumulation-based sediment standards, which would run afoul of the same WA state prohibitions on placing standards in guidance and would be technically challenging, consider developing disposal-site specific BSAFs and resulting sediment screening levels. Regional values for leave surfaces can be developed in areas where they are likely needed through existing processes, such as work already completed under Superfund for Portland Harbor or the Lower Duwamish, natural and regional background calculation efforts by the WA Dept. of Ecology and OR DEQ, etc. At the same time, I recommend a robust override process be in place due to the uncertainty of any such values. While this is not the topic of this paper, it is certainly implied in the introduction and it is worth beginning a conversation early. I request that you involve the interested public and regulated parties in this conversation prior to settling on an approach.

Thank you for this opportunity to provide comments. I would be more than happy to discuss any of these concerns with you, as well as work with you to develop alternative approaches.

Sincerely,

Teresa Michelsen
Avocet Consulting

June 16, 2014

Jonathan Freedman; U.S. EPA
1200 Sixth Ave.
Seattle, WA 98101

Laura Inouye; WDOE
P.O. Box 47600
Olympia WA 98504

RE: Port of Portland Comments on Public Review Draft Paper "*Implementation of Revised Freshwater Sediment Screening Values"* dated April 17, 2014

The following are comments prepared by Mark Dunn Lewis, PhD of Formation Environmental on behalf of the Port of Portland on the *DMMP Issue Paper: Implementation of Revised Freshwater Sediment Screening Values* prepared by Laura Inouye, Washington Department of Ecology, for the Dredged Material Management Program (DMMP) and the Regional Sediment Evaluation Team. The comments are focused on the overall concepts presented in the issue paper, primarily on the use of equilibrium-based partitioning methods to develop sediment guidelines for protection of fish, and the source of background data proposed for use in dredge project decisions for Portland Harbor.

Equilibrium Partitioning-Based SLs.

The purpose of the water-quality based sediment screening values is described as protection of fish species that reside in the water column in areas of dredging or placement of dredged materials. However, water concentrations on which the sediment concentrations are estimated are not representative of the conditions experienced by a fish in the water column.

1. **Equilibrium calculation estimates are not representative of fish exposures.** For metals, the EqP process is essentially estimating the chemical concentration in pore-water of sediments. The resulting estimates of corresponding concentrations in water are not representative of the water column where most fish reside. This is especially true for the case of bedded sediments where there is minimal interaction between the water column and interstitial water in the sediment. But the resulting estimates are also not likely representative of re-suspended sediment at the point of dredging or placement, where the water-to-sediment mass ratio may be much lower than is assumed for many Kd values that would be used in the calculations.

2. **Equilibrium assumptions do not apply for dredging or placement activities.** Conditions in at the site Kd estimates are generally representative of equilibrium or near-equilibrium conditions. However, the conditions at a dredge site or placement site are likely to be changing rapidly, and therefore would not approximate equilibrium conditions. Under dredging, or placement scenarios, water column concentrations of chemicals would be highest initially when the suspended sediment concentrations are highest. But suspended sediment and contaminant concentrations would decline rapidly as the suspended sediment is either carried away and diluted by currents, or settle out and deposits on bedded sediments. In either case, the conditions best represented by the equilibrium assumptions would be short-lived, and may not be biologically relevant for chronic effects. If anything, only sediment or water quality values based on acute toxicity should be used in such assessments.

3. **Fish experience much broader exposure areas than benthic invertebrates.** Most fish species are substantially more mobile than benthic invertebrates, and occupy areas that may be substantially larger than represented in sediment samples. Data from sediment in a prospective dredge project area may be representative of conditions experienced by individual benthic invertebrates. But individual fish will experience much broader areas, potentially much larger than the dredge placement areas. Dredge management decisions based on the application of ET values in assessing impact to fish should include consideration of the scale over which dredged material is to be placed.

4. **Overall Effect.** The overall effect of the factors described above are likely to result in required testing for all but the most pristine sediments in areas like Portland Harbor. In cases where the equilibrium ET is the only factor preventing in-water placement, the additional analysis is likely to require project-specific modeling to evaluate placement options. It is possible that a more practical approach to use of the ETs could result in environmentally protective conditions while streamlining the decision process for many sites

<u>Background Concentration Estimates</u>

1. The RSET team is proposing use of 'upstream' sediment data from the Portland Harbor Remedial Investigation of the Lower Willamette River in dredge project decisions. The upstream background concentrations are from river locations that are effectively upstream of nearly all influence of the Portland metropolitan area. Non-point source sources of organic chemicals and metals from metropolitan areas contribute to elevated concentrations in soils and sediments within developed and industrialized sections of the river. These sources are not generally controllable by the owners or dredging

project proponents, or by site-specific remediation of sediments or upland sources. As a result the proposed background data are not representative of the concentrations of sediment that are expected to deposit on sediments in Portland Harbor. The Oregon DEQ recognizes the anthropogenic effects of metro areas on background in the 2013 soil background values.

2. This issue can be particularly important for bioaccumulative chemicals such as polychlorinated biphenyls, dioxins/furans, phthalates, and mercury. In the absence of established bioaccumulation triggers, the SEF process identifies background as an alternative target.

3. The representativeness of the background data set can be particularly important in managing the newly exposed dredge surfaces because the composition of new sediment settling onto these surfaces reflects, to a large extent, the impact of the metro area on background concentrations. The SEF process for Portland Harbor should recognize the anthropogenic effects on effective background concentrations.

Thank you for considering the Port of Portland's comments. We look forward to continuing to work with the DMMP and RSET agencies and welcome further discussion on this issue.

Respectfully,

Michelle Hollis
Environmental Planner II | Port of Portland
7200 NE Airport Way
Portland, OR 97218
(503) 415-6832 (office)

2/5/2015

Jonathan Freedman
U.S. Environmental Protection Agency Region 10
1200 Sixth Avenue ECO-088
Seattle, WA 98101

Re: Port of Portland Comments on "RSET White Paper: Proposal to Revise Freshwater Sediment Screening Levels" dated 17 November 2014

The Port of Portland (Port) has reviewed the Regional Sediment Evaluation Team (RSET) White Paper referenced above, which proposes three sets of sediment screening levels (SLs) to be applied when conducting freshwater sediment dredging projects. Based on our review, we offer the following specific comments and questions for your consideration:

Comments

- WQC-based SLs for organics are based on an equation that accounts for total suspended solids (TSS) during the placement action; presumably this is a short-term effect for which acute endpoints would be appropriate. Chronic endpoints would, however, be appropriate once the action is complete and the solids have settled. Another equation for organics and metals should be used to develop chronic endpoints for fish populations.

- The source of the Kd and Koc values is unclear given that there is generally a range of values reported for a given compound depending on the study and form of the compound (e.g., type of Aroclor, metal species).

- SEF Page 10-5 contains three bullets indicating how WQ-based SLs are conservatively protective; however, in reality, contaminant concentrations would be lower. Calculated WQ-based SLs are likely to be overly conservative and mechanisms mentioned in the three bullets should be incorporated in the equations and/or decision-making process to reduce the incidence of any unnecessary follow-up elutriate testing.

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- It is unclear as to why the 2006 National Recommended Water Quality Criteria (NRWQC) was used instead of the 2009 version.

- Both equations on page 7 assume equilibrium conditions to calculate a worst-case water quality based standard. In a dynamic system such as a stream, river, or lake, equilibrium conditions are not achieved and calculated criteria are overly conservative; i.e., partioning from sediment to the water column is a slow process. Turbidity associated with dredging or capping is transitory in nature.

- Since turbidity effects are transitory, it is not appropriate to calculate WQ based criteria for chronic effects.

- The equation for WQ based standards for metals appears to be incorrect. If a units analysis is performed, the correct equation is: WQ-based SL = Kd x WQC/1000. i.e., the Log term should be removed.

- The equation for WQ based standards for organics is not applicable to ionizable compounds such as phenols and benzoic acid since they do not partition strongly to organic carbon.

Questions

- Would the SLs calculated from the FPM dataset (study populations) be applicable to placement sites?

- Are State and Federal WQC applicable to dredge placement and NSM exposure, considering the endpoints and the species used in their derivation?

- If no or little background data are available, or sediment concentrations exceed regional background, can the applicant develop a local background level based on data in the area or upstream?

- It is unclear as to how the proposed SEF SL1 and SL2 in Table 1 will be applied. The text does not indicate which level applies.

- Will a silica gel cleanup allowed on the NWTPH method so that biogenic interferences can be removed?

- TSS concentration is time and location dependent, decreasing with time since sediment disturbance and distance from the dredging or placement site. How can a chronic value be calculated when TSS would be at or nearly zero?

- How was the SL2 value derived given that there is no acute NRWQC for PCBs?

We appreciate the opportunity to review. Please do not hesitate to contact us if you have any questions or need additional information.

Regards,

Michelle Hollis
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2. Reporting Summed Concentrations with J and/or U Flags

- Fu-Shin Lee (Ecology) – e-mail dated April 17, 2015

From: Lee, Fu-Shin (ECY)
To: Vanderelst, Kelsey NWS
Subject: [EXTERNAL] EMPC data flags in EIM and comments on your 2015 DMPP clarification paper
Date: Friday, April 17, 2015 11:41:53 AM

Hi Kelsey,

I didn't see your email until I tried to find another email and saw your email in my Junk email box this morning. Hugo asked me the question about the data validation at QA1 from Carissa with BergerABAM on the data submittal associated with your project yesterday afternoon. Dave Fox told me that the DMMP and USACE project data were validated following the EPA guidelines. QA1 and QA2 are old terms used for the data validation following the old 1989 PTI data validation guidance.

I thought the DMMP/USACE HRGC/HRMS data were validated at EPA 4 levels by the validators following the EPA guidelines. Correct me if I'm wrong. The validated data should be submitted to the EIM, if the data are validated. The Lab electronic EDD with EMPC qualifiers are not the validated data. Make sure the validated data instead of original lab data are formatted in EIM templates and submitted. Feel free to call me, if you more clarification.

If the data are validated at EPA 4 level by the third party expert, the EMPC should be changed to UJ or J per EPA region 10 PCDD/PCDF validation guideline (Page 38-40) by the data validator.

http://www.epa.gov/region10/pdf/qa/final_PCDD_PCDF_validation_guidelines_EPA_910_R_14_003.pdf
<http://www.epa.gov/region10/pdf/qa/final_PCDD_PCDF_validation_guidelines_EPA_910_R_14_003.pdf
>

Excerpted below is from Page 38 of EPA region 10 PCDD/PCDF validation guideline:

"Using the SICP print-out (electronic or hard copy), check the retention times of the native (parent &daughter masses), relevant labeled compounds and the CDPE channel. For a compound to be reported as detected, the peaks/retention times for the masses of both native and labeled compounds must be aligned and elute within 2 seconds of each other. There should be no CDPE peak eluting at the same retention time as the masses of the target compound and the mass- ion abundance ratio (m/z ratio) must be met. If all the qualitative identification criteria are met except for the mass-ion abundance, the result is reported as estimated maximum potential concentration (EMPC) by the laboratory. The reviewer should rely on professional judgment and organizational policy to decide how to qualify EMPCs. If the compound meets the expanded m/z ratio criteria, then the result may be reported and flagged estimated, “J. If the m/z ratio did not meet the expanded criteria, the result is reported non-detect, “U”, at the level of detection.

If there are diphenyl ethers co-eluting interfering with the compound peak, even with additional clean-up, the compound is flagged by the lab (usually “X” or “E”) and also reported as EMPC. During validation, the reviewer must check the contribution of the CDPE peak to the masses being monitored. If the interference is significant (>25%) of the compound peak, the sample result is flagged non-detect, “UJ” elevated at the level of detection of the compound. If the interference of the CDPE is minimal (<25%), the compound is reported and flagged estimated, “J”, due to interferences."

Excerpted below is from Page 40 of EPA region 10 PCDD/PCDF validation guideline:

"If EMPC reported is <RL but >EDL, qualify data as non-detects reported at the level the analyte was detected. If the EMPC is >RL, check the chromatogram for interferences. If interferences can be minimized or removed by further extract clean-up, request additional clean-up from the laboratory through the PM/WAM. If the peak cannot be isolated from the interferences, flag the result estimated with a possible high bias."

I also got a chance to review your posted DMMP Clarification paper on Reporting Summed Concentrations with J and/or U Flags. I recommend to change the reporting limit to the U qualified reported result to avoid confusion between the Reported Result and Reporting Limit used in the EIM data field. Summarized below are my edits:

1. Your writing on Page 1: If all constituents of a group are undetected, the group sum is reported as undetected, and the highest laboratory reporting limit of all the constituents is reported as the group sum."

My edits in red text: If all constituents of a group are undetected, the group sum is reported as undetected, and the highest U qualified reported result of all the constituents is reported as the group sum.

2. Your writing on Page 1: the highest reporting limit of the constituents

My edits in red text: the highest U qualified reported result of the constituents

I plan to follow up the 2005 DMMP clarification paper on detection limits and reporting limits with you, after I gather and organize more information.

Fu-Shin Lee, Toxicologist
Toxics Cleanup Program, Aquatic Lands Cleanup Unit
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-----Original Message-----
From: Vanderelst, Kelsey NWS [mailto:Kelsey.Vanderelst@usace.army.mil]
Sent: Thursday, April 16, 2015 11:16 AM
To: Lee, Fu-Shin (ECY)
Subject: EMPC data flags in EIM (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Hi Fu-Shin,

You might have heard from Hugo that we (DMMP) are trying to figure out how best to report dioxin data in EIM that was flagged by the laboratory as an EMPC (estimated maximum possible concentration) value, since there are no EMPC flags in EIM. It is DMMP policy that EMPC values get treated as non-detects for the purposes of calculating TEQ sums, so our current approach is to report the EMPC flagged values as "U" in EIM. But I was looking at the list of result data qualifiers, and it looks like the flag "NU" would be a more appropriate choice for reporting dioxin data with EMPC flags.

What do you think?

Thanks,
Kelsey

Classification: UNCLASSIFIED
Caveats: NONE

Subject: Comments received in response to 2015 SMARM clarification papers
Date: July 21, 2015

Comments were received from the following entities in response to the 2015 SMARM meeting:

1. WA Department of Ecology – EMPC data flags and Reporting Summed Concentrations clarification paper (email dated April 17, 2015 from Fu-Shin Lee)

Data Flagging (Washington Department of Ecology's Fu-Shin Lee)

Com#	Commenter	Comment	DMMP Response
1	Ecology	I also got a chance to review your posted DMMP Clarification paper on Reporting Summed Concentrations with J and/or U Flags. I recommend to change the reporting limit to the U qualified reported result to avoid confusion between the Reported Result and Reporting Limit used in the EIM data field. Summarized below are my edits: 1. Your writing on Page 1: If all constituents of a group are undetected, the group sum is reported as undetected, and the highest laboratory reporting limit of all the constituents is reported as the group sum." My edits in red text: If all constituents of a group are undetected, the group sum is reported as undetected, and the highest U qualified reported result of all the constituents is reported as the group sum. 2. Your writing on Page 1: the highest reporting limit of the constituents My edits in red text: the highest U qualified reported result of the constituents	These comments were submitted prior to the final editing of the clarification paper before SMARM. The language in the clarification paper differs from what was commented on. It states: "when all constituents of a sum are non-detect, the sum is reported as non-detect at the highest reporting limit of the constituents" The DMMP has chosen to keep the language in the clarification paper for consistency with other DMMP guidance documents.

3. Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites

- Port of Seattle – letter dated June 3, 2015
- Port of Tacoma – letter dated June 5, 2015
- Port of Grays Harbor – e-mail dated July 24, 2015

June 3, 2015

Dredge Material Management Office
United States Corps of Engineers, Seattle District
PO Box 3755
Seattle, WA 98124

Re: Comments on Dredge Material Management Program (DMMP) Clarification Paper Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites

Dear DMMO:

The Port of Seattle respectfully submits the following comments on the DMMP Clarification paper on Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites. After thoughtful review, we feel that the paper is inconsistent with the original Puget Sound Dredge Disposal Analysis (PSDDA) debris management approaches and is not considerate of both environmental and economic goals of the DMMP. Recommendations, if maintained, should allow more flexibility in approaches for debris management. We provide the following comments to help facilitate a sound approach for debris management at DMMP disposal sites in the future.

More complete description of debris definition and purpose of removal is appropriate

The PSDDA Management Plan (PSDDA, 1988a) originally evaluated issues of debris because floatable and/or non-floatable debris was causing hazards to commercial fishing and navigation at some sites. The PSDDA agencies then further clarified that debris occurring at the project dredging area and which is of a size that could cause fouling of fishing nets should be reported as a part of the proposed dredging and disposal operating plans (PSDDA, 1989). PSDDA recognized that other regulations, including Clean water Act, had separate issues regarding debris but these were mostly focused around wood debris. As written, the clarification paper does not include this background, which is important to determining future debris management decisions. The Port recommends a more thorough evaluation of the PSDDA guidance documents to ensure consistency of historical intent in debris management.

Problem statements lack appropriate justification

Given the above, we understand that the original concerns for DMMP debris management are to prevent impacts to navigation and fishing. However, no impacts to these uses were identified in the paper. Instead, the clarification memorandum indicated general concerns regarding creating attractive habitat or potential leaching of chemicals from debris. To date, documented habitat impacts have not been observed at the sites, so these concerns appear unsubstantiated. Some

types of anthropogenic debris (like concrete or stainless steel) would have little leaching potential. Given the low habitat quality of the disposal sites, the potential attractive habitat from this debris is also limited and likely temporary based on site use frequency. Therefore, prior to making changes to debris management strategies largely based on these additional potential concerns, the Port feels it is the responsibility of the DMMP to evaluate the impacts of debris at disposal sites mostly based on the context original envisioned. If additional concerns are suspect, these should be evaluated more thoroughly before assuming impacts are present and need to be controlled.

Documentation of impacts should include a more complete evaluation of the extent of the debris issue currently seen at disposal sites. The clarification memo cites presence of debris at both the Elliott Bay and Anderson-Ketron sites. However, the nature and extent of debris has not been provided. Unless, the physical presence of debris can be quantified more accurately, it is difficult to say whether debris management approaches require revision at all.

Consistency with EPA Region IX is not justification to change guidelines

We do not feel that consistency with other Environmental Protection Agency (EPA) regions is an appropriate reason to require debris screening in Puget Sound without further review of the intent behind what other regions are doing. The primary regulatory permitting authority for the dredging of navigable waters throughout the West Coast is the U.S. Army Corps of Engineering, and not the EPA. EPA's authority given under the Clean Water Act is limited to issues regarding "the discharge of such materials into such area will have an unacceptable adverse impact on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas." Although the EPA has an important role in protecting water quality during such projects it is not EPA's role to regulate the means and methods for debris removal by dredging contractors; therefore consistency between EPA Regions IX and X is not necessarily required or even desirable.

We understand that some dredging projects in California that use ocean disposal require a debris management plan to prevent unsuitable material from being disposed of, but regulations leave the means and methods of debris management to the permittee. We also understand this is not required for all dredging projects throughout California, and that many projects do not go to open water disposal. We recommend the need, method, the size of screen be designed on a site specific basis.

Cost and Time Implications

The Port understands that the goal of PSDDA is to "provide publicly acceptable guidelines governing environmentally safe unconfined, open-water disposal of dredged material, thereby improving consistency and predictability in the decision making process. Public acceptability involves consideration of a wide range of factors. Among these are technically sound evaluation procedures and practicability, which includes cost effectiveness. Environmental and economic considerations are both major factors supporting the need for long range regional planning as a lasting, effective solution for dredged material disposal problems." (PSDDA, 1988a) In accordance with these goals, the Port understands that DMMO decisions should reflect a balance of environmental and economic considerations.

An evaluation of the cost implications of requiring debris screening has not been included in the Clarification Paper. We understand from talking with contractors that additional costs for debris screening can be at least $30,000 per event, which does not include the additional costs for disposal. In addition, production rate can slow by as much as 20% especially in more cohesive sediments. This impacts not only the total cost of a projects but also results in longer disturbances to aquatic environment during dredging. Extended durations of project could also impact ability to perform some dredging projects, because of a small work windows. While the DMMP anticipates that dredging firms in Washington would have an easy transitions to implementation since they have branches in California, local equipment inventories may not include the appropriate equipment or staff qualified in it use.

Recommendations

The following summarizes the recommended changes to the Clarification Paper:

1) Include complete history of debris management objectives and intent in paper;
2) Determine and provide more specifics on the nature and impacts of the debris at disposal sites;
3) Provide a more complete analysis of the costs of screening, when required;
4) Allow for more options for exemption, including allowing for exemption for frequently maintained berthing areas, consideration of facility use on potential presence of debris, bathymetric evidence, or likelihood of debris being present;
5) Allow for other options besides debris screening, where needed. Options could include visuals surveys during dredging with more specific corrective actions if observed, allowing for changes in size and type of screen based on site specific needs, or allowing for different screening requirement for different disposal sites.

Sincerely,

Kym Anderson
Port of Seattle
Maritime Environmental and Planning
Senior Environmental Program Manager

References:

PSDDA, 1998a, Management Plan Report- Unconfined Open-Water Disposal of Dredged Material, Phase I (Central Puget Sound)
PSDDA, 1988b, Management Plans Technical Appendix- Unconfined Open-Water Disposal of Dredged Material, Phase I (Central Puget Sound)
PSDDA, 1989. Management Plan Report, Unconfined Open-Water Disposal of Dredged Material, Phase II (North and South Puget Sound)

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June 5, 2015

DMMO
Seattle District – Corps of Engineers
PO Box 3755
Seattle, WA 98124

RE: Comment – DMMP Clarification Paper
Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites

Dear DMMO:

The Port of Tacoma (Port) supports the stated mission of the DMMO to provide economical disposal options for dredge material within Washington State, while ensuring protection of the aquatic habitat. Regrettably, the additional debris screening requirements unveiled during the 27th annual Sediment Management Annual Review Meeting (SMARM) on May 6, 2015 fall short of that goal. The Port is very concerned that this initiative will unnecessarily increase the cost and complexity of a dredging project without providing any meaningful environmental benefit. The justification presented in the Clarification Paper problem statement is deeply flawed, and in one important matter, is simply incorrect. Moreover, the exemption criteria for the use of a 12-inch X12-inch mesh to screen dredged sediments is unnecessarily vague and subject to interpretation, particularly by inexperienced staff. In this context, staff turnover within the DMMP can reasonably be expected to lead to less predictable decision making.

The Port acknowledges, appreciates and values the efforts of the Department of Natural Resources (DNR) to provide, manage and monitor the aquatic land disposal sites. The results of DNR's disposal site management activities has been a prominent feature at virtually every SMARM conducted since 1989. These efforts are intended to address the following three questions:

1. Does dredged material remain on-site?
2. Have biological effects conditions been exceeded?
3. Have adverse effects to offsite biological resources occurred?

The results of 27 years of monitoring show that dredged material disposal has not caused adverse impacts. In fact, disposal of dredged materials has even improved sediment quality at the Elliott Bay disposal site relative to predisposal sediment quality conditions.

The Port's opposition to the new requirements described in the clarification paper stem from the weakness of the problem statement and the availability of more effective, lower cost alternatives for debris management which received no apparent consideration.

Discussion of the Clarification Paper problem statements, and the Port's concern with each, are discussed in the remainder of this letter.

Problem Statement #1: Large Debris Observed at Disposal Sites.

The only evidence provided to support this assertion are three 2014 photographs taken from the bottom of Elliott Bay (Exhibit 4 of the Clarification Paper). The photographs show, one piece of concrete, one tire, and a single length of PVC pipe.

The last disposal of dredged material at the Elliott Bay disposal site occurred during 2012. It is not at all apparent that the photographed debris represents materials that were dredged, or whether they came to be located at the bottom of the bay as a result of unauthorized dumping. The location of the debris (at the surface rather than mixed or partially covered with sediment) suggests the latter. If this debris was entrained in the material dredged in 2012, this isolated occurrence can be remedied through DNR's existing authority to require the disposer to correct, at their expense, any failure to comply with Section 4.04 of the DNR Site Use Authorization (SUA).

Puget Sound dredging contractors have informed the Port that a requirement to utilize a 12-inch x 12-inch screen will reduce dredging production by up to approximately 20 percent (thereby increasing project costs by the same proportion), and increase mobilization costs on the order of $30,000. The Port believes additional justification for the proposed corrective action is warranted given the economic burden this initiative will impose on dredging proponents, and the lack of evidence clearly linking the presence of large debris at a disposal site resulting from dredging.

Problem Statement #2: Anthropogenic Debris Observed at Disposal Sites

The problem statement should describe the nature and extent of anthropogenic debris observed at the Elliott Bay and the Anderson-Ketron sites to provide context for the recommended corrective action. Observations of anthropogenic debris has not previously been raised as a concern by DNR during disposal site management activity updates in prior SMARMs. In fact, 27 years of monitoring show demonstrable compliance with the management objectives of the in-water disposal sites, and that adverse impacts have not occurred as a result of the in-water disposal of dredged materials.

Problem Statement #3 Presence of Large Debris May Change Habitat Quality at Open Water Sites

In-water disposal sites have been carefully sited to avoid sensitive habitat areas (such as shellfish growing areas) and most are sited in deep water. Habitat monitoring (e.g. impacts to Rockfish and Rockfish larvae) have been an essential element of disposal site management activities implemented by DNR since 1989. Observable large debris-related habitat changes have not been reported by DNR during disposal site management activity updates in prior SMARMs. This appears to be more of a potential concern than an issue warranting changes to the DMMP operating practices – particularly in light of the economic impact this initiative will impose on dredging proponents.

As a matter of constructability, the surface DMMUs, where debris would be present if located within a dredge prism, are dredged first and often disposed of at the disposal site first, followed by any subsurface DMMUs. Additionally, the sequencing of placing the surface DMMUs or DMMUs with higher chemical concentrations before subsurface DMMUs or those with lower chemical concentrations is a standard DMMP disposal Best Management Practice (BMP) and included in the Users Manual relative to the dioxin guidelines. Therefore, both the nature of the dredging and disposal of DMMUs and the DMMP BMP act to reduce the likelihood that debris would be present at the surface within the disposal site and thereby impact habitat quality.

Problem Statement #4 User Manual doesn't explicitly define anthropogenic debris

This definitional matter can be better remedied by defining anthropogenic debris on the User Manual rather than adopting a general requirement for dredging proponents to utilize a 12-inch x12-inch mesh grid to screen debris from dredged sediments. The definition should be based on the type of debris likely to improve habitat criteria, which should be expected to be larger than anthropogenic debris with a nominal 2-inch diameter.

Problem Statement #5 Disposal of Anthropogenic Debris May Erode Public Acceptance of Disposal Sites

The DMMP was successfully created from a crisis, where a judge issued an injunction against an open-water disposal site, garnering policy attention from high levels of the government. The four public agencies comprising the DMMP came together in cooperation, to develop solutions and contribute resources for policy and technical needs. As a result, the DMMP has a rigorous process for evaluating dredging projects and regulating safe and effective in-water disposal. This is consistent with the mission statement of the DMMP described in the introduction of this letter.

It is noted that the presence of anthropogenic debris has not been raised as a concern during prior SMARMs. And so this appears to be a potential concern rather than a data-driven problem warranting changes to the DMMP operating practices. Simply put, more objective information should be provided in the clarification paper within the context of the mission statement of the DMMP in order to justify this costly initiative.

Problem Statement #6 Inconsistent Debris Screening Requirements between West Coast EPA Regions

The primary regulatory permitting authority for the dredging of navigable waters throughout the West Coast is the U.S. Army Corps of Engineering, and not the EPA although the EPA has an important role in protecting water quality during such projects. It is not EPA's role to regulate the means and methods for debris removal by dredging contractors; therefore consistency between EPA Regions IX and X is not necessarily required or even desirable. That being said, the problem statement "(i)n California, debris screening using a grizzly is a standard operating procedure for all dredging projects unless it can be demonstrated that there is a low likelihood of debris in the sediments to be dredged" is false.

Dredging projects in California do require a debris management plan to prevent unsuitable material from being disposed of, but regulations leave the means and methods of debris management to the permittee. Attached is a recent General Permit from the Los Angeles District USACE that lists their boilerplate special conditions for dredging and disposal operations. Also attached are two regional general permits for maintenance dredging that provide fairly recent examples of how the boilerplate conditions are incorporated into maintenance dredging permits. Use of a grizzly to screen debris is not generally required in California. The DMMP should not adopt a general requirement for the use of a grizzly to screen debris as contemplated in this clarification paper.

Conclusion

The DMMP User Manual includes requirements for the identification of debris during the sediment characterization process, and the required Dredging and Disposal Quality Control Plan already includes a requirement for the removal of floatable and non-floatable debris. The DMMP can also require post disposal monitoring of the disposal site to verify the absence of problem debris, and DNR can require corrective action (at the expense of the permittee) if problem debris is placed in the disposal site.

The problem statement in the clarification paper provides scant evidence to warrant a change to the status quo, particularly when weighed against the information provided by DNR during disposal site management updates presented during the last 27 years of the SMARM which have robustly demonstrated that dredged material disposal has not caused adverse environmental impacts. The initiative in this clarification paper will

impose significant additional and unnecessary costs to dredging proponents, with negligible environmental benefits. In light of the discussion in this letter – and the general weakness of the problem statement in the clarification paper – the Port recommends rescission of the Clarification Paper by the DMMP.

Please contact me at (253) 383-9428 if there are questions or concerns.

Sincerely,

Scott Hooton
Environmental Project Manager

Attachments

Attachments on file in the DMMO office.

From: Randy Lewis
To: Fox, David F NWS
Cc: Gary G. Nelson; Leonard L. Barnes
Subject: [EXTERNAL] Port of Grays Harbor comments on the SMARM clarification paper on debris screening
Date: Friday, July 24, 2015 4:10:55 PM

David,

This Email is a response to the presentation you made at the Semi-Annual Dredge Conference on June 25 concerning the current SMARM clarification paper on debris screening for future dredging operations. Please accept the following from the Port of Grays Harbor:

The Port of Grays Harbor agrees with the concerns expressed by the Ports of Seattle and Tacoma that mandatory debris screening should not become a standard requirement but be required on a case by case basis where conditions indicate it would be beneficial to do so. Examples of such conditions would be areas that haven't been dredged for a significant period of time, those that have a high likelihood of having debris such as marinas, and areas that have a history of having debris. It would seem that requiring screening in an area such as our terminal maintenance dredging which is done annually and which hasn't had a history of any significant quantity or instances of hazardous debris such as tires or drums, would increase costs and slow production rates without any appreciable benefit. There are current standards that require dredgers to remove large debris and dispose of upland. Those instances and amounts should be reported if not already being done so and could be used as a basis for determining the appropriateness of screening for specific areas. If the quantities of these materials are not currently being recorded the Corps should begin collecting this data.

Thank you for accepting these comments. Feel free to contact me if you have questions on these comments or would like further information from the Port. Also, please keep me informed of the progress of this proposed policy.

Randy Lewis

Director of Environmental and Engineering Services

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Comments and Responses Table – Debris Screening

Subject: Comments received in response to 2015 SMARM clarification paper: Debris Screening
Date: October 8, 2015

Comments were received from the following entities in response to the 2015 SMARM meeting:

1. Port of Seattle – Debris Screening Requirements clarification paper response (Letter dated June 3, 2015)
2. Port of Tacoma – Debris Screening Requirements clarification paper response (Letter dated June 5, 2015)
3. Port of Grays Harbor – Debris Screening Requirements clarification paper response (email dated July 24, 2015).

Comments are categorized by topic in the tables below.

Com#	Commenter	Comment	DMMP Response
1	Port of Seattle	**Clarification needs a more complete discussion of debris and reasons for its removal based on historical PSDDA documents** "The PSDDA Management Plan (PSDDA, 1988a) originally evaluated issues of debris because floatable and/or non-floatable debris was causing hazards to commercial fishing and navigation at some sites. The PSDDA agencies then further clarified that debris occurring at the project dredging area and which is of a size that could cause fouling of fishing nets should be reported as a part of the proposed dredging and disposal operating plans (PSDDA, 1989). PSDDA recognized that other regulations, including Clean water Act, had separate issues regarding debris but these were mostly focused around wood debris. As written, the clarification paper does not include this background, which is important to determining future debris management decisions. The Port recommends a more thorough evaluation of the PSDDA guidance documents to ensure consistency of historical intent in debris management."	The clarification paper has been revised to include a more complete discussion of debris based on historical PSDDA documents, including the basis for the original 2'x2' size restriction. The rationale for debris removal and the basis for the evolution of DMMP's debris management policy are also provided. The revised paper presents the definition of debris in the current DMMP User Manual (UM) and provides language for insertion into the next update of the UM.
2	Port of Seattle	**Clarification is not aligned with original PSDDA concerns re. debris management** "… we understand that the original concerns for DMMP debris management are to prevent impacts to navigation and fishing. However, no impacts to these uses were identified in the paper. " "… prior to making changes to debris management strategies largely based on these additional potential concerns, the Port feels it is the responsibility of the DMMP to evaluate the impacts of debris at disposal sites mostly based on the context original envisioned."	While earlier guidance regarding debris was focused on impacts to fishing and navigation, our current clarification is related to concerns about debris altering habitat quality and jeopardizing public acceptance of the open-water disposal sites. Furthermore, all material disposed at open-water disposal sites must meet the approval of federal and state agencies through their regulatory permits, or land use authorizations. The DNR Site Use Authorization identifies what can be placed on the disposal site on State Managed Lands. Section 2.01 Permitted Use states, "*Grantee shall have non-exclusive use of the premises only for the disposal of <u>approved dredged material</u> of a volume not to exceed xxx cubic yards, as authorized by federal, state, and local regulatory agencies*."

			The only material expressly permitted for disposal at designated dredged material disposal sites is dredged material that has been adequately characterized and deemed chemically and/or biologically suitable. Permitted dredged material does not include debris such as tires, large rock, rebar or any other solid waste. Section 301(a) of the Clean Water Act states that, <u>except where permitted</u>, "… *the discharge of any pollutant by any person shall be unlawful." [33 USC 1311 – emphasis added]. For purposes of the CWA, the definition of a pollutant given in 40 CFR 122.2 (and similarly in 40 CFR 230.3(o)) is "… dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.)), heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water*."
3	Port of Seattle Port of Tacoma	**Adverse effects to disposal site habitat have not been sufficiently documented** "…the clarification memorandum indicated general concerns regarding creating attractive habitat or potential leaching of chemicals from debris. To date, documented habitat impacts have not been observed at the sites, so these concerns appear unsubstantiated." "Documentation of impacts should include a more complete evaluation of the extent of the debris issue currently seen at disposal sites. The clarification memo cites presence of debris at both the Elliott Bay and Anderson-Ketron sites. However, the nature and extent of debris has not been provided. Unless, the physical presence of debris can be quantified more accurately, it is difficult to say whether debris management approaches require revision at all." "The only evidence provided to support this assertion are three 2014 photographs taken from the bottom of Elliott Bay (Exhibit 4 of the Clarification Paper). The photographs show, one piece of concrete, one tire, and a single length of PVC pipe. "The problem statement should describe the nature and extent of anthropogenic debris observed at the Elliott Bay and the Anderson-Ketron sites to provide context for the recommended corrective action.	The DMMP's concerns about the effects of large and anthropogenic debris disposal are based on recent disposal site monitoring. Visual documentation (in the form of pre-disposal barge photos, ROV-collected images and trawl logs) of the presence of these prohibited materials at the 2 disposal sites evaluated to date is sufficient to justify the proposed modifications to debris removal procedures and size limits without the need to exhaustively characterize the nature and extent of debris present or to prove that adverse effects are already occurring at the sites.

4	Port of Seattle	**Debris at the sites should only be controlled if it is shown to have adverse effects** "Some types of anthropogenic debris (like concrete or stainless steel) would have little leaching potential." "If additional concerns are suspect, these should be evaluated more thoroughly before assuming impacts are present and need to be controlled." "The problem statement in the clarification paper provides scant evidence to warrant a change to the status quo, particularly when weighed against the information provided by DNR during disposal site management updates presented during the last 27 years of the SMARM which have robustly demonstrated that dredged material disposal has not caused adverse environmental impacts."	The DMMP's approach to site management is to anticipate and avoid problems and, when necessary, amend the program accordingly in order to keep the sites available for continued dredged material disposal. The dredged material characterization guidelines and site monitoring structure reflect this proactive approach to managing the program. Along these lines, an important consideration relating to the disposal of large debris or solid waste at open-water sites is the effect that this could have on public acceptance of the disposal sites, as well as the DMMP's ability to monitor the sites, and to avoid changing their habitat type such that they attract a different mix of species that could obviate the original basis for site selection.
5	Port of Seattle Port of Tacoma	**There is a low potential for debris to create habitat at disposal sites** Given the low habitat quality of the disposal sites, the potential attractive habitat from this debris is also limited and likely temporary based on site use frequency. As a matter of constructability, the surface DMMUs, where debris would be present if located within a dredge prism, are dredged first and often disposed of at the disposal site first, followed by any subsurface DMMUs. Additionally, the sequencing of placing the surface DMMUs or DMMUs with higher chemical concentrations before subsurface DMMUs or those with lower chemical concentrations is a standard DMMP disposal Best Management Practice (BMP) and included in the User Manual relative to the dioxin guidelines. Therefore, both the nature of the dredging and disposal of DMMUs and the DMMP BMP act to reduce the likelihood that debris would be present at the surface within the disposal site and thereby impact habitat quality.	We disagree. Over time, addition of large debris to a non-dispersive site <u>could</u> fundamentally change its habitat quality. For sites with relatively little disposal (e.g., Anderson-Ketron), these changes may not be (physically) ameliorated by subsequent disposal events. And the larger the debris, the longer any amelioration might require even at sites with higher volumes of disposal. As discussed earlier (see response to comment #2) all non-permitted materials are prohibited from being disposed at open-water sites, regardless of whether they alter habitat quality by ending up on the surface of the disposal site or if they are buried by subsequent disposals.
6	Port of Seattle and Port of Tacoma	**It is not EPA's role to dictate means and methods for debris removal** "The primary regulatory permitting authority for the dredging of navigable waters throughout the West Coast is the U.S. Army Corps of Engineering, and not the EPA. EPA's authority given under the Clean Water Act is limited to issues regarding "the discharge of such materials into such area will have an unacceptable adverse impact on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas." Although the EPA has an important role in protecting water quality during such projects it is not EPA's role to regulate the means and methods for debris removal by dredging contractors; therefore consistency between EPA	This clarification paper is meant to reflect the position of all the DMMP agencies. It was not meant to assert only EPA's authority relative to the Clean Water Act. The clarification paper has been revised to better represent how the requirement for debris screening is consistent with all of the authorities of the DMMP agencies. As discussed above, both dredged material and solid waste are considered pollutants under the CWA and can only be discharged if permitted by the USACE (404) and Ecology (401). The USACE

		Regions IX and X is not necessarily required or even desirable."	permit allows the discharge of dredged material but not solid waste. Currently, 401 Water Quality Certifications issued by Ecology specifically exclude items greater than 2-feet in ANY dimension. Furthermore, as manager of the public lands on which these disposal sites are located, it is DNR's shared responsibility to reasonably assure only approved dredged material is placed on the disposal site. Point source discharges of pollutants (including solid waste and large debris) at open-water sites is a violation under Federal and State authorities. EPA (as well as the State and the USACE) has authority to enforce restrictions and require means and methods that will prevent disposal of unpermitted material.
7	Port of Seattle Port of Tacoma	**Debris screening is not obligatory in CA** "We understand that some dredging projects in California that use ocean disposal require a debris management plan to prevent unsuitable material from being disposed of, but regulations leave the means and methods of debris management to the permittee. We also understand this is not required for all dredging projects throughout California, and that many projects do not go to open-water disposal. We recommend the need, method, the size of screen be designed on a site specific basis." "That being said, the problem statement "(i)n California, debris screening using a grizzly is a standard operating procedure for all dredging projects unless it can be demonstrated that there is a low likelihood of debris in the sediments to be dredged" is false. Dredging projects in California do require a debris management plan to prevent unsuitable material from being disposed of, but regulations leave the means and methods of debris management to the permittee. Attached is a recent General Permit from the Los Angeles District USAGE that lists their boilerplate special conditions for dredging and disposal operations. Also attached are two regional general permits for maintenance dredging that provide fairly recent examples of how the boilerplate conditions are incorporated into maintenance dredging permits. Use of a grizzly to screen debris is not generally required in California. "	According to Brian Ross (EPA R10): USACE San Francisco District has standard permitting conditions requiring use of 12-inch by 12-inch debris screens for all projects disposing at 404 sites in San Francisco Bay. Some maintenance dredging projects are not required to physically screen material that meets exemption criteria similar to those proposed in the DMMP's clarification paper. Open-water disposal of dredged material covered by the USACE Los Angeles District is primarily at ocean sites designated and managed by EPA. In its Site Management and Monitoring Plans (SMMPS) and concurrence letters, EPA Region 9 routinely includes requirements for physical screening for projects in LA, San Francisco, and Honolulu Districts. Allowance of site-specific screen sizes (as suggested by the Port of Seattle) would complicate projects and may further increase costs, as dredgers would need to have several screen sizes on hand, not just one. Use of a single grid size is appropriate to maintain predictability and consistency within the program.
8	Port of Seattle	**Debris screening will have unacceptable cost and time implications that run counter to the PSDDA approach of balancing environment and economics.** "The Port understands that the goal of PSDDA is to "provide publicly acceptable guidelines governing environmentally safe unconfined, open-water disposal of dredged material, thereby improving consistency and predictability in the decision making process. Public acceptability involves consideration of a wide range of factors. Among these are technically sound evaluation procedures and	We reiterate that the requirement to remove large debris from dredged material prior to open-water disposal has been in effect since the beginning of the PSDDA program and is not being changed by this clarification paper. The lower-cost approach of using visual identification to identify debris hasn't worked. Physical screening will be more effective at keeping large debris (and solid waste) from being disposed at the open-water sites.

	Port of Tacoma	practicability, which includes cost effectiveness. Environmental and economic considerations are both major factors supporting the need for long range regional planning as a lasting, effective solution for dredged material disposal problems." (PSDDA, 1988a) In accordance with these goals, the Port understands that DMMO decisions should reflect a balance of environmental and economic considerations." "The Port believes additional justification for the proposed corrective action is warranted given the economic burden this initiative will impose on dredging proponents, and the lack of evidence clearly linking the presence of large debris at a disposal site resulting from dredging." "The initiative in this clarification paper will impose significant additional and unnecessary costs to dredging proponents, with negligible environmental benefits."	Although debris screening will increase costs and decrease production rates to some extent, it will also help keep the open-water disposal sites available for future use. The availability of these sites depends on continued public acceptance of the stewardship role the DMMP agencies play. The presence of debris at the sites has the potential to jeopardize this trust.
9	Port of Seattle	**The DMMP should provide a complete analysis of the costs of screening** "An evaluation of the cost implications of requiring debris screening has not been included in the Clarification Paper. We understand from talking with contractors that additional costs for debris screening can be at least $30,000 per event, which does not include the additional costs for disposal. In addition, production rate can slow by as much as 20% especially in more cohesive sediments. This impacts not only the total cost of a projects but also results in longer disturbances to aquatic environment during dredging. Extended durations of project could also impact ability to perform some dredging projects, because of a small work windows. While the DMMP anticipates that dredging firms in Washington would have an easy transitions to implementation since they have branches in California, local equipment inventories may not include the appropriate equipment or staff qualified in it use.	While the clarification paper does recognize that there are elements of the screening approach that may increase costs of dredging, the DMMP isn't in a position to quantify ranges of costs which will necessarily reflect project-specifics and may be influenced by economies of scale. The DMMP agencies would be interested in seeing a detailed cost breakdown associated with the $30,000 estimate. Note that mobilization of debris scow and the offloading/disposal of debris are <u>already</u> required under the DMMPs existing debris removal guidelines. Thus, the costs associated with these activities should not be included in any estimates of the costs associated with screening.
	Port of Tacoma	"Puget Sound dredging contractors have informed the Port that a requirement to utilize a 12-inch x 12-inch screen will reduce dredging production by up to approximately 20 percent (thereby increasing project costs by the same proportion), and increase mobilization costs on the order of $30,000. "	The DMMP agencies realize that there will be additional costs associated with this clarification. It is for that reason that we have included the screening exemption criteria whereby project proponents can provide lines of evidence to demonstrate that debris is unlikely to be present. The screening exemption criteria are intended to reduce costs where possible and to focus screening on those projects where the presence of debris has been demonstrated or is likely. The costs of screening should be considered to be included in the cost of doing business and necessary to implement a reasonable pollution prevention measure to exclude inappropriate materials

			from our nation's waters.
10	Port of Tacoma	**Exemption Criteria is too vague and could be easily misinterpreted** The exemption criteria for the use of a 12-inch X12-inch mesh to screen dredged sediments is unnecessarily vague and subject to interpretation, particularly by inexperienced staff. In this context, staff turnover within the DMMP can reasonably be expected to lead to less predictable decision making.	The exemption criteria were intended to focus screening requirements on those projects that are most likely to have debris. They were worded in such a way as to generally describe a line of evidence yet leave room for project-specific interpretation. Based on feedback received at our meeting with the Ports (9/3/15) we have reworded the criteria and clarified that these are examples (but not a complete listing) of why a project could be exempt from screening. The basis for the decision on whether or not to require screening for a specific project will be documented in the DMMP's Suitability Determination. To maintain transparency and increase predictability, all DMMP suitability determinations are posted on the DMMO's website. The DMMP agencies remain committed to providing a predictable, transparent process for the characterization of dredged material.
11	Port of Tacoma	**The DMMP's history of disposal site monitoring has not shown debris to be an issue** "The results of 27 years of monitoring show that dredged material disposal has not caused adverse impacts. In fact, disposal of dredged materials has even improved sediment quality at the Elliott Bay disposal site relative to predisposal sediment quality conditions." "Observations of anthropogenic debris has not previously been raised as a concern by DNR during disposal site management activity updates in prior SMARMs. In fact, 27 years of monitoring show demonstrable compliance with the management objectives of the in-water disposal sites, and that adverse impacts have not occurred as a result of the in-water disposal of dredged materials. "Observable large debris related habitat changes have not been reported by DNR during disposal site management activity updates in prior SMARMs. This appears to be more of a potential concern than an issue warranting changes to the DMMP operating practices - particularly in light of the economic impact this initiative will impose on dredging proponents." "In-water disposal sites have been carefully sited to avoid sensitive habitat areas (such as shellfish growing areas) and most are sited in deep water. Habitat monitoring (e.g. impacts to Rockfish and Rockfish larvae) have been an essential	It is true that the results of 27 years of site monitoring have not documented any adverse biological impacts to the disposal sites; however the site monitoring framework was not designed to evaluate the presence or effects of debris since debris is not permitted for disposal. As stated previously, results of recent surveys at the Elliott Bay and Anderson-Ketron disposal sites demonstrated that unauthorized debris was present at both sites indicating that disposal of unauthorized debris is occurring. These results were the main impetus for this clarification paper. With regard to habitat, the disposal site monitoring plans include assessment of benthic community structure and diversity, but do not include evaluation of habitat for rockfish or impacts to rockfish larvae. The Port of Tacoma is apparently referring to a specific study carried out by the National Marine Fisheries Service, with support from DMMP, evaluating the presence of rockfish larvae in waters overlying some of the open-water disposal sites. There has been no directed surveying of any of the disposal sites for adult rockfish largely because it was presumed that no suitable habitat was present.

		element of disposal site management activities implemented by DNR since 1989." "It is noted that the presence of anthropogenic debris has not been raised as a concern during prior SMARMs. And so this appears to be a potential concern rather than a data driven problem warranting changes to the DMMP operating practices. Simply put, more objective information should be provided in the clarification paper within the context of the mission statement of the DMMP in order to justify this costly initiative."	
12	Port of Tacoma Port of Grays Harbor	**The DMMP should use lower cost alternatives for debris management** "The Port's opposition to the new requirements described in the clarification paper stem from the weakness of the problem statement and the availability of more effective, lower cost alternatives for debris management which received no apparent consideration. " "The last disposal of dredged material at the Elliott Bay disposal site occurred during 2012. It is not at all apparent that the photographed debris represents materials that were dredged, or whether they came to be located at the bottom of the bay as a result of unauthorized dumping. The location of the debris (at the surface rather than mixed or partially covered with sediment) suggests the latter. If this debris was entrained in the material dredged in 2012, this isolated occurrence can be remedied through DNR's existing authority to require the disposer to correct, at their expense, any failure to comply with Section 4.04 of the DNR Site Use Authorization (SUA)." "The DMMP can also require post disposal monitoring of the disposal site to verify the absence of problem debris, and DNR can require corrective action (at the expense of the permittee) if problem debris is placed in the disposal site." "There are current standards that require dredgers to remove large debris and dispose of upland. Those instances and amounts should be reported if not already being done so and could be used as a basis for determining the appropriateness of screening for specific areas. If the quantities of these materials are not currently being recorded the Corps should begin collecting this data."	The DMMP agencies have been using a lower cost approach for debris management for many years – visual identification during dredging. Any debris estimated by the dredger to be greater than 2-feet in any dimension was to be either placed directly on a debris barge, or removed from the disposal barge prior to disposal. Recent observations of debris at the disposal sites provides strong evidence that this procedure for debris management is not working. The permission to use public land for disposal only includes approved dredged material. Prevention, using known and reasonable technology, is preferred over retrieval. It is not in DNR's best interest to spend public dollars to investigate and enforce removal of material after it has been placed in 300+ feet of water. At the Elliott Bay site, we were able to correlate the debris seen during the ROV survey with that appearing in the pre-disposal barge photos thus confirming that dredged material disposal was the source of the large debris. However, because this debris is located in approximately 350-ft of water, it would be extremely difficult, if not impossible, to retrieve. Post-facto identification and retrieval as a management tool is a highly impractical (and expensive) approach because of the difficulty of associating a particular debris item at the disposal site to a particular disposal event, particularly in light of the fact that dredgers don't typically photograph debris in barges prior to disposal. The potential (raised in the Port of Tacoma's comment) for debris at the sites resulting from unauthorized dumping, further complicates the possibility of correlating a particular item of debris with a particular disposal event.

			DMMP/DNR rarely received reports from the dredgers that they are encountered debris, i.e., dredgers are likely not reporting or underreporting the debris that they come across over the past 25+ years. The consideration of this, coupled with recent observations of debris at two disposal sites, has led to the DMMP's current clarification to increase the frequency of physical screening. Recording and provision of information on debris will necessarily increase as a result of this change in the program. Projects seeking an exemption from the screening requirement could provide "evidence from previous rounds of dredging demonstrating that no debris was encountered using a screen".
13	Port of Tacoma	**Size limitation on debris should focus on 2'x2' size since this more likely to improve habitat** "This definitional matter can be better remedied by defining anthropogenic debris in the User Manual rather than adopting a general requirement for dredging proponents to utilize a 12-inch x12-inch mesh grid to screen debris from dredged sediments. The definition should be based on the type of debris likely to improve habitat criteria, which should be expected to be larger than anthropogenic debris with a nominal 12-inch diameter."	We agree that 2'x2' sized debris at our deep water disposal sites is more likely to serve as habitat for benthic fish, rockfish and crab. However, the Elliott Bay photos and our experience trawling at the Anderson-Ketron site illustrate that both smaller-sized wood/rock and anthropogenic debris are also present at the sites and are serving as habitat. The rationale for decreasing the allowable debris dimensions to 1'x1' is to provide for more effective removal of <u>both</u> anthropogenic debris (tires, garbage, rebar, etc) and large-sized woody/rock debris. The current standard is that material 2-foot in ANY dimension is not allowed; a 1'x1' screen would be considered an "all known and reasonable technology" (AKART) for removal of anthropogenic debris that is not permitted at the disposal sites.
14	Port of Seattle Port of Grays Harbor	**Recommend allowing for more options for exemption, including allowing for exemption for frequently maintained berthing areas, consideration of facility uses on potential presence of debris, bathymetric evidence, or likelihood of debris being present** "…mandatory debris screening should not become a standard requirement but be required on a case by case basis where conditions indicate it would be beneficial to do so. Examples of such conditions would be areas that haven't been dredged for a significant period of time, those that have a high likelihood of having debris such as marinas, and areas that have a history of having debris. It would seem that requiring screening in an area such as our terminal maintenance dredging which is done annually and which hasn't had a history of any significant quantity or instances of hazardous debris such as tires or drums, would increase costs and slow production rates without any appreciable	We agree that the clarification text could be clearer and we have revised it as follows: DMMP agencies acknowledge that there may be projects other than the types discussed above where debris may not be present. Project-specific information such as that generated by sub-bottom profiling or historical dredging records will also be considered in making a decision regarding debris screening.

		benefit.“	
15	Port of Seattle	**Recommend allowing for other options besides debris screening, where needed.** “Options could include visuals surveys during dredging with more specific corrective actions if observed, allowing for changes in size and type of screen based on site specific needs, or allowing for different screening requirement for different disposal sites.”	The DMMP agencies agree that there may be other methods aside from screening that could be successfully implemented to improve the identification and removal of debris. Furthermore, for projects where debris are concentrated at specific location(s), the requirement to screen could likewise be limited to that portion of the project. The decision on use of alternative techniques for debris removal would be made by the DMMP based on the dredging site specifics and information provided by the applicant. It’s important to remember that the decision whether or not to screen for debris is based on the dredge site conditions and not on the disposal site being proposed for use. DMMP’s debris guidelines apply across the entire program.

4. Tributyltin (TBT) Measurement Basis

- Port of Tacoma – letter dated June 5, 2015
- WindWard Environmental – memo dated June 5, 2015

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June 5, 2015

DMMO
Seattle District – Corps of Engineers
PO Box 3755
Seattle, WA 98124

RE: Comment – DMMP Clarification Paper
Tributyltin (TBT) Measurement Basis

Dear DMMO:

The Port of Tacoma (Port) supports the stated mission of the DMMO to provide a dependable, scientifically based, transparent inter-agency process for the evaluation of dredged material. Regrettably, the Tributyltin (TBT) Measurement Basis Clarification Paper unveiled during the 27th annual Sediment Management Annual Review Meeting (SMARM) on May 6, 2015 falls short of that goal. The Port is concerned by the lack of scientific explanation and technical justification for DMMP's apparent tilt toward Bulk TBT analysis. This concern is heightened by what this clarification paper portends – essentially eviscerating the tiered assessment approach for TBT in marine sediments utilized by the DMMP since 1996. The Port urges the DMMP to withdraw the Clarification Paper and maintain the status quo for tiered testing of marine sediments for TBT as currently described in the DMMP User Manual. The Port also seeks confirmation that bioaccumulation testing will not be required when the TBT porewater data does not exceed the screening criteria of 0.15 ug/L.

The reason why the DMMP agencies previously concluded that TBT porewater data is the most relevant method of analysis is because TBT partitioning is highly complex, and the relationship between concentrations and observed effects data is much stronger for interstitial water and tissue concentrations than is the case for bulk samples.

TBT partitioning variability, uncertainty over appropriate effects levels, testing strategies and interpretive criteria led the DMMP to adopt a tiered assessment approach. The suitability criteria were judged to be appropriate by the DMMP for in-water disposal of dredged materials onto disposal sites carefully sited to avoid sensitive habitats (such as shellfish growing area) and sited in deep water. The results of 27 years of careful monitoring at these disposal sites show that dredged material disposal has not caused adverse impacts.

The Port recommends maintaining the current approach as outlined in the DMMP Usser Manual. The remainder of this letter discusses the four bullets presented in the DMMP Clarification Paper section entitled "Problem Identification."

Problem Statement #1: Collection of Sufficient Volume of Porewater from Environmental Samples is Commonly a Challenge.

The Port acknowledges this. However, the remedy to this potential difficulty is already as included in the DMMP User Manual: simply collect and test bulk samples for TBT. This potential difficulty is typically addressed by a dredging proponent in the Sampling and Analysis Plan, which is submitted to the DMMP for review and approval. There is no technical basis in this problem statement to discourage the collection of pore water TBT data in favor of bulk TBT data when porewater is available.

Problem Statement #3: Consistent Porewater/Tissue Relationships Have Not Been Observed in Some Studies

The Clarification Paper asserts that no relationship was observed between TBT concentrations in porewater and tissue for two projects located adjacent to Harbor Island. None of the referenced studies appear in a published, peer-reviewed scientific journal. Variability between porewater and tissue concentrations was also cited as a basis for favoring bulk TBT data over porewater TBT data. No technical analysis of the cited studies is presented to support the conclusion in this problem statement. Salient findings from the referenced reports should be described in the problem statement. The problem statement should also address the relationship between TBT concentrations in tissue and bulk sample measurements, and then compared to the correlation between porewater and TBT concentrations in tissue. The form of TBT in these studies should be described.

It is noted that the toxicity and bioaccumulation of TBT are affected by a variety of factors, including organic carbon in sediment and water, pH, salinity, clay fraction, presence of iron oxides, and the form of TBT released into the environment. The most toxic and bioavailable form of TBT leaches directly from vessel hull paints; paint wastes from sandblasting may represent a long-term source of a less bioavailable form. Different species have widely varying uptake, metabolic, and elimination rates for TBT, in part explaining the widely varying sediment and water concentrations that yield similar tissue concentrations and associated effects (Michelsen, 1996). In light of the aforementioned, the lack of consistent porewater/tissue relationship in the project information cited by the authors is unsurprising. If there is a better relationship between tissue concentrations and bulk sediment testing results as advocated in this Clarification Paper, then the analysis should be presented to support a transparent discussion of the scientific basis for this initiative.

Several agencies have assessed TBT partitioning with varying outcomes. In 2002, the National Marine Fisheries Service (NMFS) published a study conducted to determine TBT's partitioning behavior in sediment using bench-scaled tests with spiked sediments. It was noted that "...additional testing with field-contaminated sediment is needed to

confirm the mean Koc value as representative for most marine sediments" (Meador 2000). The collection of paired porewater and bulk TBT samples should be encouraged to improve the understanding of partitioning behavior as advocated by NMFS. The collection of porewater should not be discouraged by the DMMP.

The Port recognizes that numerous field studies have been conducted in an attempt to correlate TBT concentrations in tissue with bulk sediments and/or porewater. Findings vary between the individual study programs. Tests conducted in the east waterway in Seattle (Port of Seattle 2014) found a weak correlation (R-squared of about 0.3) between bulk sediment and TBT concentrations in invertebrate tissue. Tissue TBT concentrations reported in the West Waterway had highly variable correlation with bulk sediment TBT concentrations depending on the species studied and treatment of outliers. **This suggests that, while TBT concentrations in tissue and porewater are both valid means of assessing the bioavailability of TBT, porewater is likely to be the more accurate method for making this determination in field-contaminated sediments due to complexity and variability of tissue testing.**

A review of various laboratory and field studies that compared TBT concentrations in sediments and invertebrates was published by NMFS in 2002 (Meador et al. 2002) to determine the threshold TBT concentrations in sediment for protection of endangered salmonids. The study concluded that TBT concentrations in tissue and porewater were both valid methods for evaluating TBT toxicity.

Based on the foregoing, the Port recommends maintaining the current testing approach for porewater TBT testing as outlined in the DMMP User Manual.

<u>Problem Statement #4 Inconsistency of Porewater/Tissue Relationships May Be A Consequence of Analytical Variability</u>

The Port believes references supporting this concern should be provided. While analytical methods for TBT received considerable attention during the 1999 SMARM, developments supporting the concern in this problem statement should be provided in the Clarification Paper.

It is abundantly clear in available peer-reviewed literature that TBT concentrations in sediment show wild variances in toxic responses and tissue concentrations. In some cases, despite extremely elevated concentrations of TBT in sediments, no acute toxicity was exhibited by the standard suite of bioassay organisms (EPA, 1996; Michelsen, 1996). **This is illustrative of the complexity of TBT partitioning in the environment and uncertainty over appropriate effects levels, testing strategies and interpretive data. In this context, analytical variability is at most a minor confounding factor.**

Problem Statement #5 Alignment between Freshwater and Marine Testing Requirements for TBT

The DMMP User Manual does not permit porewater TBT measurements at freshwater projects because TBT in freshwater may be more susceptible to state and oxidation changes than in marine sediments. This, in turn, could result in misinterpretation of the toxicity and bioaccumulation potential of TBT associated with a freshwater porewater sample. This technical concern is not associated with marine sediments, and provides no support for changing the tiered testing approach for marine sediments in the DMMP User Manual.

Conclusion

The Port recommends maintaining the existing tiered testing framework for TBT as outlined in the 2014 Users Manual so that there is clarity, transparency and predictability in the process applied to determining the suitability of in-water disposal for marine dredging projects. In certain circumstances, porewater screening may be the most appropriate approach. In other situations, a dredging proponent may request approval from the DMMP to use bulk criteria as a screening approach.

The Port recommends that the DMMP vacate and withdraw the Clarification Paper. If the DMMP does not vacate the Clarification Paper, it should be explicitly stated that in no way do bulk TBT results trump porewater TBT results. Put another way, it should be clearly stated in the Clarification Paper that, if a bulk TBT result exceeded the 73 ug/kg screening level, and the result of a paired porewater sample did not exceed the 0.15 ug/L screening level, such material is compliant with DMMP criteria for in-water marine disposal and does not in and of itself, prejudice the suitability determination process for in-water disposal or beneficial use in any way. In closing, the Port maintains that TBT porewater data is an important and relevant line of evidence that should remain available for use at the discretion of a dredging proponent.

Please contact me at (253) 383-9428 if there are questions or concerns.

Sincerely,

Scott Hooton
Environmental Project Manager

REFERENCES

Meador, J.P. 2000. "Predicting the fate and effects of tributyltin in marine systems." *Review of Environmental Contamination and Toxicology.* 166:1-48.

Meador. J.P, T.K. Collier, and J.E. Stein.2002. "Determination of a tissue and sediment threshold for tributyltin to protect prey species of juvenile salmonids listed under the US Endangered Species Act." *Aquatic Conservation: Marine and Freshwater Ecosystems*, v. 12, p. 539-551.

Michelsen, T., T.C. Shaw, and S. Stirling, 1996. Testing, reporting and evaluation of tributyltin data in PSDDA and SMS programs. Final PSDAA Issue Paper/SMS Technical Information Memorandum, October 1996.

Port of Seattle. 2014. *Supplemental Remedial Investigation Report, East Waterway Operable Unit.* Submitted to USEPA Region 10. Prepared by Windward Environmental and Anchor QEA. January.

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MEMORANDUM

To: DMMO, Army Corps of Engineers, Seattle Office

From: Susie McGroddy and Kathy Godtfredsen

Subject: Comments on TBT clarification paper presented at 2015 SMARM

Date: June 5, 2015

Thank you for the opportunity to provide comment on the clarification paper presented for tributyl tin (TBT) at the 2015 Sediment Management Annual Review Meeting (SMARM). We agree that TBT is a difficult chemical to assess and appreciate the time the Dredged Material Management Program (DMMP) has invested in this topic since 1996. We have two main comments and a recommended path forward, as summarized below.

The focus of this debate should remain on the site-specific bioavailability of TBT as well as the ability to accurately assess it.

The DMMP Users Manual currently identifies porewater TBT measurement as the preferred option in the evaluation of TBT. Bulk sediment analysis is an option in instances where it is not feasible to obtain porewater samples. This flexibility should be maintained. In the 2015 clarification paper, the proposal is to require only bulk TBT for sediment proposed for open-water disposal, but to allow porewater analysis to be conducted at the request of the applicant. We believe the current tiering should be maintained.

However, in the instances when both bulk and porewater data are available, we recommend that the porewater analysis trump the bulk analysis because (assuming the analysis was done correctly) porewater will provide a more site-specific indication of bioavailability of TBT than bulk sediment. A porewater comparison also provides the advantage of comparing a concentration in water to a water quality criterion-based trigger.

The existing bioaccumulation trigger of 73 µg/kg does not have a sound technical basis, and if a bulk sediment trigger is required, then this value needs additional scrutiny.

The value of 73 µg/kg was proposed as an interim screening level (SL) in 1989 based on three steps summarized below:

- **Step 1 – Review of data available for Puget Sound –** TBT was found in four non-urban bays to range from 0-37 µg/kg dry weight as tin (0-90.3 µg/kg as TBT) and concentrations in urban bays and PSDDA baseline studies of disposal sites ranged from 1-400 µg/kg dry weight as tin (2.44-976 µg/kg as TBT).
- **Step 2 Professional judgment –**

  "Professional judgment calls for initiating biological testing generally occur between 30 µg/kg and 100 µg/kg (Sandy Lemlich, San Francisco District, Corps, personal communication)." (From EPA 1996, Appendix D)

  Note: 30 -100 µg/kg as tin is equivalent to 73 - 244 µg/kg as TBT.
- **Step 3 Equilibrium partitioning** - An equilibrium partitioning evaluation indicated that bulk sediment concentrations of TBT less than 40 µg/kg (TBT as Sn) (equivalent to 98 µg/kg as TBT) are required to meet a dissolved concentration of 0.531 µg/L, which was the acute EPA water quality advisory value.

After conducting these steps, DMMP selected an SL and a bioaccumulation trigger (BT) of 73 µg/kg as TBT. This value is primarily based on the professional judgment of one individual in 1989. The analysis that was provided to support the interim SL in 1989 is provided as an attachment to our comments.

In 1996, the porewater TBT SL and bioaccumulation trigger was established as 0.15 µg/L. This trigger was based on the interim sediment SL from 1989 (73 µg/kg as TBT) and a Koc value of 25,000 from Meador et al. (1997), and an assumed TOC of 2% (Michelsen et al. 1996). The porewater value was assessed relative to water toxicity data associated with acute and chronic adverse effects levels, and found to be appropriate (EPA, 1996).

There are a few key issues associated with this calculation. First, there is considerable uncertainty associated with the application of equilibrium partitioning coefficients to an ionizable organometallic compound, such as TBT. The partitioning of TBT may be controlled by both organic sorption and anionic surface complexation (Meador et al. 1997) rather than simple equilibrium partitioning mechanisms.

Second, studies of TBT partitioning have observed high levels of variability and higher than predicted Koc values (Meador et al. 1997). The Koc values calculated by Meador et al. (1997) ranged from 23,400 to 104,700 for sediments ranging from 0.12% to 0.87% TOC (mean TOC of 0.48%). Higher Koc values reflect a stronger affinity for particulates and

potentially reduced bioavailability. Using 25,000 likely underestimates sorption to sediment particles, thus overestimating bioavailability.

Third, the source of TBT has an important influence on its bioavailability, making site-specific assessments relevant. For example, paint particles in areas where sandblasting has occurred can contain TBT. The presence of this unique matrix can result in elevated bulk sediment concentrations with low bioavailability. However, the unique binding characteristics of the paint matrix can result in porewater and tissue TBT concentrations that are much lower than would be predicted by the bulk sediment concentrations (EPA 1996). Thus, bioavailability can be very site-specific, and any bulk sediment trigger and application process would need to be evaluated with the above considerations in mind. In other words, extrapolating from water-based toxicity data to bulk sediment concentrations is fraught with uncertainty.

As a path forward, we recommend:

- If a site has both bulk sediment and porewater data, the porewater data should trump the sediment data.
- A more formalized process is needed to develop a bulk sediment TBT trigger. This trigger should be site specific, whether it is based on porewater data, site-specific TOC, or based on a site-specific partitioning study, with the results used to calculate a bulk trigger.

We would be happy to engage in this process. Please let us know if you have any questions.

References

EPA 1996. Recommendations for screening values for tributyltin in sediments at Superfund sites in Puget Sound WA. Prepared for EPA Region 10, Superfund by Roy F. Weston

Meador JP, C.A. Krone, D.W. Dyer, U. Varanase. 1997. Toxicity of sediment-associated tributyltin to infaunal invertebrates: species comparison and the role of organic carbon. *Marine Environmental Research* **43**:219-241.

Michelsen T, T.C. Shaw, S. Stirling. 1996. SMS Technical information memorandum: testing, reporting and evaluation of tributyltin data in PSDAA and SMS Programs. PSDDA Issue Paper October 1996.

Attachment 1

Attachment on file in the DMMO office.

TBT Measurement Basis Comment and Responses Table

Subject: Comments received in response to 2015 SMARM clarification paper on TBT Measurement Basis
Date: September 30, 2015

Comments were received from the following entities in response to the 2015 SMARM meeting:

1. Port of Tacoma – TBT clarification paper response (Letter dated June 5, 2015)
2. WindWard Environmental – TBT clarification paper response (Memo dated June 5, 2015)

Comments were parsed from their respective letters and are categorized by topic in the table below.

TBT Clarification Paper Comments (Port of Tacoma and WindWard Environmental)

Comment #	Commenter	Comment	DMMP Response
1	Port of Tacoma	The Port is concerned by the lack of scientific explanation and technical justification for DMMP's apparent tilt toward Bulk TBT analysis. This concern is heightened by what this clarification paper portends - essentially eviscerating the tiered assessment approach for TBT in marine sediments utilized by the DMMP since 1996. The Port urges the DMMP to withdraw the Clarification Paper and maintain the status quo for tiered testing of marine sediments for TBT as currently described in the DMMP User Manual.	The impetus for the DMMP's proposal to default to bulk TBT analysis was based on practical considerations and not a scientific analysis of bioavailability. We have observed that many projects struggle with the logistics associated with porewater analysis. At the same time, our project-related data set of synoptically measured porewater and tissue TBT shows little to no relationship between the two (see Appendix A). It was in consideration of these issues that the DMMP proposed use of bulk TBT measurements as the default method for TBT analysis. We would like to clarify that the option of using porewater TBT remains, and if a project proponent would like to use porewater TBT instead of bulk, they are welcome to do so. The shift to bulk TBT measurement as the default method in no way changes the tiered testing approach as described in the User Manual. Sediment that exceeds the existing BT levels for TBT, either 73 ug/kg bulk or 0.15 ug/l porewater, will require bioaccumulation testing before sediments can be taken to open-water disposal.
2	Port of Tacoma	The Port also seeks confirmation that bioaccumulation testing will not be required when the TBT porewater data does not exceed the screening criteria of 0.15 ug/L	In cases where both porewater and bulk TBT data exists for a DMMU/z-sample, the porewater data will be considered the best approximation of bioavailability and therefore, the porewater results will determine whether there is a need for bioaccumulation testing.

3	Port of Tacoma	Problem Statement #1: Collection of Sufficient Volume of Porewater from Environmental Samples is Commonly a Challenge. The Port acknowledges this. However, the remedy to this potential difficulty is already as included in the DMMP User Manual: simply collect and test bulk samples for TBT. This potential difficulty is typically addressed by a dredging proponent in the Sampling and Analysis Plan, which is submitted to the DMMP for review and approval. There is no technical basis in this problem statement to discourage the collection of pore water TBT data in favor of bulk TBT data when porewater is available.	The inability to collect porewater from either the prism sediments or z-samples is not always anticipated by dredging proponents, and remobilization to collect bulk samples or analysis of archived sediment may not be a timely or available option for some dredging projects. By making bulk analysis the default, the DMMP seeks to simplify and streamline the assessment of dredged material for open-water disposal. We are not trying to discourage the collection of porewater TBT data (particularly for those projects with the experience and resources to run porewater).
4	Port of Tacoma	Problem Statement #3: Consistent Porewater/Tissue Relationships Have Not Been Observed in Some Studies. The Clarification Paper asserts that no relationship was observed between TBT concentrations in porewater and tissue for two projects located adjacent to Harbor Island. None of the referenced studies appear in a published, peer-reviewed scientific journal. Variability between porewater and tissue concentrations was also cited as a basis for favoring bulk TBT data over porewater TBT data. No technical analysis of the cited studies is presented to support the conclusion in this problem statement. Salient findings from the referenced reports should be described in the problem statement. The problem statement should also address the relationship between TBT concentrations in tissue and bulk sample measurements, and then compared to the correlation between porewater and TBT concentrations in tissue. The form of TBT in these studies should be described. It is noted that the toxicity and bioaccumulation of TBT are affected by a variety of factors, including organic carbon in sediment and water, pH, salinity, clay fraction, presence of iron oxides, and the form of TBT released into the environment. The most toxic and bioavailable form of TBT leaches directly from vessel hull paints; paint wastes from sandblasting may represent a long-term source of a less bioavailable form. Different species have widely varying uptake, metabolic, and elimination rates for TBT, in part explaining the widely varying sediment and water concentrations that yield similar tissue concentrations and associated effects (Michelsen, 1996). In light of the aforementioned, the lack of consistent porewater/tissue relationship in the project information cited by the authors is unsurprising. If there is a better relationship between tissue concentrations and bulk sediment testing results as advocated in this Clarification Paper, then the analysis should be presented to support a	The DMMP agencies compiled all the paired porewater and tissue TBT data available from past dredging and cleanup projects in Washington State. A summary of the data compiled, which was presented at SMARM, is included here in Appendix A. The DMMP's proposal to default to bulk for TBT analysis is not based on a re-evaluation of bioavailability. In fact, we agree that porewater is likely the most toxicologically relevant medium of exposure for this chemical. However, we are not confident that current standard practices for porewater extraction and measurement are providing an accurate or consistent measure of TBT. This concern appears to be underscored by the lack of correlation seen in the existing (albeit small) bioaccumulation data set between porewater and tissue TBT concentrations in the standard test species *Macoma* and *Nephtys*. Thus, the DMMP's current position is that there is insufficient paired bulk or porewater and tissue TBT data to determine which of the two is the best measure of bioavailable TBT for standard bioaccumulation test species.

		transparent discussion of the scientific basis for this initiative. Several agencies have assessed TBT partitioning with varying outcomes. In 2002, the National Marine Fisheries Service (NMFS) published a study conducted to determine TBT's partitioning behavior in sediment using bench-scaled tests with spiked sediments. It was noted that " ... additional testing with field-contaminated sediment is needed to confirm the mean Koc value as representative for most marine sediments" (Meador 2000). The collection of paired porewater and bulk TBT samples should be encouraged to improve the understanding of partitioning behavior as advocated by NMFS. The collection of porewater should not be discouraged by the DMMP. The Port recognizes that numerous field studies have been conducted in an attempt to correlate TBT concentrations in tissue with bulk sediments and/or porewater. Findings vary between the individual study programs. Tests conducted in the east waterway in Seattle (Port of Seattle 2014) found a weak correlation (R-squared of about 0.3) between bulk sediment and TBT concentrations in invertebrate tissue. Tissue TBT concentrations reported in the West Waterway had highly variable correlation with bulk sediment TBT concentrations depending on the species studied and treatment of outliers. **This suggests that, while TBT concentrations in tissue and porewater are both valid means of assessing the bioavailability of TBT, porewater is likely to be the more accurate method for making this determination in field-contaminated sediments due to complexity and variability of tissue testing.** A review of various laboratory and field studies that compared TBT concentrations in sediments and invertebrates was published by NMFS in 2002 (Meador et al. 2002) to determine the threshold TBT concentrations in sediment for protection of endangered salmonids. The study concluded that TBT concentrations in tissue and porewater were both valid methods for evaluating TBT toxicity. Based on the foregoing, the Port recommends maintaining the current testing approach for porewater TBT testing as outlined in the DMMP User Manual.	Collection of porewater TBT data remains an option for any dredging proponent that wishes to do so. The DMMP has reviewed the comments on this clarification paper and decided to proceed with adopting use of bulk as the default measure of TBT in sediments. We have edited the clarification paper to emphasize that all projects retain the option to measure TBT in porewater and that porewater data will trump bulk TBT measurements for determination of dredged material suitability.
5	Port of Tacoma	Problem Statement #4 Inconsistency of Porewater/Tissue Relationships May Be A Consequence of Analytical Variability. The Port believes references supporting this concern should be provided.	The available data from dredging and clean-up related bioaccumulation testing that the DMMP considered in making our recommendation to change the default to bulk analysis is presented in Appendix A, which can be

		While analytical methods for TBT received considerable attention during the 1999 SMARM, developments supporting the concern in this problem statement should be provided in the Clarification Paper. It is abundantly clear in available peer-reviewed literature that TBT concentrations in sediment show wild variances in toxic responses and tissue concentrations. In some cases, despite extremely elevated concentrations of TBT in sediments, no acute toxicity was exhibited by the standard suite of bioassay organisms (EPA, 1996; Michelsen, 1996). **This is illustrative of the complexity of TBT partitioning in the environment and uncertainty over appropriate effects levels, testing strategies and interpretive data. In this context, analytical variability is at most a minor confounding factor.**	found at the end of this response to comment table.. The DMMP acknowledges that TBT partitioning and variability is complex, and that analysis of TBT is challenging. With the data sets currently available there is no definitive way to differentiate between analytical variability and spatial variability due to the complexity of TBT partitioning in the environment.
6	Port of Tacoma	Problem Statement #5. Requirements for TBT Alignment between Freshwater and Marine Testing. The DMMP User Manual does not permit porewater TBT measurements at freshwater projects because TBT in freshwater may be more susceptible to state and oxidation changes than in marine sediments. This, in turn, could result in misinterpretation of the toxicity and bioaccumulation potential of TBT associated with a freshwater porewater sample. This technical concern is not associated with marine sediments, and provides no support for changing the tiered testing approach for marine sediments in the DMMP User Manual.	The DMMP adopted the freshwater sediment criteria established by Ecology in 2013, including the bulk sediment criteria for butyltins which were developed with a multiple regression approach. In the freshwater data set, the correlation of toxicity with bulk TBT was better than that with porewater. Potential explanations for this are that there was more bulk data available and over a wider concentration range, or there may be other physical/chemical/toxicological reasons. Under current DMMP guidelines, projects located in freshwater areas such as Lake Washington that are proposing disposal at DMMP disposal sites in marine waters would be required to analyze porewater TBT in the dredge prism for comparison to marine values and bulk TBT in the leave surface for comparison to freshwater values. Without bulk butlytin data in the dredge prism to compare to the leave surface, it is difficult to assess antidegradation. Currently, projects in these cases are required to analyze both porewater and bulk butyltins in the dredged material. **The intent of the clarification paper was to simplify the testing required and reduce testing costs by allowing bulk TBT analysis only in the dredged material.**
7	Port of Tacoma	Conclusion. The Port recommends maintaining the existing tiered testing framework for TBT as outlined in the 2014 Users Manual so that there is clarity, transparency and predictability in the process applied to determining the suitability of in-water disposal for marine dredging	The DMMP has reviewed the comments on this clarification paper and decided to proceed with adopting use of bulk as the default measure of TBT in sediments. The clarification paper has been edited to

		projects. In certain circumstances, porewater screening may be the most appropriate approach. In other situations, a dredging proponent may request approval from the DMMP to use bulk criteria as a screening approach. The Port recommends that the DMMP vacate and withdraw the Clarification Paper. If the DMMP does not vacate the Clarification Paper, it should be explicitly stated that in no way do bulk TBT results trump porewater TBT results. Put another way, it should be clearly stated in the Clarification Paper that, if a bulk TBT result exceeded the 73 ug/kg screening level, and the result of a paired porewater sample did not exceed the 0.15 ug/L screening level, such material is compliant with DMMP criteria for in-water marine disposal and does not in and of itself, prejudice the suitability determination process for in-water disposal or beneficial use in any way. In closing, the Port maintains that TBT porewater data is an important and relevant line of evidence that should remain available for use at the discretion of a dredging proponent.	clarify that (a) the tiered testing framework is still in place and that analysis of porewater TBT is still available as an option for assessment of the suitability of dredged material and (b) in cases where both bulk and porewater TBT have been measured, the porewater results will be used to determine suitability of the dredged material.
8	Windward Environmental	**The focus of this debate should remain on the site-specific bioavailability of TBT as well as the ability to accurately assess it.** The DMMP Users Manual currently identifies porewater TBT measurement as the preferred option in the evaluation of TBT. Bulk sediment analysis is an option in instances where it is not feasible to obtain porewater samples. This flexibility should be maintained. In the 2015 clarification paper, the proposal is to require only bulk TBT for sediment proposed for open-water disposal, but to allow porewater analysis to be conducted at the request of the applicant. We believe the current tiering should be maintained. However, in the instances when both bulk and porewater data are available, we recommend that the porewater analysis trump the bulk analysis because (assuming the analysis was done correctly) porewater will provide a more site-specific indication of bioavailability of TBT than bulk sediment. A porewater comparison also provides the advantage of comparing a concentration in water to a water quality criterion-based trigger.	We intend for the tiered testing flexibility to be maintained under the proposed clarification. The clarification paper has been edited to clarify that both bulk and porewater TBT analyses are options for assessing the suitability of dredged material, but bulk TBT analysis will be used as the default analysis method. When both porewater and bulk TBT data is collected, the porewater results will be used to determine suitability of the dredged material.
9	Windward Environmental	**The existing bioaccumulation trigger of 73 µg/kg does not have a sound technical basis, and if a bulk sediment trigger is required, then this value needs additional scrutiny.** The value of 73 µg/kg was proposed as an interim screening level (SL) in 1989 based on three steps summarized below:	The DMMP agrees that further evaluation of the bioaccumulation triggers used for both bulk and porewater TBT is needed.

		Step 1 – Review of data available for Puget Sound – TBT was found in four non-urban bays to range from 0-37 µg/kg dry weight as tin (0-90.3 µg/kg as TBT) and concentrations in urban bays and PSDDA baseline studies of disposal sites ranged from 1-400 µg/kg dry weight as tin (2.44-976 µg/kg as TBT). **Step 2 Professional judgment** – "Professional judgment calls for initiating biological testing generally occur between 30 µg/kg and 100 µg/kg (Sandy Lemlich, San Francisco District, Corps, personal communication)." (From EPA 1996, Appendix D) Note: 30 - 100 µg/kg as tin is equivalent to 73 - 244 µg/kg as TBT. **Step 3 Equilibrium partitioning** - An equilibrium partitioning evaluation indicated that bulk sediment concentrations of TBT less than 40 µg/kg (TBT as Sn) (equivalent to 98 µg/kg as TBT) are required to meet a dissolved concentration of 0.531 µg/L, which was the acute EPA water quality advisory value. There are a few key issues associated with this calculation. First, there is considerable uncertainty associated with the application of equilibrium partitioning coefficients to an ionizable organometallic compound, such as TBT. The partitioning of TBT may be controlled by both organic sorption and anionic surface complexation (Meador et al. 1997) rather than simple equilibrium partitioning mechanisms. Second, studies of TBT partitioning have observed high levels of variability and higher than predicted Koc values (Meador et al. 1997). The Koc values calculated by Meador et al. (1997) ranged from 23,400 to 104,700 for sediments ranging from 0.12% to 0.87% TOC (mean TOC of 0.48%). Higher Koc values reflect a stronger affinity for particulates and potentially reduced bioavailability. Using 25,000 likely underestimates sorption to sediment particles, thus overestimating bioavailability. Third, the source of TBT has an important influence on its bioavailability, making site specific assessments relevant. For example, paint particles in areas where sandblasting has occurred can contain TBT. The presence of this unique matrix can result in elevated bulk sediment concentrations with low bioavailability. However, the unique binding characteristics of the paint matrix can result in porewater and tissue TBT concentrations that are much lower than would be predicted by the bulk sediment concentrations (EPA 1996). Thus, bioavailability can be very site-specific, and any bulk sediment	Understood, but using a compromise K_{oc} value may still be defensible for the purposes of developing a screening value to determine the need for bioaccumulation. It will be important to involve topic experts such as Jim Meador in deliberations on how to revise the TBT bioaccumulation triggers. According to Jim Meador (personal communication, September 14, 2015) the occurrence of TBT associated with paint chips is very specific to dry-docks and areas of intensive boat maintenance. These locations comprise a minority of areas associated with dredging projects. Furthermore, positive identification of the presence of paint chips requires microscopic confirmation which is rarely performed. So while the oft-used paint chip explanation for variability in bulk/porewater TBT relationships is convenient, it may not be applicable to the majority of dredging projects considered by the DMMP

		trigger and application process would need to be evaluated with the above considerations in mind. In other words, extrapolating from water-based toxicity data to bulk sediment concentrations is fraught with uncertainty.	
10	Windward Environmental	As a path forward, we recommend: • If a site has both bulk sediment and porewater data, the porewater data should trump the sediment data. • A more formalized process is needed to develop a bulk sediment TBT trigger. This trigger should be site specific, whether it is based on porewater data, sitespecific TOC, or based on a site-specific partitioning study, with the results used to calculate a bulk trigger.	We agree that a formalized process is needed, and that this must involve the scientific community as well as resources agencies, tribes, and other stakeholders. The ability to fund and prioritize this effort must be determined by the DMMP agencies in light of current agency staffing and workload issues.

Appendix A: Paired Porewater and Tissue Tributyltin Data from Puget Sound

Data Evaluation

We compiled the existing porewater, bulk and tissue TBT data from dredging and cleanup projects in Puget Sound. Seven regional studies have evaluated TBT in porewater and tissues from standard laboratory bioaccumulation tests of bedded sediments. Two of these studies also analyzed bulk TBT in the test sediments. Table 1 lists the studies, references and TBT analyses made for each of the seven studies. An excel table of all data used in Figures 1 and 2 is available upon request to the DMMO.

There were several irregularities in the compiled data. Tissue TBT results from Port of Seattle T-18 Phase 1 were reported by the lab as wet weight measurements, but are assumed to be dry weight values due to their magnitude. These data points, for both *Macoma* and *Nephtys*, are plotted as dry weight in figures 1 and 2 at the values that were reported by the laboratory. Tissue TBT data for the Port of Anacortes, Cap Sante project were also reported on a wet weight basis. No percent solids data was available for these samples, so an average percent solids value of 15% (average of reported % solids for *Macoma* from all projects) was assumed to convert *Macoma* results to dry weight tissue concentrations. An average percent solids value of 18% (average of reported *Nephtys* % solids from East Waterway Phase 2 and Hylebos Waterway) was assumed to convert *Nephtys* results to dry weight tissue concentrations for Port of Anacortes, Cap Sante and Port of Seattle T-18 Stage 1A.

Comparisons between porewater and tissue TBT (Figure 1a) and bulk and tissue TBT (Figure 1b) were made for both *Macoma* and *Nephtys*. A weak correlation between porewater and tissue TBT was observed. Unexpectedly, a slightly stronger correlation between bulk and tissue TBT data was observed. However, both correlations are influenced by the single data points with anomalously high porewater and bulk TBT values. Note these are not the same sample; the high porewater value is from East Waterway Phase 2 and the high bulk value is from West Waterway Superfund.

Figure 2 shows all the same data plotted by project. The data shows that no consistent relationships between porewater and tissue TBT data have been observed within or between studies. The two largest studies (East Waterway Phase 2 and West Waterway Superfund) observed little to no relationship between porewater and tissue concentrations. Likewise, porewater/tissue correlations between studies are inconsistent, with a given porewater TBT concentration being associated with significant bioaccumulation at one location and negligible bioaccumulation at another.

Consistent porewater/tissue relationships for TBT have not been observed within or between studies from various urban embayments in Puget Sound.

Table 1. Summary info for TBT bioaccumulation studies in Puget Sound.

Study Name	**Reference**	**TBT data collected**
West Waterway Superfund	EVS Solutions, 1999	Porewater, bulk and tissue
Port of Seattle T-18 Phase 1	DMMP, 1997	Porewater and tissue
Port of Seattle T-18 Stage 1A	DMMP, 1999	Porewater and tissue
East Waterway Phase 2	Windward, 2003 and DMMP, 2003	Porewater, bulk and tissue
Olympia Harbor	DMMP, 2000	Porewater and tissue
Hylebos Waterway	DMMP, 2000	Porewater and tissue
Port of Anacortes, Cap Sante	DMMP, 2001	Porewater and Tissue

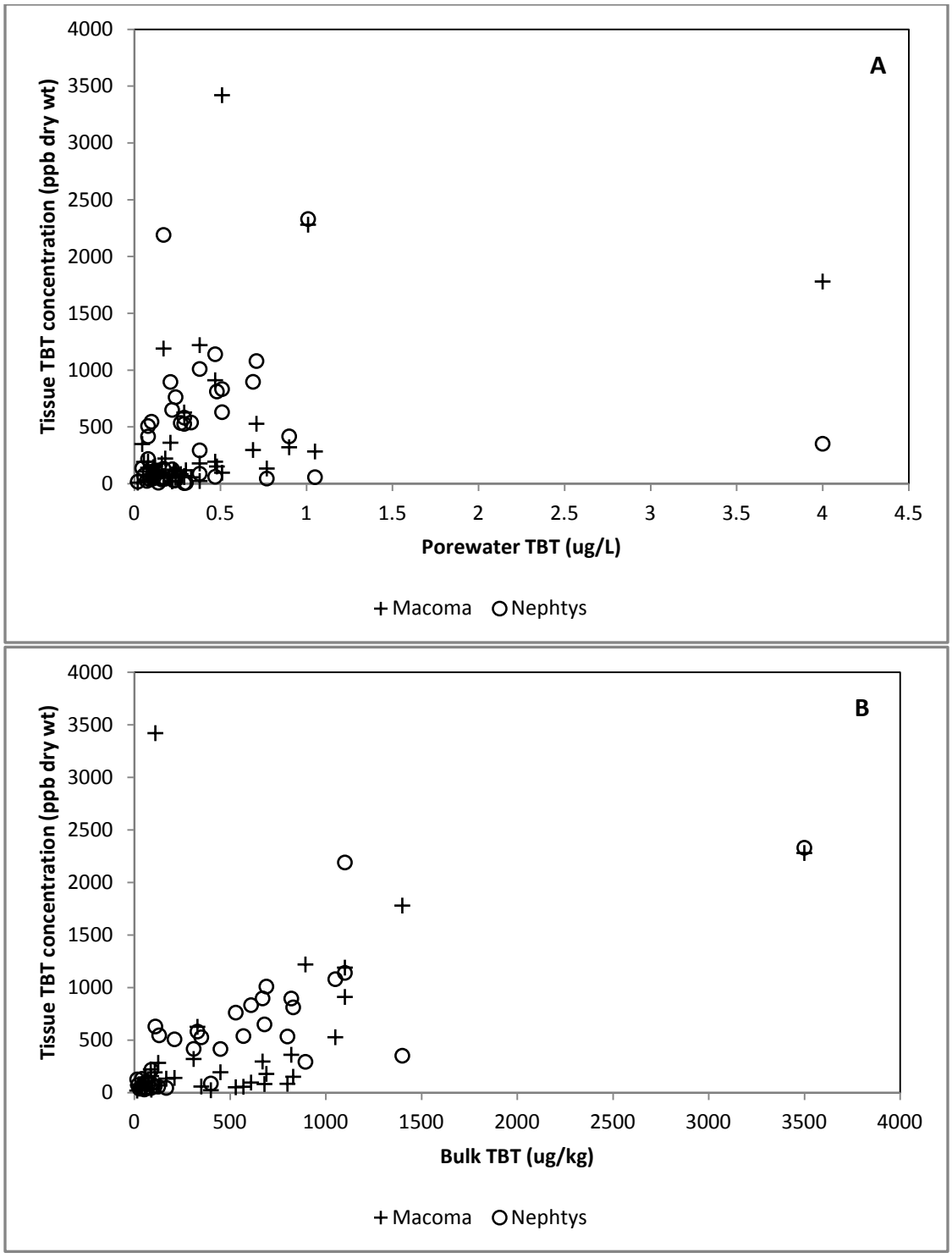

Figure 1. All *Macoma* (+) and *Nephtys* (○) TBT data from Puget Sound projects a) porewater vs. tissue TBT concentrations and b) bulk vs. tissue TBT concentrations.

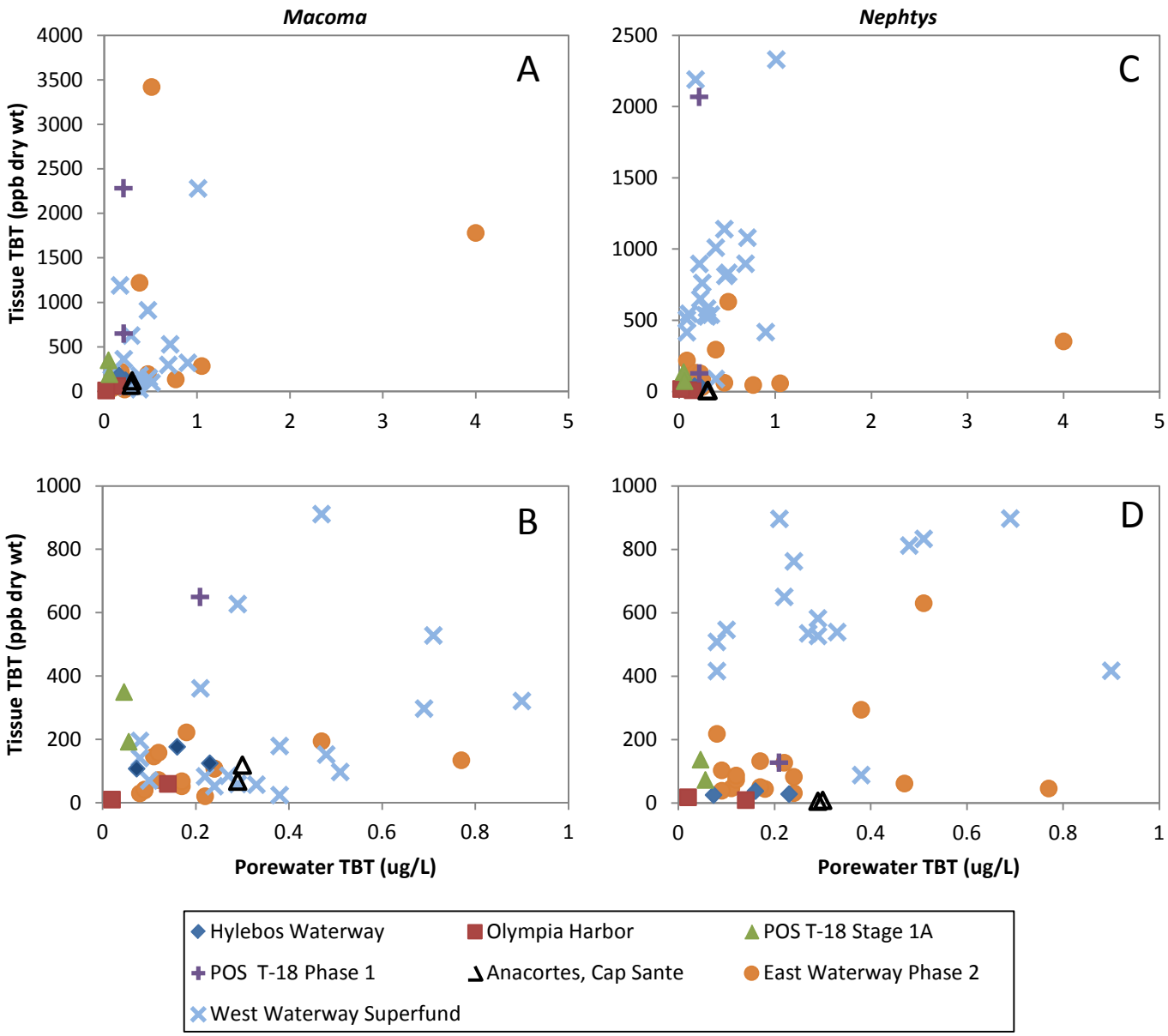

Figure 2. Porewater and tissue TBT data plotted by project. Left column (tiles A and B) is *Macoma* data, right column (tiles C and D) is *Nephtys* data. Tile B shows a close-up of the data near the origin of tile A, and tile D shows a close-up of the data near the origin of tile C.

References

DMMP, 2003. Determination on the Suitability of Dredged Material Tested Under the East Waterway Terminal Stage 1A Characterization (2003-2-00074), Evaluated Under Section 404 of the Clean Water Act (CWA) for Open-Water Disposal at the Elliott Bay Disposal Site. Prepared by USACE for the DMMP Agencies. February 11, 2003.

DMMP, 2001. Determination of the Suitability of Dredged Material Tested Under DMMP Evaluation Procedures for the Port of Anacortes Cap Sante Marina Dredging Project (2001-2-00399) with Proposed Disposal at the Rosario Strait Open Water Disposal Site. Prepared by USACE for the DMMP Agencies. April 11, 2001.

DMMP, 2000a. Determination of the Suitability of the Dredged Material Tested Under DMMP Evaluation Procedures for the Olympia Harbor Navigation Project for Disposal at the Anderson/Ketron Open Water Disposal Site. Prepared by USACE for the DMMP Agencies. May 17, 2000.

DMMP, 2000b. Determination on the Suitability of Dredged Material Evaluated for Weyerhaeuser Company Section 404 of the Clean Water Act (CWA) for Open-Water Disposal at the Commencement Bay Disposal Site. Prepared by USACE for the DMMP Agencies. November 27, 2000.

DMMP, 1999b. Determination on the Suitability of Dredged Material Tested Under the East Waterway Stage II Project and U.S. Coast Guard Slip 36, Evaluated Under Section 404 of the Clean Water Act (CWA) for Open-Water Disposal at the Elliott Bay Disposal Site. Prepared by USACE for the the DMMP Agencies. November 2, 1999 with Erratum on August 8, 2007.

DMMP, 1997. Determination of the Suitability of Dredged Material Tested Under PSDDA Evaluation Procedures for the Port of Seattle Terminal 18 Dredging Project (95-02133) for Disposal at the Elliott Bay Open-Water Site. Prepared by USACE for the DMMP Agencies. March 17, 1997.

EVS Solutions, 1999. Tributyltin in Marine Sediments and the Bioaccumulation of Tributyltin: Combined Data Report. Prepared for the Port of Seattle, Lockheed Martin Corp. and Todd Shipyards Corp. Project No. 8/203-16.3, May 1999.

Windward Environmental, 2003. Bioaccumulation Data Summary Report for the East Waterway Operable Unit, Harbor Island Superfund Site. Prepared for the U.S. EPA Region 10. December 2003.

APPENDIX 5

Program Updates:
Final Issue and Clarification Papers

1. Revision of Freshwater Sediment Screening Levels (Parts 1 and 3)
2. Reporting Summed Concentrations with J and/or U Flags
3. Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites
4. Tributyltin (TBT) Measurement Basis
5. Freshwater Bioassays Species, Endpoints, Methods and Interpretive Criteria
6. Modifications to Ammonia and Sulfide Triggers for Purging and Reference Toxicant Testing for Marine Bioassays

October 1, 2015

RSET White Paper: Proposal to Revise Freshwater Sediment Screening Levels

October 2015: The DMMP has accepted Parts 1 and 3 of the tiered approach with the understanding that the RSET agencies will continue to work on technical issues identified in Part 2.

November 17, 2014

Prepared by Laura Inouye (Washington Department of Ecology), Jeremy Buck (U.S. Fish and Wildlife Service), June Bergquist (Idaho Department of Environmental Quality), Jonathan Freedman (Environmental Protection Agency – Region 10), and James McMillan (US Army Corps of Engineers – Portland District) for the RSET Agencies

As noted, Parts 1 and 3 will be applied; Part 2 is on hold until further notice

The three parts of this paper must be used in conjunction with each other; they may not be applied separately. Examples of how the three sets of screening levels will be applied appear in Appendix A, and Figure 1 presents a flow chart on how the values are applied. An impact analysis conducted for the Washington Dredged Material Management Program's 2013 Sediment Management Annual Review Meeting presentation on this approach is supplied in Appendix B.

Due to Endangered Species Act concerns, the following disclaimer was developed by the U.S. Fish and Wildlife Service and the National Marine Fisheries Services:

The revised freshwater sediment benthic toxicity screening levels were derived with the analytical tools used to develop the Washington State Sediment Management Standards (SMS) (WAC 173-204-563). The standards were developed by Washington with the intent to protect benthic invertebrate communities. The Regional Sediment Evaluation Team is proposing to adopt these as regional freshwater screening levels. The Washington SMS were not intended to address bioaccumulative impacts (potential effects to higher trophic levels such as fish, wildlife, or humans) or effects to listed species as required by the Endangered Species Act (ESA). When used as part of an overall evaluation framework, the standards proposed may address the fish prey base but not direct effects on species of fish or invertebrates listed as threatened or endangered. Fish and some sensitive invertebrates (particularly snails and mussels) respond to some contaminants in sediment in a way that may not be accounted for in benthic invertebrate tests, and impacts to fish can occur at lower concentrations than those considered protective of invertebrate communities. As well, benthic bioassays are more indicative of population-level or community-level effects, whereas the ESA requires analysis of effects to individuals within the population. Additionally, waters with more unique attributes or high-quality habitat may include certain species that are especially vulnerable to sediment contaminants and may not be protected by the revised benthic screening levels.

While the Sediment Evaluation Framework for the Pacific Northwest and the framework proposed in the 2014 RSET white paper advance the protection of most exposed benthic populations during and following a dredging event, it may not be adequately protective of more sensitive species or individuals from listed species. In some instances, subsequent or additional analyses may be required by the National Marine Fisheries Service or the U.S. Fish and Wildlife Service (the Services) during RSET review. In particular, the Services are concerned about the following:

- *The protectiveness of the proposed approach for petroleum compounds such as polyaromatic hydrocarbons (PAHs)*

- *Bioaccumulative compounds such as DDT and its metabolites and polychlorinated biphenyls*

- *The metals copper, lead, and, zinc, which in the dissolved form, can have particular effects to fish and the invertebrate prey base at low concentrations.*

Of particular concern to the Services is exposure of fish and the invertebrate prey base to contaminants remaining near the sediment surface post-dredging. The newly disturbed surface may not provide adequate protection for fish or listed invertebrate species, especially if the areas are within high quality habitat for these species.

To address some of these concerns, the Services will propose a sediment screening level and approach to evaluate PAHs that is considered protective of fish by the end of 2014, an approach to address specific bioaccumulative compounds by the end of 2015, and may require applicants to compare test results to Probable Effect Concentrations (PECs; MacDonald et al. 2000) for copper, lead and zinc.

Part 1: Benthic Screening Levels

Part 1 is accepted for implementation starting Oct 2015

INTRODUCTION

In the early 2000s, Ecology evaluated existing freshwater sediment benthic toxicity screening levels (SLs), and determined that the existing SLs either had extremely high false positive rates, or extremely high false negative rates, depending on how they were derived (SAIC and Avocet, 2002). In 2003, Ecology released a report that led to the 2006 freshwater SLs currently used by the Regional Sediment Evaluation Team (RSET) (SAIC and Avocet, 2003). These values were based on the Floating Percentile Method (FPM) and the dataset and endpoints available at the time. In 2007, the RSET began to revise the freshwater benthic toxicity SLs using FPM with a larger dataset and additional endpoints. The final FPM report was released in 2011 (Avocet, 2011). Through rulemaking, Ecology promulgated these freshwater sediment values in the Sediment Management Standards (SMS) as freshwater benthic sediment standards (WAC 173-204-563) on February 22, 2013. Revised standards were also adopted for freshwater bioassays. The RSET agencies review and consider new approaches and best available science whenever appropriate and are evaluating Washington's freshwater benthic sediment standards for incorporation into the *Sediment Evaluation Framework for the Pacific Northwest* (SEF) for use in evaluating freshwater sediments.

These standards were developed for the protection of benthic invertebrate communities, and were not intended to address bioaccumulative impacts; potential effects to higher trophic levels such as fish, wildlife or humans; effects to individual organisms as required under the federal Endangered Species Act (ESA); or other species with state protection. As a result, there are concerns that if the sediment benthic standards are used alone, they would not adequately protect aquatic communities including ESA-listed fish species. The RSET agencies agree that additional measures are needed to be more protective of the aquatic environment; for example, SLs must protect other ecological receptors such as federally-listed and non-listed fish in addition to benthic invertebrates, and must account for the potential effects of bioaccumulative compounds, as appropriate.

To address these concerns, the RSET Freshwater Technical Working Group developed the following multi-tiered approach based on: 1) the revised benthic freshwater SLs; 2) water quality-based sediment SLs that would be more protective of the aquatic environment; 3) fish and wildlife-based SLs which include bioaccumulative compounds; and 4) background-based SLs for selected metals. While details of the multi-tiered approach were not finalized in time to be formally proposed at the 2013 RSET meeting, a presentation regarding future implementation was made. A discussion regarding the fish and wildlife-based bioaccumulative SLs ensued and concerns were expressed that the RSET agencies were considering implementation of these guidelines without appropriate public input. Further, concern was expressed that implementing of bioaccumulative SLs for freshwater sediment would set a precedent for their use in the marine environment.

Based on the feedback received at the RSET meeting, the RSET agencies decided to delay development of fish and wildlife-based SLs and proceed instead with adoption of the revised freshwater benthic SLs the water quality-based SLs, and the site-specific background SLs for some metals for use in the SEF. The present paper focuses on the first element – adoption of the revised freshwater benthic SLs for use in the SEF. The latter two elements are addressed in separate parts of this white paper. The fish and wildlife SLs and bioaccumulation concerns will be addressed in a separate process and will cover both freshwater and marine sediment evaluations.

PROBLEM STATEMENT

1. Freshwater SLs were not published in the May 2009 version of the SEF, and SEF users have been applying 2006 interim screening levels to determine dredged material suitability in freshwater environments. The 2006 interim SLs were developed using the FPM on a limited dataset (primarily from the Columbia and Lower Willamette Rivers) and did not include chronic bioassay data.

2. The 2009 SEF currently recommends only 10-day bioassays, while the revised Washington State standards require the use of at least one longer-term (20- or 28-day) exposure, which is a more sensitive bioassay.

APPROACH

The proposed approach includes the revised freshwater benthic SLs (Washington's FPM-based sediment management standards for benthic communities) and a bioassay over-ride. Similar to marine SLs, sediments failing the revised freshwater benthic SLs can be tested using bioassays to gather additional information for decision-making. Adoption of the revised benthic SLs in the SEF will also improve the results of bioassay testing by including a long-term exposure test.

The revised freshwater benthic SLs must be used in conjunction with the water-quality based SLs and the background concentration of metals outlined in Parts 2 and 3 of this white paper (Water Quality-based SLs, and Consideration of Background Concentrations of Metals). To be found suitable for in-water disposal, sediment must pass the revised freshwater benthic SLs (or bioassays if one or more SLs are exceeded). In addition, sediment concentrations must also be compared against the corresponding WQ-based SLs to ensure that water quality standards would not be exceeded. If the natural background for certain metals is higher than either the revised benthic or WQ-based SL, then the background value can be substituted as the SL.

DERIVATION OF THE VALUES

Development of Screening Levels for Benthic Communities

The revised freshwater benthic SLs are the combined result of the RSET Freshwater subgroup (2007 through 2009) and the Washington rule revision process that culminated in the adoption of the freshwater benthic SLs as standards in 2013 (WAC 173-204-563). The benthic SLs were derived using the FPM model, which is described in Ecology's publication #11-09-05, *Development of Benthic SQVs for Freshwater Sediments in Washington, Oregon, and Idaho* (Avocet, 2011).

PROPOSED VALUES AND APPLICATION FOR SEDIMENT EVALUATIONS

The proposed benthic SLs are presented in Table 1.

If project sediment data exceed one or more of the revised benthic SLs, then the material is considered unsuitable for in-water placement unless bioassays are conducted. However, sediments with sulfide and/or ammonia concentrations exceeding SLs, but with no other SL exceedances, may not require bioassays. Project proponents should consult with their local review team if sulfide and/or ammonia are present in sediments.

Tiered Biological Testing for Benthic Toxicity Assessment

If the revised benthic SLs are exceeded, then applicants may conduct bioassays to gather additional information for decision-making. These results may over-ride the benthic SL exceedances. Details for conducting bioassays are provided in Chapter 7 of the SEF. Bioassays should include three endpoints using both *Hyalella* and *Chironomus*, at least one chronic endpoint (20-day *Chironomus* or 28-day *Hyalella*), and at least one sub-lethal endpoint (growth). Three endpoints are required because the FPM numbers were developed using these bioassays.

Table 1. Proposed RSET Freshwater Benthic Screening Levels

Analyte	BENTHIC Screening Levels SL1	SL2
Metals (mg/kg)		
Arsenic	14	120
Cadmium	2.1	5.4
Chromium	72	88
Copper	400	1200
Lead	360	>1300
Mercury	0.66	0.8
Nickel	26	110
Selenium	11	>20
Silver	0.57	1.7
Zinc	3200	>4200
Organic contaminants (ug/kg)		
4-Methylphenol	260	2000
Benzoic acid	2900	3800
beta-Hexachlorocyclohexane	7.2	11
bis(2)-Ethylhexyl)phthalate	500	22000
Carbazole	900	1100
Dibenzofuran	200	680
Dibutyltin	910	130000
Dieldrin	4.9	9.3
Di-n-butyl-phthalate	380	1000
Di-n-octyl-phthalate	39	>1100
Endrin ketone	8.5	**
Monobutyltin	540	>4800
Pentachlorophenol	1200	>1200
Phenol	120	210
Tetrabutyltin	97	>97
DDDs	310	860
DDEs	21	33
DDTs*	100	8100
PAHs	17000	30000
PCB Aroclors	110	2500
Tributyltin	47	320
Bulk Petroleum Hydrocarbons (mg/kg) (NW-TPH method)		
TPH-Diesel	340	510
TPH-Residual	3600	4400
Conventionals (mg/kg)[3]		
Ammonia	230	300
Total sulfides	39	61

* Elutriate-based DDT value is based on the sum of sum of o,p'- and p,p'-DDXs
** no SL2 available
[1]SL1 corresponds to a concentration below which adverse effects to benthic communities would not be expected.

[2]SL2 corresponds to a concentration above which more than minor adverse effects may be observed in benthic organisms. Chemical concentrations at or below the cleanup screening level but greater than the sediment quality standard correspond to sediment quality that may result in minor adverse effects to the benthic community.

[3]Ammonia and sulfides are generally used only to inform bioassay testing; sediments only containing elevated ammonia and/or sulfides (and no other chemical exceedances) may be determined suitable for aquatic placement.

Part 2 is on hold until further notice; agencies continue to work on technical issues. However, these SLs and associated approaches may be applied on a case by case basis if deemed necessary by permitting agencies.

Part 2: Water Quality-based Screening Levels

INTRODUCTION

Part 1 of this white paper presented the history of development of freshwater benthic screening levels (SLs) and proposed revised benthic SLs based on recently promulgated standards for the State of Washington. As indicated in part 1, the RSET agencies agreed that additional measures are needed to be more protective of the wider aquatic environment, especially federally-listed and non-listed fish. This part proposes one such additional measure, the use of water quality-based SLs. Other measures, such as evaluation fish and wildlife-based SLs which include bioaccumulative compounds, are still under development.

PROBLEM STATEMENT

Sediment is resuspended in the water column during dredging and remains in suspension for short periods of time during in-water placement. Washington's benthic Sediment Management Standards, developed under the Floating Percentile Method (FPM) and proposed as revised benthic SLs for the SEF, only account for chemical toxicity to benthic invertebrate communities and may not be protective of sensitive fish species and other organisms during dredging and disposal. Since non-benthic species occur in the vicinity of nearly all dredging projects and dredged material placement sites in the Pacific Northwest, the RSET has identified the need to develop SLs that are protective of non-benthic receptors of concern.

APPROACH

As part of the requirements of the Clean Water Act, each state developed rules called water quality standards designed to meet the Clean Water Act requirements of fishable, swimmable water. Within these standards are numeric criteria developed to be protective of a wide range of receptors. Therefore, it is presumed that development of sediment SLs based on those criteria would protect species not covered by the proposed revised benthic SLs derived using the FPM approach. The approach proposed in this paper derives default SLs from EPA's recommended water quality criteria using typical values for hardness, pH, and TOC. These default SLs do not account for site-specific conditions or differences between state water quality standards and federal water quality criteria. The WQ-based SLs can easily be modified on a case-by-case basis to use state water quality standards and/or site-specific water quality values. As with the revised benthic SLs, tiered testing procedures (see "*Tiered Testing for Exceedances of Water Quality-based Screening Levels"* below) are included for the WQ-based SLs.

Part 2 is on hold until further notice; agencies continue to work on technical issues. However, these SLs and associated approaches may be applied on a case by case basis if deemed necessary by permitting agencies.

DERIVATION OF THE VALUES

Development of Screening Levels for Non-Benthic Receptors (Water Quality -based SLs)

For development of SLs that are protective of non-benthic receptors such as fish, RSET proposes using the same equilibrium partitioning approach that was used to develop the Elutriate Triggers (ETs) in Chapter 10 of the Sediment Evaluation Framework (SEF, 2009). Since 2009, the SLs have been expanded to include chronic water quality criteria, and these have been renamed "water quality-based SLs." The equations for calculating these triggers are described below.

Water Quality -based SLs for metals (in mg/kg) are derived using the following equation:

$$\textbf{WQ-based } SL_{metal} = \text{Log } K_d \times WQC/1000$$

where:

K_d is the metal partitioning coefficient in L/kg.

WQC is the water quality criterion in µg/L.

The calculation of Water Quality -based SLs for organic constituents is modified in two important ways. First, the equilibrium partitioning coefficients are expressed as a function of the organic carbon content of the sediments. Second, because organic constituents are regulated on a "total" basis (whereas metals are regulated on a "dissolved" basis), both the dissolved and the particulate fractions of the water column concentration need to be considered.

The Water Quality -based SLs for organics (in µg/kg-sed) are derived using the following equation:

$$\textbf{WQ-based } SL_{organic} = WQC / [(TSS_{inc} \times 10^{-6}) + (K_{oc} \times f_{oc})^{-1}]$$

where:

WQC is the water quality criterion in µg/L.

K_{oc} is the organic carbon partitioning coefficient in L/kg-oc.

f_{oc} is the decimal fraction of organic carbon in kg-oc/kg-sed.

TSS_{inc} is the incremental added mass of suspended solids in the water column generated by the dredging or placement action in mg/L.

10^{-6} is a conversion factor of milligrams per kilogram of sediment.

For the lower screening level (SL1), EPA chronic WQ criteria were used in the calculations; the higher screening level (SL2) used the EPA acute water quality criteria. This approach was used for all compounds that have EPA-promulgated water quality criteria. In order to develop generally-protective SLs for dredging sites and aquatic placement of dredged material, the parameters in the formula were assigned the following default values:

Part 2 is on hold until further notice; agencies continue to work on technical issues. However, these SLs and associated approaches may be applied on a case by case basis if deemed necessary by permitting agencies.

- Total organic carbon: 1%
- Total suspended solids: 100 mg/L
- Water hardness: 25 mg/L $CaCO_3$
- pH: 7.0

The default value of 25 mg/L $CaCO_3$ for water hardness differs from the 2009 SEF default (100 mg/L $CaCO_3$), and is based on a survey of water hardness in the Willamette River (Portland Harbor RI/FS August 29, 2011). This change generated lower SLs and was considered more realistic and protective than the SEF default.

PROPOSED VALUES AND APPLICATION FOR SEDIMENT EVALUATIONS

The water quality-based SLs must be used in conjunction with the revised benthic SLs and the background concentration of metals outlined in parts 1 and 3 of this white paper (Benthic SLs, and Consideration of Background Concentrations of Metals). Sediment may pass the revised benthic SLs and therefore not require bioassays for determining suitability for in-water disposal or for new surface material toxicity evaluation. Sediment concentrations should also be compared against the corresponding WQ-based SL to ensure that water quality standards would not be exceeded. If the natural background for certain metals exceed either the WQ-based SLs or benthic SLs, then the background value can be substituted as the SL.

WQ-based SLs may be modified with agency approval using local or site-specific water quality information regarding hardness, pH, and sediment TOC. These parameters can be used to calculate water quality-based SLs that are specific to a project. Site specific values may be required if your location contains ESA-listed species or some other unique characteristic revealed during development of the conceptual site model. If local water quality data are available, then you may be directed to use it. Keep in mind that SLs are not designed to protect beneficial uses beyond those of aquatic life uses (e.g., recreation, domestic water supply, etc.), there may be other considerations depending on your location.

The primary intent of the WQ-based approach is to augment the revised benthic SLs to better address potential contaminant exposure to fish in the water column. Because contaminants within sediment porewater or adhered to sediment particles become liberated (released) when sediment is disturbed, they can impact organisms in the water column near the area of disturbance (i.e., at the dredge or inwater disposal site). WQ-based SLs provide an estimate of porewater concentrations that could be harmful to aquatic life when compared to the sediment chemistry concentrations analyzed in a dredge prism sample. Typically, when WQ-based SLs are exceeded in the dredge prism sample, elutriate testing would then be conducted to provide a more accurate estimate of porewater contaminants. Because fish in the water column would not be exposed directly to porewater, additional modeling may be considered before or after conducting elutriate tests to provide a better estimate of contaminant concentrations released into the water column from dredging or inwater disposal.

Part 2 is on hold until further notice; agencies continue to work on technical issues. However, these SLs and associated approaches may be applied on a case by case basis if deemed necessary by permitting agencies.

A secondary goal of the WQ-based SLs is to protect fish with sediment-dwelling life stages. In particular, juvenile pacific lamprey (ammocoetes), which live and feed on algae directly within the sediment (Kastow 2002), could be exposed directly to porewater contaminants when colonizing the surface sediment exposed by dredging. Lamprey ammocoetes would be the fish most at risk from this type of exposure due to their unique burrowing and feeding behavior. Using the WQ-based SLs for ammocoetes would be considered protective because they appear to be generally as sensitive as salmonids to specific contaminant groups based on water exposure tests (Anderson et. al 2010). To better address risk to lamprey ammocoetes, contaminants in both the dredge prism and new surface material samples (when analyzed) should be compared against WQ-based SLs, especially in cases where contaminants in the underlying surface (i.e., area that will be exposed after dredging) exceed SLs or exceed concentrations in the dredge prism sample. Exceedance of WQ-based SLs in the dredge will trigger elutriate testing, or in some cases modeling, which is further described below.

The proposed default WQ-based SL values are presented in Table 2. Typically, projects are screened against the SL1; the use of SL2 values will depend on project-specific variables, including project design and duration of the project. If sediment concentrations are below the applicable WQ-based SLs, then the material may be suitable for in-water disposal (keep in mind that the material must also pass the revised benthic SLs). If the sediment concentrations for one or more chemical exceed the applicable SLs, then the project proponent may opt to undergo tiered testing as described below.

Tiered Testing for Exceedances of Water Quality-based Screening Levels

Tiered testing procedures for WQ-based SL exceedances may use several approaches, depending on the concerns at the dredge and placement sites. These could include elutriate testing (discussed below), development of site-specific water quality SLs, or site-specific mixing zone modeling to determine if water quality would be met at the point of compliance.

Elutriate Testing

Elutriate testing attempts to mimic conditions during dredging and in-water disposal so water column pollutant concentrations can be predicted in the laboratory. There are several tests developed to determine water quality consequences. If the concern is for suspension of pollutants during dredging, then the dredging elutriate test (DRET) should be used (Di Giano et al., 1995). To evaluate potential impacts at in-water placement sites, the standard elutriate test should be used (EPA/USACE, 1998). Results from elutriate testing are then compared to the applicable water quality criteria (acute or chronic). If concentrations exceed the applicable criteria, then modeling should be conducted to determine if the criteria will be met at the project's point of compliance. If the criteria cannot be met at the point of compliance, then other disposal options or special project Best Management Practices (BMPs), such as silt curtains, would be considered.

Part 2 is on hold until further notice; agencies continue to work on technical issues. However, these SLs and associated approaches may be applied on a case by case basis if deemed necessary by permitting agencies.

Use of Site-Specific Water Quality Parameters

If site-specific data are available, then the proponent may be required to, or have the option to, calculate site-specific screening levels using water quality data from the dredging or placement site. Site-specific SLs can be developed using the spreadsheet provided in Attachment 1, where site organic carbon and expected suspended sediments can be taken into account. Site-specific ambient water chemistry (hardness and pH) can also be collected and used in this spreadsheet to further refine the site-specific screening levels. Development of site-specific SLs is subject to approval by the RSET agencies.

Table 2. Proposed Water Quality-based Screening Levels

	WQ-BASED SLs (EPA)[1]	
Analyte	SL1 chronic	SL2 acute
Metals (mg/kg)		
Arsenic	1900	3400
Cadmium[2]	4.7	26
Chromium(III)[2]	2998	23047
Copper[2]	137	182
Lead[2]	215	5527
Mercury	154	279
Nickel[2]	641	5769
Silver[2]	--	24
Zinc[2]	4595	4595
Organic contaminants (ug/kg)		
Pentachlorophenol	39	51
DDTs[3]	7	7970
PCB Aroclors	33	4722
Tributyltin	18	113

[1]U.S. EPA National Recommended Water Quality Criteria (2006) have been used to calculate table values. You may be required to use state-specific water quality standards. In coordination with the local review team, you may also be able to use site-specific parameters (pH, sediment TOC, hardness) to adjust the water quality-based SLs using the spreadsheet available at the following webpage: http://www.nws.usace.army.mil/Missions/CivilWorks/Dredging/SMARMs.aspx

Contact the applicable agency for this information. Other water quality values used to derive these screening levels were a pH of 7.0 and a sediment total organic carbon content of 1.00% dry weight.

[2]A hardness of 25mg/L calcium carbonate was used to calculate the water quality criteria for these metals; arsenic and mercury are not affected by changes in water hardness.

[3]Elutriate-based DDT value is based on the sum of o,p'- and p,p'-DDXs

Part 3: Consideration of Background Concentrations of Metals

Part 3 is accepted for implementation starting Oct 2015

INTRODUCTION

Part 1 of this white paper presented the history of development of freshwater benthic screening levels (SLs) in Washington and the addition of these benthic SLs to the *Sediment Evaluation Framework of the Pacific Northwest*. The benthic SLs were calculated using the floating percentile method on a database of freshwater chemical and bioassay testing results and provide the best available science regarding chemical thresholds for adverse effects on benthic communities. Part 2 presented water quality-based SLs for the protection of non-benthic species. However, thoughtful implementation of the benthic and WQ-based SLs also requires consideration of background concentrations for chemicals of concern, particularly metals. The development of a background approach for metals in freshwater sediment is presented in this part.

PROBLEM STATEMENT

The Pacific Northwest region is known to have naturally elevated metals concentrations, in large part due to the volcanic nature of this region. In some areas, the background sediment concentrations of metals can exceed the benthic and WQ-based SLs. Therefore, background concentrations must be taken into account when evaluating dredging projects in these areas. However, background concentrations vary between regions, watersheds, and water body types. Very little natural background data exist for freshwater sediments and, while substantially more data are available for soil background values near freshwater areas, the applicability of soil background to sediments has not previously been defined in policy for Washington or Oregon.

APPROACH

The background-based SLs must be used in conjunction with the benthic and water quality SLs outlined in parts 1 and 2 of this white paper (benthic SLs, and WQ-based SLs). Where background metals are above other proposed SLs, the SL will default to background. Because metals background varies geographically, and the rules for the participating states differ, each state has its own proposed background approach, based on a combination of soil or sediment background.

DERIVATION OF THE VALUES

Development of RSET Freshwater Sediment Background Concentrations for Use in Oregon State

For dredging projects on the Lower Willamette River, the Willamette upstream sediment natural background metals values calculated for the Portland Harbor Superfund area will be used (LDWG 2012). Sediment natural background concentrations may also be calculated for other areas of the state if sufficient data are available. If no sediment background data are available, local soil background will be used in other parts of Oregon (ODEQ, 2013).

Development of RSET Freshwater Sediment Background Concentrations for Washington State

Based on data in Ecology's publication #09-03-032 (*Baseline Characterization of Nine Proposed Freshwater Sediment Reference Sites*, 2008), many metals in Washington sediment had higher concentrations compared to the background values from the Willamette, thus Willamette background may not be appropriate for Washington.

Using available sediment data for Washington State and performing outlier analysis, only nickel appears to clearly have sediment background higher than a benthic or WQ-based screening level – in this case, the benthic SL1 (see Appendix C). However, more freshwater sediment data are needed before a statistically robust background concentration can be calculated.

Since it appears that the Willamette sediment background may not be appropriate for Washington sediments, and sufficient Washington sediment data are not yet available, the DMMP agencies developed interim background values using Washington State soil data from Ecology's publication #94-115 (*Natural Background Soil Metals Concentrations in Washington State*, 1994). Using this data set, nickel had a background concentration (90th percentile = 38 mg/kg) higher than the benthic SL1 (see Appendix A). In Washington, the DMMP agencies propose using this value for the nickel SL1 until sufficient sediment data are available to calculate background.

Development of RSET Freshwater Background Sediment Concentrations for Idaho State:

Natural background concentrations of metals in sediments exceeding benthic or WQ-based screening levels may indicate the character of highly mineralized soils and the variable composition of sediment parent material found in many Idaho watersheds. In the event that natural sediment background levels are not available, soils and parent material representative of watershed sediment could be used as a reference for screening level thresholds. In certain circumstances, use of site specific screening levels for the protection of beneficial uses may override considerations for application of background sediment concentrations as screening thresholds. Idaho will examine this issue on a case by case basis as it arises.

Examples for sources of this information include the following:

U.S. Environmental Protection Agency. *Record of Decision Bunker Hill Mining and Metallurgical Complex OU 3*. September 2002.

U.S. Geological Survey. *Geochemical and Mineralogical Data for Soils of the Conterminous United States.* 2013.

Idaho Geological Survey Maps. http://www.idahogeology.org/Products/MapCatalog/

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SAIC and Avocet. 2003. Development of Freshwater Sediment Quality Values in Washington State, Phase II Final Report. Prepared by SAIC, Bothell, WA and Avocet Consulting, Kenmore, WA for the Washington Department of Ecology, Olympia, WA.

U.S. Environmental Protection Agency/US Army Corps of Engineers. 1998. Evaluation of dredged material proposed for discharge in waters of the U.S. – Testing manual. EPA-823-B-98-004, Washington, D.C.

U.S. Environmental Protection Agency. *Record of Decision Bunker Hill Mining and Metallurgical Complex OU 3*. September 2002.

U.S. Geological Survey. *Geochemical and Mineralogical Data for Soils of the Conterminous United States.* 2013.

Glossary of Terminology

Benthic Screening Levels (Benthic SLs): Sediment screening levels based on regional data and the Floating Percentile Model (Avocet, 2011).

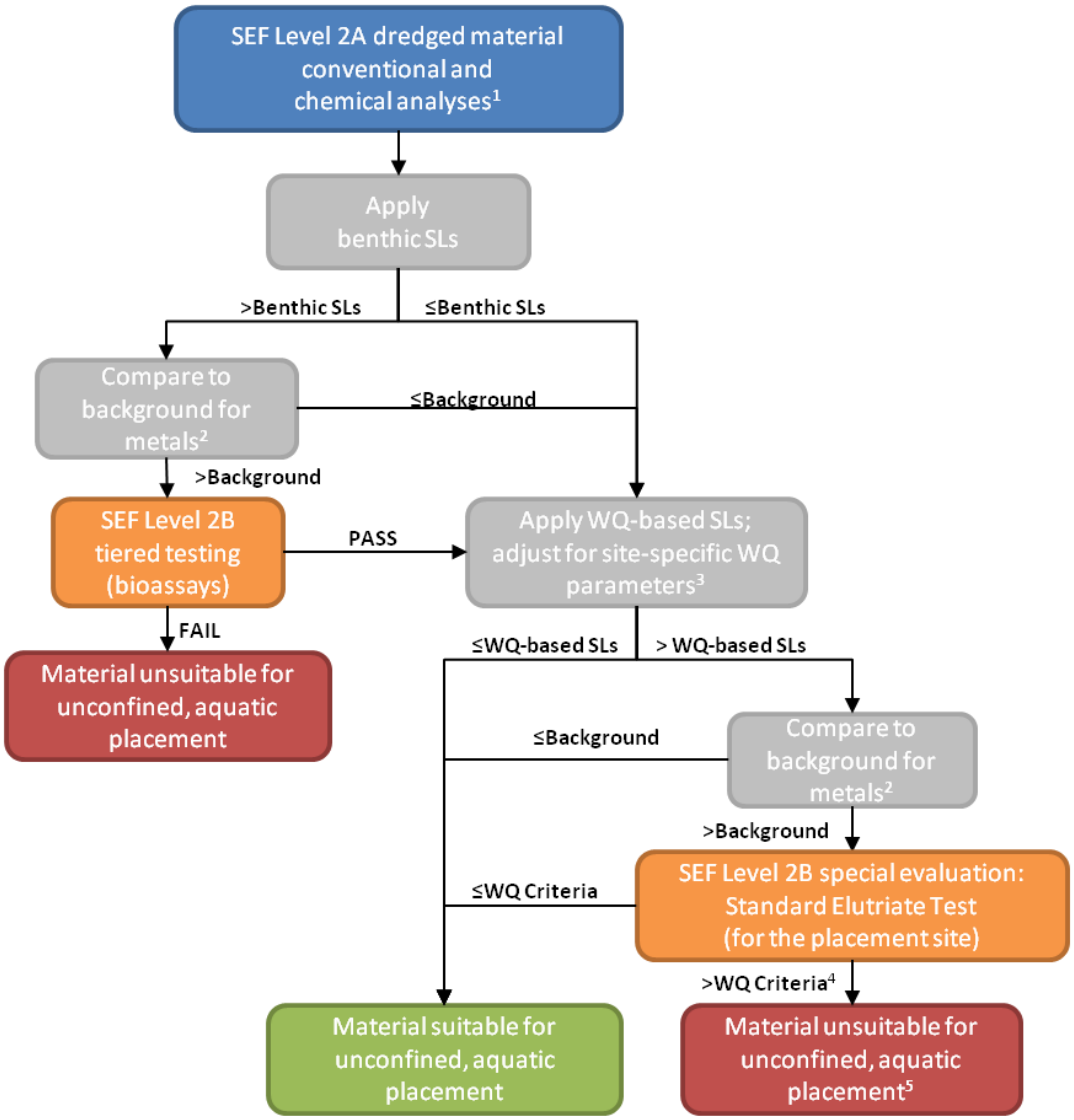
Elutriate Test: A sediment test where water and sediment are shaken, allowed to settle for a pre-determined amount of time, and the overlying water and suspended sediments are analyzed for chemical concentrations.

Elutriate Trigger (ET): An elutriate trigger is a sediment screening level (SL) calculated by multiplying the applicable water quality criteria (µg/L) by the logarithm of an applicable equilibrium constant of the sediment (L/kg) divided by 1,000. The result is a screening level or elutriate test trigger in mg/kg. The equilibrium constant or K_d value, as it applies to dredged material, is a measure of how much of a metal or organic constituent remains bound to sediment particles and how much is expected to dissolve in the water column. These trigger levels were originally developed in the SEF for acute water quality criteria (WQC) only. This paper expanded the use to include chronic WQC, and re-named the resulting sediment SLs as the WQ-based SLs.

Tiered Approach: A structured, hierarchical procedure for determining data needs relative to decision-making, which involves a series of tiers or levels of intensity of investigation. Typically, tiered testing involves decreased uncertainty and increased available information with increasing tiers. This approach is intended to ensure the maintenance and protection of environmental quality, as well as the optimal use of resources. Specifically, least effort is required in situations where clear determinations can be made of whether (or not) unacceptable adverse impacts are likely to occur based on available information. Most effort is required where clear determinations cannot be made with available information.

Water Quality-based Screening Levels (WQC-based SLs): Sediment SLs based on water quality criteria and equilibrium partitioning.

Figure 1. Application of proposed freshwater screening levels for the aquatic placement of dredged materials.



1 - Specific to the state in which the project is located, this process may also be used to predict toxicity of the new surface material (i.e., the surface exposed after dredging) and address water quality concerns at the dredge area.
2 - Background concentrations are used only for metals and are specific to the state in which the project is located, as determined by the state water quality agency (WA - Ecology; OR - ODEQ; ID - IDEQ).
3 - In coordination with the local review team, site-specific total organic carbon, hardness, and pH may be used to adjust the water quality-based SLs at the dredge area and placement area.
4 - The standard elutriate test or modeling indicate WQ criteria would be exceeded at the dredged material placement site. Modeling efforts must be coordinated with local review team.
5 - Dredging with upland disposal may still be a viable option. The dredging elutriate test (DRET) and water-quality compliance modeling would need to be conducted to assess the effects of dredging at the dredge area. Depending on the results, modifications to the dredging project may be proposed to ameliorate adverse water quality effects in the dredge area.

Appendix A. Example projects

This appendix contains three examples of the application of the SLs presented in this paper.

Case 1 is for the Port of Vancouver (2008), where there were exceedances of both benthic SLs and WQ-based SLs. In this case, Berths 8/9 had several chemical exceedances. The Port opted out of bioassays, so the dredged material was considered unsuitable for in-water disposal. Additionally, the TBT exceeded the benthic SL2, as well as the elutriate trigger (now called the WQ-based SL, at that time it was the elutriate trigger for acute WQ criteria). The Port conducted DRET testing, and then modeled the resulting data to predict water quality during dredging.

Case 2 is from the Port of Anacortes, Pier 2 (2013), and is another example of TBT, where TBT was the only constituent that exceeded any SL. The memorandum below documents the process by which the Port of Anacortes evaluated the potential impacts to water quality. While this project is marine rather than freshwater, the evaluation is more thorough due to its more recent evaluation, and so was included as an example here.

Case 3 is from Chester Morse Lake Pump Plant (2014). The material was being evaluated for in-water disposal, and failed only the nickel benthic SL, triggering comparison to background (at this time, WQ-based SLs were not in place so were not evaluated). The DMMP suitability determination attached below describes the process by which the project was evaluated.

Appendix B. DMMP impact evaluation of the proposed SLs (from SMARM 2014)

IMPACT ANALYSIS

The DMMP agencies evaluated the potential impact of the proposed freshwater approach on projects. Data from DMMP freshwater projects over a five-year span (2009-2013) were compared to the new SLs, to determine if there would have been significant changes in the evaluation (suitable or non-suitable). There were 12 projects with 43 DMMUs, mostly in the Columbia River but also including Lake Union (one project, seven DMMUs) and Lake Washington (two projects, four DMMUs).

Of these 43 DMMUs, 25 DMMUs had no change in decisions (six passed both sets of SLs, 16 had detected exceedances of both sets of SLs, and three had non-detected exceedances of both sets of SLs) (Table 3). Two DMMUs passed the 2006 SLs but had detected proposed SL exceedances for nickel. These DMMUs would now require bioassays or site-specific background evaluation for nickel. Both of these were in the same project (South Lake Union).

Twelve DMMUs passed the 2006 SLs but had non-detects above SL (five for silver, five for pentachlorophenol (PCP), two for PCB) that previously had no exceedances of the 2006 guidance. These non-detect exceedances could be avoided for silver and PCP- the proposed silver (0.57 ppm) and PCB SLs (33 ppb) and are at or above the Ecology median PQLs (0.5 ppm and 33 ppb respectively) (Ecology draft SCUM II, appendix F). If sediment concentrations were actually present above the SL, the PCB exceedances would have triggered further evaluation based on the WQ-based SL (elutriate testing, modeling) and the silver exceedance would have triggered bioassays. For PCP, the standard methodology (typically SW8270D) PQL (265 ppb) and MDL (48 ppb) are above the proposed WQ-based SL (39 ppb). Non-detects exceeding the proposed PCP SL would normally trigger further evaluation (elutriate testing, modeling). Although an alternative method (EPA 8270 LL) could reach PQLs and MDLs below the proposed SL, unless there is a reason to believe that PCP is an issue at the project site, the agencies will not require the alternative method and instead will require reporting of PCP down to the MDL. Only detected exceedances of the WQ-based SL will trigger further evaluations.

Three DMMUs that exceeded the 2006 SLs (Cd, Zn, and bis(ethylhexyl)phthalate) had no detected exceedances of the proposed SLs, but did have non-detected exceedances for PCP. Bioassays were not run on two of these DMMU, so it is not known whether the exceedances of the 2006 guidelines were associated with toxicity; however, bioassays were conducted and passed for the project with the Cd exceedance (Kitittas).

A single DMMU had a non-detect exceedance of the 2006 SLs (Hg) and a detected exceedance of the proposed nickel SL; either exceedance would have triggered bioassays.

Table 3. Matrix Comparing DMMU Evaluations for Impact Analysis

	All COCs are less than or equal to proposed SLs	One or more detected exceedance of proposed SLs	One or more non-detects exceed proposed SLs
All COCs are less than or equal to 2006 SLs	6	2 (Ni)	12 (5 Ag, 5 PCP, 2 PCB)
One or more detected exceedance of 2006 SLs	0	16	3 (PCP)
One or more non-detects exceeded 2006 SLs	0	1 (2006 Hg, proposed Ni)	3

Appendix C. Supplemental analysis of available sediment and soils data for Washington State.

Dredging projects need a way to determine when background concentrations of metals in freshwater sediments may be above the risk-based screening values (benthic SL or WQ-based SL). According to the SMS, when natural background concentrations are above risk-based values, background concentrations over-ride the screening values.

For freshwater, there are no established sediment natural background values. Data from both Washington state soil ("Natural background soil metals concentrations in Washington state", Ecology publication #94-115) and sediment data (Ecology's publication #09-03-032, "Baseline characterization of nine proposed freshwater sediment reference sites, 2008") were examined to determine which, if any, metals may need to default to natural background. Soil 90th percentile[1] and sediment 90/90 UTLs were compared to the sediment SLs (benthic, WQ-based) (Table 2). Only four metals had values higher than SL: Ni, As, Cu, and Hg, which could be the basis of an over-ride.

Because it is preferable to have a sediment background value for use in dredging rather than defaulting to soil values, the sediment data from publication #09-03-032 were examined more closely to determine whether that data could be used to generate Washington state freshwater background concentrations. The data were not normally distributed for any of the metals, and while outlier analysis indicated there may be some outliers, there is insufficient data for the non-normally distributed dataset to prove that the potential outliers were either in or out of the background distribution. For this analysis, outliers were removed from the data set, and the 90/90UTLs re-calculated and compared to their respective SLs. Only Ni remained higher than the risk-based SLs; no outliers had been identified for this metal.

In order to determine if sufficient nickel data were available, the approach used in the regional background studies was applied. The precision for the 95%UCL on the mean was higher than 25%, indicating more samples are needed to better characterize the upper part of the distribution that is used to set the background value.

The RSET FW technical group is proposing that the Willamette upstream natural background values calculated for the Portland Superfund area be used for metals natural background unless there are other data to support natural background for other regions. Based on data in Ecology's publication #09-03-032, many metals in Washington sediment had higher concentrations compared to the background values from the Willamette, thus Willamette background may not be appropriate for WA.
Using available sediment data for the state and biasing towards lower concentrations by using outlier analysis, only Nickel appears to clearly have sediment background higher than risk-based level.

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[1] 90th percentile reported in the publication was used for soil since the publication did not have the individual data values available to calculate the 90/90UTL.

However, statistics indicate that more freshwater sediment data are needed for nickel to better define the upper tail, which is what defines the background concentration. Since it appears that the Willamette sediment background may not be appropriate for WA sediments, but sufficient WA sediment data is not available, the DMMP needs an approach for assessing nickel in the interim. Either the 90th percentile of WA soil data or the 90/90UTL of existing WA sediment reference (Ecology's publication #09-03-032) data can be used in the interim. Given the uncertainties around the sediment data, and the fact that the soil data are lower than the sediment, the DMMP proposes to continue to use the soil background data for nickel until sufficient sediment background concentrations can be established.

Table A-1. Metals concentrations (ppm dry wt) in selected sediments and soil. More Washington state freshwater sediment data are needed to determine usable background concentrations. Nickel is the only metal where Washington sediment and soil were above the SL after outliers were removed.

Metal (lowest risk-based SL in parentheses)	Willamette sed bkg (95th %ile)	WA sed (all data) (90/90UTL)	WA sed (outliers removed) (90/90UTL)	WA soil (90th %ile)
Arsenic (14)	3.8	17	6.5	7
Cadmium (2.1)	0.2	0.7	0.5	1
Chromium (72)	32.7	60	no outliers	42
Copper (110)	38.0	146	49	36
Lead (160)	14.3	53	12	17
Mercury (0.66)	0.1	0.22	0.14	0.04
Nickel (26)	**26.1**	**57**	**no outliers**	**38**
Selenium (11)	0.4	2	0.6	na
Silver (0.6)	0.7	0.19	0.13	na
Zinc (3200)	105.0	110	no outliers	85

DMMP CLARIFICATION PAPER **Final: August 7, 2015**

REPORTING SUMMED CONCENTRATIONS WITH J AND/OR U FLAGS

Prepared by Kelsey van der Elst (U.S. Army Corps of Engineers) for the DMMP agencies

INTRODUCTION

In the standard list of DMMP Chemicals of Concern there are multiple chemicals that are sums of three or more individual components. These include: Total PAHs, Total LPAHs, Total HPAHs, Total Benzofluoranthenes, Total DDT, Total PCBs, and Total Chlordane.

PROBLEM STATEMENT

Previous guidance from the DMMP is clear on how to calculate and report sums when all the constituents are non-detect (U-flagged), however the guidance has not clearly indicated how to calculate and qualify sums with a combination of J-flagged, U-flagged and detected concentrations.

The DMMP User Manual states "For comparison to [DMMP guidelines], group summations are performed using all detected concentrations. Undetected results are not included in the sum. Estimated values between the method detection limit and the laboratory reporting limit (i.e. J-flagged values) are included in the summation at face value. If all constituents of a group are undetected, the group sum is reported as undetected, and the highest laboratory reporting limit of all the constituents is reported as the group sum."

Recently issues have come up with projects not adding sums correctly and/or not flagging the summed values correctly.

PROPOSED CLARIFICATION

The DMMP User Manual will be altered as follows with the addition of the text in bold underline, "Estimated values between the method detection limit and the laboratory reporting limit (i.e. J-flagged values) are included in the summation at face value **<u>and the sum is also J-flagged. Values that are J-flagged due to minor quality control deviations are also to be handled in this way.</u>**"

For clarity and consistency, the DMMP agencies are providing example calculations of the correct way to calculate sums and flag the summed values for different combinations of detected, J-flagged and U-flagged results.

Handling sums that include non-detect (U-flagged) concentrations.

As per existing DMMP guidance, when all the constituents of a sum are non-detect, the sum is reported as non-detect at the highest reporting limit of the constituents (DMMP User Manual), as follows:

All constituents non-detect, sum is highest non-detect value

4,4' DDD	4.3	U
4,4' DDE	2.7	U
4,4' DDT	1.8	U
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	4.3	U

When a portion of the constituents of a sum are detected and the rest are non-detect (U-flagged), the sum is calculated by adding only the detected concentrations, as follows:

One non-detect and the remaining detected, non-detect is not included in sum

4,4' DDD	4.3	
4,4' DDE	2.7	
4,4' DDT	1.8	U
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	7	

Handling sums that include J-flagged concentrations

When all the constituents of a sum are J-flagged, the sum is also J-flagged, as follows:

All constituents J-flagged -> sum J-flagged

4,4' DDD	4.3	J
4,4' DDE	2.7	J
4,4' DDT	1.8	J
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	8.8	J

When a portion of the constituents of a sum are J-flagged and the rest are detected, the sum is also J-flagged regardless of the number of J-flagged concentrations. Both of the following cases are reported the same.

Any number of J-flagged values, rest detect, sum is J-flagged

4,4' DDD	4.3	
4,4' DDE	2.7	
4,4' DDT	1.8	J
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	8.8	J

or

4,4' DDD	4.3	
4,4' DDE	2.7	J
4,4' DDT	1.8	J
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	8.8	J

Handling sums that include a combination of detected, J-flagged and/or U-flagged concentrations

When a portion of the constituents of a sum are J-flagged and the rest are non-detect (U-flagged), the sum is calculated by adding only the J-flagged values and the sum is also J-flagged, as follows:

Two constituents J-flagged, one non-detect, sum is J-flagged, non-detect not included

4,4' DDD	4.3	J
4,4' DDE	2.7	J
4,4' DDT	1.8	U
nsum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	7	J

Similarly, when the constituents are a combination of J-flagged, U-flagged and detected concentrations, the sum is calculated by adding all the detected and J-flagged values and including the J-flag on the sum, as in the following cases:

One constituent J-flagged, one detect, and one non-detect, sum is J-flagged and non-detect not included

4,4' DDD	4.3	J
4,4' DDE	2.7	
4,4' DDT	1.8	U
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	7	J

or

4,4' DDD	4.3	U
4,4' DDE	2.7	
4,4' DDT	1.8	J
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	4.5	J

FINAL DMMP Clarification Paper – October 2, 2015

Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites

Prepared by Erika Hoffman (U.S. Environmental Protection Agency), Celia Barton (Washington State Department of Natural Resources), and David Fox (U.S. Army Corps of Engineers) for the DMMP agencies.

Introduction

Providing affordable and environmentally protective options for open-water disposal of dredged material is the primary goal of the Dredged Material Management Program (DMMP). A key element of the program is the rigorous evaluation of the suitability of dredged material for open-water disposal. Suitability determinations are based largely on chemical and biological testing of sediment; however, management of debris in dredged material is also an important consideration. Proper management of debris is needed to avoid creating hazards to commercial fishing and navigation; altering habitat quality; and jeopardizing public acceptance of the continued use of open-water disposal sites.

Current Restrictions on Disposal of Debris at Open-Water Sites

The Puget Sound Dredged Disposal Analysis (PSDDA) Management Plan Report (MPR) – Phase I (PSDDA, 1988) provided the following guidance regarding debris management:

> *"Dredging site inspections will be made by the Corps and Ecology to ensure that contractors are removing identifiable nonfloatable debris prior to discharge at unconfined open-water disposal sites. Floatable debris will be either removed at the dredging site or picked out of the water at the disposal sites. The size of debris which must be removed will be specified in Corps 404 permits and contracts."*

The PSDDA agencies provided further clarification in MPR – Phase II (PSDDA, 1989):

> "*Debris is defined by the PSDDA agencies as material that could cause interference with particular uses. Floatable debris comprises material, such as logs, that could cause navigation hazards or solids, such as plastic or wood chunks, that could foul beaches. Nonfloatable debris comprises material that could reasonably be expected to cause conflicts with bottom-net or trawl fishing. Because functional definitions of debris are used, dredged material, if consolidated into large chunks, could itself be considered debris if, for example, it could snag nets and thus interfere with fishing activities. The contractor must include with the proposed dredging operations and disposal operations plans, the method (or methods) that will be used to remove debris or, if needed, to break*

large chunks of dredged material up, and this could include physically forcing material through a sieve or screen."

"*Pre-dredging testing of dredged material shall include an assessment of floatable and non-floatable debris hazards (defined as hazards to navigation or other significant beneficial uses) likely to result from dredging. The assessment may be based on the following types of information:*

a) Interviews with dock owners and users familiar with types of cargo handled that could have spilled in the dredging area.

b) Test dredging to confirm presence of log debris.

c) Side-scan sonar of dredge area to confirm presence and aerial extent of log debris.

d) Diver observations of dredging area.

e) Review of previous dredging records in the area which may be representative of types and relative amounts of log debris encountered.

If the [dredge] site assessment indicates the presence of log debris or other debris hazards, the contractor's dredging plan shall include methods of separating debris before open-water disposal. Screening may be accomplished by a clamshell dredge operator retrieving debris from the barge hopper. If this cannot be done effectively, the contractor shall propose other methods, such as passing material through a steel grid (e.g., 24" x 24" mesh)."

The DMMP User Manual (DMMP, 2014) provides the following additional guidance:

"*In general, debris is not allowed to be disposed at the DMMP open-water sites. This includes all floatable debris and large non-floatable debris such as logs, piling, rip-rap and concrete. Occasionally it [dredged material] may include smaller non-floatable woody debris such as sawdust, bark or wood chips, if these are inseparable from the sediment and are present in small enough proportion (less than 50% by volume). Large woody debris is most often segregated from sediment using a clamshell bucket during the dredging operation. In cases where a heterogeneous mix of smaller woody debris and sediment exists, which otherwise meets DMMP disposal guidelines, open-water disposal may occur as long as none of the debris measures more than two feet in its longest dimension. Occasionally, a relatively small quantity of rip-rap may be approved for open-water disposal. However, a 2-ft by 2-ft steel mesh must be used during the dredging operation to remove larger pieces of rip rap. Pre- and post-disposal monitoring*

may be required at the disposal site, on a case-by-case basis, to verify the absence of problem debris."

DMMP guidance with regard to debris management has been focused primarily on larger debris, such as logs and rip rap. Barge-mounted steel grids or mesh are rarely used in Washington State dredging projects to meet the debris removal requirement. Instead, a visual approach has been used whereby large debris and solid waste (e.g., tires, rebar, garbage) are removed only when observed in the dredge bucket (e.g., bucket will not close) or when identified on the surface of the sediment barge (Exhibit 1). Debris is removed from the sediment barge using the clamshell bucket and placed in a separate debris barge or containment area for later disposal at an upland facility. Since 1993, there have been only two dredging projects (Port of Seattle – T30, 1994; Port of Everett – Pacific Terminal, 2012) where a screening apparatus was used.

Problem statement

Debris Observed at Disposal Sites

The visual observation approach used historically in the majority of DMMP projects may be effective for projects with large debris and relatively small dredge buckets, but it does not appear to be rigorous enough to prevent all large debris from going to the disposal sites. Recent monitoring and inspection events at the Elliott Bay and Anderson-Ketron sites included remotely operated vehicle (ROV) surveys and trawling; large debris (e.g. piling, chunks of concrete) was observed at both sites. Other solid waste was also observed (e.g. PVC pipe, tires). At the Elliott Bay site, debris photographed by the contractor (Exhibit 1) in a bottom-dump barge prior to disposal was subsequently identified in photos from an ROV survey of the disposal site (Exhibit 2). At the Anderson-Ketron site, bottom trawls retrieved debris from the center of the site. The site was subsequently inspected with an ROV, which verified the presence of solid waste at the site. Debris was not found in trawls or by the ROV in areas outside the disposal site boundary, which indicates that the on-site debris was likely from the disposal of dredged material.

Presence of Large Debris May Change Habitat Quality and Impede Monitoring at Open-Water Sites

Disposal of large debris may fundamentally alter the nature of disposal sites, potentially attracting certain species (e.g. rockfish, crab) to areas that were chosen for disposal – in large part – because of their relatively low use by biota. Continued use of the open-water sites is subject to periodic review by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA) and the Essential Fish Habitat

provisions of the Magnuson-Stevens Fisheries Conservation and Management Act. Attraction of juvenile or adult rockfish to the disposal sites could jeopardize their continued use.

Debris can also interfere with monitoring of the sites by impeding sediment profile imaging (SPI), grab samplers and trawling equipment. Mapping of dredged material deposits and evaluation of benthic community structure requires good penetration by SPI cameras. Similarly, van Veen grab samplers need to achieve sufficient penetration and be unimpeded when closing. Trawl nets can become snagged on, or overloaded with, debris.

For sites with relatively little disposal (e.g., Anderson-Ketron), debris may remain exposed for extended periods of time. Even at sites that are more frequently used (e.g., Elliott Bay), larger debris may remain exposed for years, depending on the proximity to the site center and the timing of disposal events.

Disposal of Solid Waste May Erode Public Acceptance of Disposal Sites

Continued use of multiuser open-water disposal sites is largely dependent on public acceptance. The DMMP agencies have worked extremely hard to engender public trust with over a quarter century of collaborative management of the disposal sites. However, public trust can be easily eroded if reasonable and prudent precautions are not built into the management guidelines for open-water disposal. In addition, every disposal site is permitted under the Shoreline Management Act by local regulatory entities. These permits must be renewed every 5-7 years and are subject to public review and comment. Unintended disposal of solid waste at sites could erode public acceptance of open-water disposal and jeopardize the DMMP's ability to secure permits to keep the disposal sites open and available.

Inconsistent Debris Screening Requirements between West Coast USACE Districts

The DMMP's current requirements for and enforcement of debris removal are inconsistent with the more rigorous approach required of dredgers in California. The USACE San Francisco District has standard permitting conditions requiring use of 12-inch by 12-inch debris screens (Exhibit 3) for the majority of projects using open-water disposal sites in San Francisco Bay. Some maintenance dredging projects are not required to physically screen sediments as long as it can be demonstrated that they are unlikely to contain debris. Open-water disposal of dredged material regulated by the USACE Los Angeles District is primarily at ocean sites designated and managed by EPA. In its Site Management and Monitoring Plans (SMMPs) and concurrence letters, EPA Region 9 routinely includes requirements for physical screening for projects in Los Angeles, San Francisco, and Honolulu Districts (Brian Ross, personal communication, January 7, 2015).

Proposed Clarification

All projects must use a screen to remove debris unless it can be demonstrated that debris is unlikely to be present or that the debris present is large woody debris that can be easily observed and removed by other means during dredging.

Dredging projects will be required to screen sediments through a grid (or equivalent device) prior to open-water disposal at both non-dispersive and dispersive sites, unless the proponent can demonstrate that debris is unlikely to be present or that the debris present is large woody debris that can be easily observed and removed without use of a grid. Examples of project characteristics and/or information that can be provided to demonstrate that debris requiring use of a grid is unlikely to be present in project sediments include:

- Dredging of native sediments, unless it is determined that large consolidated chunks could create problems at the disposal site.
- Dredging of frequently maintained areas (e.g., navigation channels, berths that experience sand waves).
- Dredging of areas where debris is not expected based on operational use of a particular facility.
- Dredging in non-urban areas removed from marina/industrial/shipping activities.
- Evidence from previous rounds of dredging (at the same location) demonstrating that no debris was encountered while using a screen.

The inclusion of exemptions is intended to reduce costs where possible and to focus screening requirements on those projects that are most likely to have debris within the dredge prism. The DMMP agencies acknowledge that there may be projects other than the types discussed above where debris may not be present. Project-specific information such as sub-bottom profiling or historical dredging records will also be considered in making a decision regarding debris screening. It is the responsibility of the applicant to provide adequate information to the DMMP to support the determination of an exemption from screening. The determination of whether or not a grid will be required for a given project will be documented in the DMMP Suitability Determination.

Modification to Allowable Size of Debris that can be Disposed at Open-Water Sites

The maximum size of debris that may be taken to the open-water disposal sites will now be that which can pass through a 12-inch by 12-inch grid. The rationale for reducing the maximum allowable dimension from two feet to one foot is to provide more effective removal of both solid waste and woody/rock debris.

Implementation

Implementation of the requirement for physical screening of debris will begin in the dredging year 2017 (which starts on June 16, 2016), to allow time for dredging proponents to adjust their contracting procedures and for dredgers to acquire or construct the necessary equipment.

The User Manual section on debris management will be updated to read:

> *In general, debris is not allowed to be disposed at the DMMP open-water sites. This includes all floatable debris, large non-floatable debris such as logs, piling, rip rap and concrete, and all solid waste (e.g., tires, rebar, garbage). Occasionally, suitable dredged material may include smaller non-floatable woody debris such as sawdust, bark or wood chips, if these are inseparable from the sediment and represent less than half of the dredged material by volume. In cases where a heterogeneous mix of smaller woody debris and sediment exists, which otherwise meets DMMP disposal guidelines, open-water disposal may occur as long as none of the woody debris measures more than 12 inches in its longest dimension. As described in the 2015 DMMP Clarification on Debris Screening Requirements (Hoffman et al., 2015), all projects must use a 12-inch x 12-inch screen to remove debris unless it can be demonstrated that debris is unlikely to be present or that the debris present is large woody debris that can be easily observed and removed by other means during dredging. It is the responsibility of the applicant to provide adequate information to the DMMP to support the determination for an exemption from screening. Examples of project characteristics and/or information that can be provided to demonstrate that debris is unlikely to be present in project sediments are given in the 2015 Clarification paper. The determination of whether or not a grid will be required for a given project will be documented in the DMMP Suitability Determination.*

Debris grids can be permanently affixed to a dredge scow or may be removable. They typically cover part of the scow and their design can vary from a flexible heavy-duty chain mesh to an inflexible steel mesh, examples of which are shown in Exhibit 3. The debris items captured on the grid may be individually transferred to a storage area on land or on the dredge derrick, or the entire grid may be cleared onto a separate debris barge (Exhibit 4). Details regarding the type of grid to be used, how it is attached to the disposal barge, and means for clearing the screen must be proposed by the contractor as part of the Dredging and Disposal Quality Control Plan (QCP).

Compliance with the requirement to use a 12-inch by 12-inch grid for debris removal will be enforced through site inspections. Failure to use a grid when required may result in fines being levied by DNR, EPA, Ecology and/or USACE. If there is a reason to believe that a dredger did not

use a grid for those projects or portions of projects where use of a grid was required, then post-disposal monitoring may be required at the disposal site, on a case-by-case basis, to verify the absence of problem debris. The cost of site monitoring and redress would be borne by the dredging proponent.

References

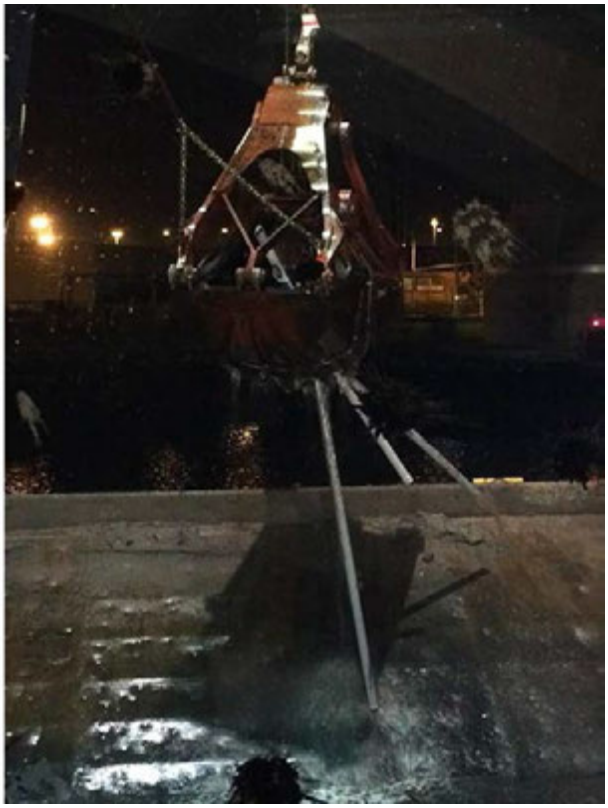
DMMP, 2014. Dredged Material Evaluation and Disposal Procedures – User Manual; prepared by the Corps of Engineers for the Dredged Material Management Program, December 2014.

PSDDA, 1988. Management Plan Report: Unconfined Open-Water Disposal of Dredged Material – Phase I (Central Puget Sound).

PSDDA, 1989. Management Plan Report: Unconfined Open-Water Disposal of Dredged Material – Phase II (North and South Puget Sound).

Exhibit 1: Debris in unscreened dredged sediments (WA)

Miscellaneous dredge debris in dump scow; Note: 20-30” diameter tire, PVC pipe, steel cable and woody debris (Lower Duwamish Waterway)



PVC pipe debris in clam shell bucket (Lower Duwamish Waterway)

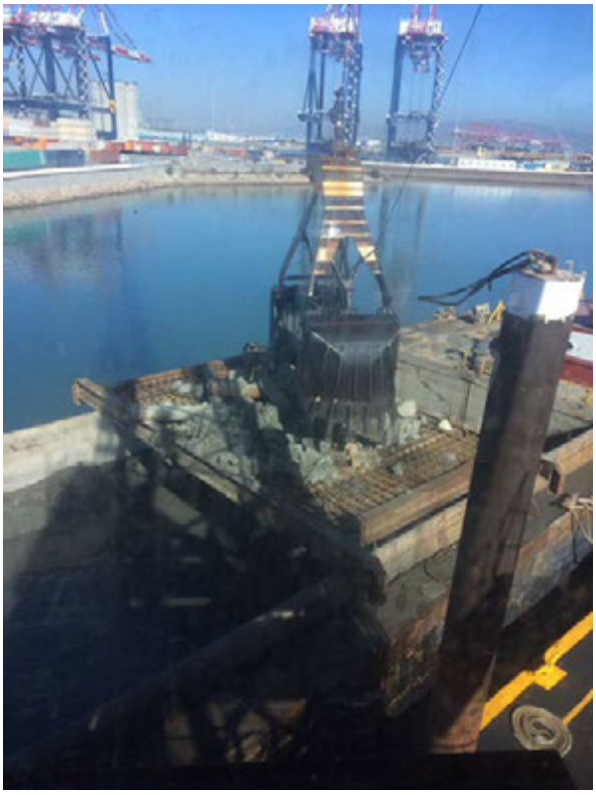
Exhibit 2: Photos illustrating debris at the Elliott Bay disposal site (2014)

Concrete

20- 30” tire

PVC pipe with crab

Exhibit 3: Examples of Grizzlies



Steel grizzly - Port of Long Beach

Dredging into a barge with debris screen – Port of Long Beach (CA)

Exhibit 3: Examples of Grizzlies (continuted)

Large scow with movable steel grizzly – Port of Oakland (CA)

Chain grizzly (California)

Exhibit 3: Examples of Grizzlies (continued)

Small bottom-door scow with fixed grizzly - San Francisco Bay (CA)

Exhibit 4: Debris captured on 1-ft square grizzlies (California)

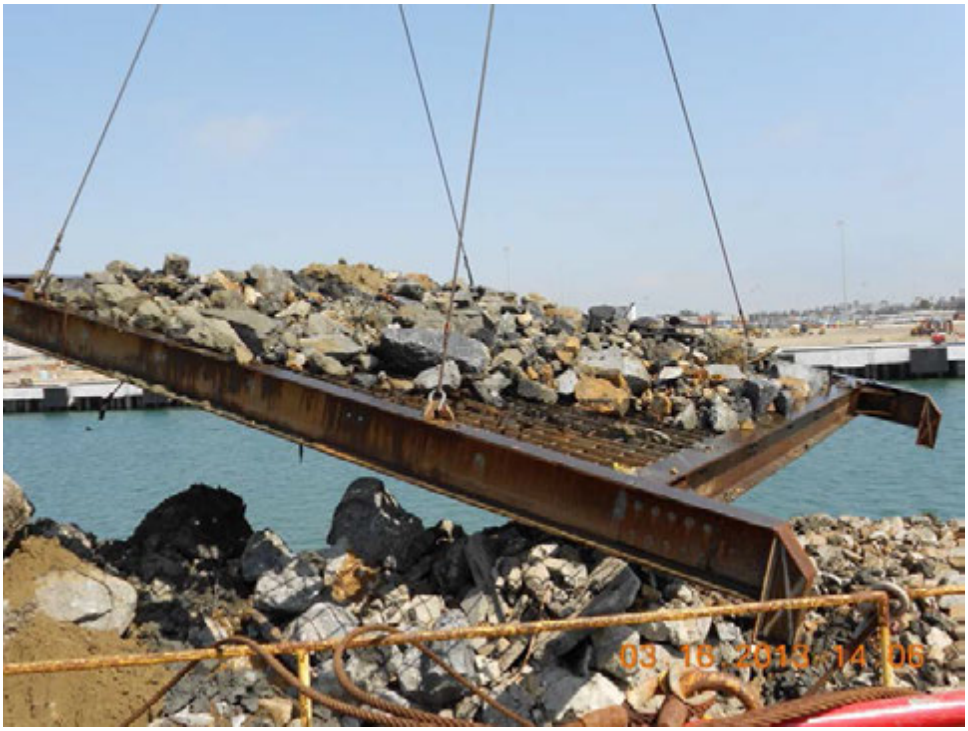


Exhibit 4: Debris captured on 1-ft square grizzlies (continued)

FINAL DMMP CLARIFICATION PAPER **SEPTEMBER 30, 2015**
TRIBUTYLTIN (TBT) MEASURMENT BASIS

Prepared by Kelsey van der Elst (U.S. Army Corps of Engineers) and Erika Hoffman (U.S. Environmental Protection Agency) for the DMMP agencies.

Introduction

Tributyltin (TBT) is a special chemical of concern under the Dredged Material Management Program (DMMP). For characterizations in marine waters, TBT analysis is only required in areas where it is likely to be found, such as marinas, ship repair facilities, and in areas where TBT has previously been detected. In 1996 the DMMP agencies reviewed available literature and concluded that the most environmentally relevant method for analyzing TBT was with porewater analysis (EPA, 1996; Michelsen, 1996). Following the 1996 SMARM the DMMP agencies adopted porewater TBT analysis as the standard for the program.

Questions and difficulties with the analysis of TBT in porewater led to an interim technical clarification paper on the proper extraction and analysis techniques for TBT (DMMP, 1998). In the following year, the DMMP agencies contracted with Striplin Environmental Associates and Avocet Consulting to conduct surveys of the various laboratories, consultants, and regulated parties to better understand their concerns and recommendations about porewater TBT extraction/analysis methods and the bioavailability of TBT. The results of these surveys were presented and discussed at the 1999 SMARM (DMMP, 1999).

Responses to the survey on TBT porewater protocols indicated that laboratories were successfully following the DMMP's interim guidelines although there were specific differences in their methods which may affect TBT extraction and measurement (e.g., aerobic versus anaerobic extraction conditions; filtration of porewater; GC/MS versus Flame Photometric detection methods). When questioned whether to focus on porewater versus bulk sediment TBT, respondents recommended that the fraction which best correlates with bioaccumulation/toxicity results should be selected and that site-specific factors (TBT source and form) would dictate whether to measure TBT in bulk sediments or in porewater. Respondents also thought that sample holding, processing and porewater extraction methods introduce the most variability in the results, and that TBT in freshwater may be more susceptible to state and oxidation changes than in marine sediments. Suggestions were made for additional investigation, including evaluation of holding times, refinement of porewater extraction techniques, and conducting additional bioavailability studies. Funding constraints have limited the DMMP agencies' ability to invest in further research. Instead, the agencies have sought to refine the methodology by applying lessons learned from individual dredging projects.

In the 15 years since the last TBT clarification, collection and analysis of porewater has presented logistical challenges for a number of projects. In addition, the DMMP agencies have adopted Ecology's 2013 freshwater standards which includes bulk butyltins as a standard COC. These issues have caused the DMMP agencies to re-evaluate the practicability of using porewater analysis as the default measurement for sediment characterization of TBT in marine sediments.

Problem identification

Experience with a variety of projects underscores many of the difficulties with porewater TBT analysis:

- Collection of sufficient porewater is commonly a challenge, especially for samples with high sand content and in highly consolidated sediments such as deep Z-samples.
- The holding time for sediment samples prior to the extraction of porewater is 7 days, making analysis of porewater impractical for a tiered Z-sampling approach. For example, if TBT is found to be elevated in the dredge prism, the corresponding Z-sample analysis will, by necessity, be of bulk TBT since the holding time for porewater extraction will have expired by the time the Z-samples are analyzed. Since porewater TBT in the dredged material cannot be compared with bulk TBT in the Z-samples, an additional bulk analysis of the dredged material may be needed in order to make an antidegradation determination.
- The inconsistency of porewater/tissue relationships may be a reflection of the differences in the porewater extraction efficiency of various laboratories' methods (e.g., centrifugation vs filtration, centrifugation speeds) or the loss of TBT on laboratory glassware used in sample processing and porewater extraction. The relative influence of method-related loss versus environmental heterogeneity on quantification of porewater TBT has proven to be difficult to quantify and control.
- Projects in freshwater may need to analyze for both porewater and bulk TBT. The freshwater butyltin sediment standards adopted by Ecology in 2013 are expressed as bulk butyltins, while the DMMP marine guidelines are based on porewater analysis. Thus, for projects located in freshwater areas proposing disposal at a DMMP disposal site in marine waters (such as projects in Lake Union and Lake Washington), analysis of bulk butyltins for antidegradation evaluation and porewater TBT to determine suitability for open-water disposal are both required.

Proposed Clarification

In order to simplify the analysis of TBT and align DMMP requirements with freshwater sediment standards, the DMMP agencies propose that the default TBT analysis method be on bulk sediments. This will reduce the need for both bulk and porewater testing of the dredged material for projects that are unable to collect porewater in z-samples, are proposing a tiered z-sample testing approach or are using freshwater sediment criteria for anti-degradation. Bulk TBT data will continue to be evaluated using the existing bioaccumulation trigger of 73 μg/kg.

Porewater TBT data is still considered to be a better approximation of the bioavailable fraction and porewater analysis remains an option in addition to or instead of bulk analysis at the discretion of the project proponent. In those cases porewater data will continue to be compared to the existing bioaccumulation trigger of 0.15 μg/L. In instances where paired bulk and porewater TBT data are collected for a sample, the porewater results will be used to determine suitability of the dredged material.

References

DMMP, 1999a. Sediment Management Annual Review Meeting Summary. May 5, 1999.

DMMP, 1998. Tributyltin Analysis: Clarification of interstitial water extraction and analysis methods – interim. Prepared for the DMMP agencies by Erika Hoffman. December 22, 1998.

EPA, 1996. Recommendations for Screening Values for Tributyltin in Sediments at Superfund Sites in Puget Sound, WA. Prepared for EPA Region 10, Superfund by Roy F. Weston, Seattle, WA.

Michelsen, T., T.C. Shaw, and S. Stirling, 1996. Testing, reporting and evaluation of tributyltin data in PSDDA and SMS programs. Final PSDDA Issue Paper/SMS Technical Information Memorandum, October 1996.

Final: August 31, 2015

PROPOSED DMMP/RSET Clarification Paper: Freshwater Bioassays Species, Endpoints, Methods and Interpretive Criteria

Prepared by Laura Inouye (Washington Department of Ecology) for the DMMP and RSET agencies.

NOTE: THIS PAPER UPDATES AND REPLACES THE SMARM 2014 DMMP/RSET CLARIFICATION PAPER: FRESHWATER BIOASSAYS

INTRODUCTION

The Washington State Sediment Management Standards (SMS) and DMMP/RSET dredging guidance require biological testing of dredged material when chemical testing results indicate the potential for unacceptable adverse environmental or human health effects. The response of bioassay organisms exposed to the sediment sample representing each DMMU is compared to the response of these organisms in both control and reference treatments. This comparison will determine whether the material is suitable for unconfined, open-water disposal.

In 2014, the freshwater bioassay standards were adopted as guidance by DMMP/RSET, with the SCO representing SL1 and CSL representing SL2. One and two hit guidance were also adopted at this time to be consistent with marine guidance. However, there are differences in the origins and use of the marine and freshwater guidance, which requires a different approach for freshwater. This paper outlines the proposed changes and will replace the 2014 paper.

Species and Endpoints

In both SMS and DMMP/RSET dredging guidance, bioassay results are considered to be more informative of potential resource impacts than exceedance of numeric chemical sediment standards (DMMP/RSET 2014). Thus bioassay results always take precedence over chemical results. This structure exists largely because chemical standards are informed by biological observations from some of the same suite of biological tests used to evaluate dredged material. The floating percentile model (FPM) used to develop the new Washington State freshwater sediment standards (WAC 173-204-563) used input from both acute (10-day *Chironomus* and *Hyalella*) and chronic (28-day *Hyalella*) tests. The standards were based on the most sensitive test, which was often the chronic 28-day *Hyalella* growth bioassay.

Prior to 2014, the Sediment Evaluation Framework for the Pacific Northwest (SEF 2009) and the DMMP User Manual (DMMP 2013) required only short-term bioassays using either *Hyalella* or *Chironomus*. Since the new freshwater SLs are often based on the results from a chronic bioassay, however, it is important that at least one of the bioassays conducted to override exceedances of the numeric standards should evaluate a chronic exposure measuring a sublethal endpoint.

Interpretive Criteria

Based on the updated SMS, interpretive criteria were developed for the DMMP freshwater bioassay tests (Section 9.6.7 and Table 9-5, UM 2014). These were modeled after the “one hit”/”two hit” criteria used in the DMMP marine guidelines. In the bioassay guidance, the “one hit” and “two hit” designations refer to a toxic response with a “one hit” response representing a greater level of impact than a “two hit” response.

There are, however some important differences between the DMMP's marine and freshwater interpretive criteria both in their derivation and application:

- This interpretive guidance was established prior to adoption of the SMS, and the "hit" definitions are more conservative than those used for SMS marine cleanup criteria. Therefore all sediments meeting the DMMP "one hit" or "two hit" definition also meet the marine Sediment Quality Standard (SQS), which is the sediment quality goal for protection of benthic communities for Washington State.
- In the freshwater guidance, the SL1 is equivalent to the Sediment Cleanup Objective (SCO) which is a no adverse effects level. The SL2 is equivalent to the Cleanup Screening Level (CSL) which establishes minor adverse effects.
- The SMS freshwater SCOs and CSLs were adopted prior to the development of freshwater guidance for the dredging program and were not designed as guidelines for open-water disposal, but rather for the identification of potential cleanup sites. The SCO/SL1 is the state goal for freshwater sediments for the protection of benthic communities, while the CSL/SL2 is used in defining potential cleanup sites. They are not equivalent to the marine "two hit" and "one hit" level of effects, both of which are more stringent than the state goal for marine sediments.
- In addition, the DMMP marine guidance includes more stringent standards for dispersive sites than those used for non-dispersive sites, which are actively monitored and managed. Open-water disposal sites in freshwater are almost exclusively dispersive in nature, and all disposed sediments must meet the more stringent SCO/SL1.

PROBLEM STATEMENTS

1. Species and Endpoints

a. Previous guidance required only 10-day acute endpoint bioassays to override the chemical testing results, although the freshwater benthic screening levels (FW benthic SLs) were often based on longer-term exposures and sublethal endpoints.

b. When the new Washington State freshwater sediment chemical standards (WAC 173-204-563) were implemented in September 2013, chronic tests with sublethal endpoints for *Chironomus* and *Hyalella* were added to the list of approved SMS bioassays. Testing under SMS now requires a chronic test and a sublethal endpoint to be included in the suite of three bioassays used to identify toxicity in test sediments. DMMP/RSET guidance for conducting freshwater bioassays needs modification to be consistent with the new state freshwater sediment standards.

2. Interpretive Criteria

a. In consideration of the differences between the freshwater and marine guidelines and their relationship to the Washington State Sediment Management Standards (SMS), a modification to the "one hit/two hit" approach is needed for freshwater bioassay interpretive criteria. Application of SL1/SL2 values in a manner similar to the "one hit"/"two hit" approach of the marine guidelines would result in open-water disposal of dredged material that exceeds the freshwater sediment quality goal for Washington State. Therefore, current freshwater bioassay hit definitions are inconsistent with WA State goals for freshwater sediments.

b. Open water disposal sites in freshwater are almost exclusively dispersive in nature, thus it is important that the sediments disposed there meet the SL1 criteria or Sediment Cleanup Objective (SCO).

PROPOSED PROGRAM MODIFICATIONS

1. **Bioassay Species, Endpoints, and Methods.** In order to address the issues identified above, the DMMP/RSET agencies propose making the freshwater bioassay species and endpoint requirements for dredged material consistent with the SMS rule (WAC 173-204-563).

   The SMS rule includes the following requirements for freshwater sediment bioassays. Categories are defined in Table 1.

   - Two different test species
   - Three endpoints
   - One chronic test; and
   - One sublethal endpoint

Table 1. Freshwater biological tests, species, and applicable endpoints

Species, biological test, and endpoint	Acute effects biological test	Chronic effects biological test	Lethal effects biological test	Sub-lethal effects biological test
Amphipod: *Hyalella azteca*				
10-Day mortality	X		X	
28-Day mortality		X	X	
28-Day growth		X		X
Midge: *Chironomus dilutus*				
10-Day mortality	X		X	
10-Day growth	X			X
20-Day mortality		X	X	
20-Day growth		X		X

Bioassay Methods: The bioassays should follow the protocols specified below. These tests and parameters were developed based on the most updated American Society for Testing and Materials protocols.

Acute Effects Tests

- *Hyalella azteca* 10-day mortality: ASTM E1706-05 (2010)/EPA Method 100.1 (US EPA, 2000)
- *Chironomus dilutus* 10-day mortality: ASTM E1706-05 (2010)/EPA Method 100.2 (US EPA, 2000)
- *Chironomus dilutus* 10-day growth: ASTM E1706-05 (2010)/EPA Method 100.2 (US EPA, 2000)

Chronic Effects Tests

- *Hyalella azteca* 28-day mortality: EPA Method 100.4 (US EPA, 2000)
- *Hyalella azteca* 28-day growth: EPA Method 100.4 (US EPA, 2000)
- *Chironomus dilutus* 20-day mortality: EPA Method 100.5 (US EPA, 2000)
- *Chironomus dilutus* 20-day growth: EPA Method 100.5 (US EPA, 2000)

2. **Bioassay Interpretative Criteria.** In order to address the issues identified above, the DMMP/RSET agencies propose that for dispersive disposal the "one hit" and "two hit" designations be dropped for freshwater bioassays. Failure to meet the SL1/SCO would result in material not being suitable for open-water dispersive disposal (Table 2). Failure of SL2/CSL (WAC 173-204-563 Table VII) would still be considered for antidegradation evaluation (see clarification paper "Quality of Post-Dredge Sediment Surfaces", SMARM 2008) or non-dispersive disposal cases, but would be applied in a case-by-case manner depending on project specifics.

Table 2. Performance standards and interpretive criteria for freshwater bioassays.

Biological Test/ Endpoint [a]	Performance Standard[b]		Screening Level 1 (SL1) or Sediment Cleanup Objective (SCO)	Screening Level 2 (SL2) or Cleanup Screening Level (CSL)
	Control[c]	Reference		
Hyalella azteca				
10-day mortality	$M_C \leq 20\%$	$M_R \leq 25\%$	$M_T - M_C > 15\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 25\%$ and M_T vs M_C SD ($p \leq 0.05$)
28-day mortality	$M_C \leq 20\%$	$M_R \leq 30\%$	$M_T - M_C > 10\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 25\%$ and M_T vs M_C SD ($p \leq 0.05$)
28-day growth	$MIG_C \geq 0.15$ mg/ind	$MIG_R \geq 0.15$ mg/ind	$(MIG_C - MIG_T)/MIG_C > 0.25$ and MIG_T vs MIG_C SD ($p \leq 0.05$)	$(MIG_C - MIG_T)/MIG_C > 0.40$ and MIG_T vs MIG_C SD ($p \leq 0.05$)
Chironomus dilutus				
10-day mortality	$M_C \leq 30\%$	$M_R \leq 30\%$	$M_T - M_C > 20\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 30\%$ And M_T vs M_C SD ($p \leq 0.05$)
10-day growth	$MIG_C \geq 0.48$ mg/ind	$MIG_R/MIG_C \geq 0.8$	$(MIG_C - MIG_T)/MIG_C > 0.20$ and MIG_T vs MIG_C SD ($p \leq 0.05$)	$(MIG_C - MIG_T)/MIG_C > 0.30$ and MIG_T vs MIG_C SD ($p \leq 0.05$)
20-day mortality	$M_C \leq 32\%$	$M_R \leq 35\%$	$M_T - M_C > 15\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 25\%$ and M_T vs M_C SD ($p \leq 0.05$)
20-day growth	$MIG_C \geq 0.60$ mg/ind	$MIG_R/MIG_C \geq 0.8$	$(MIG_C - MIG_T)/MIG_C > 0.25$ and MIG_T vs MIG_C SD ($p \leq 0.05$)	$(MIG_C - MIG_T)/MIG_C > 0.40$ and MIG_T vs MIG_C SD ($p \leq 0.05$)

Notes:

M = Mortality; C = Control; R = Reference; T = Test; F = Final; MIG = Mean Individual Growth at time final; mg = milligrams.

Reference performance standards are provided for sites where the agencies have approved a freshwater reference sediment site(s). For reference interpretive criteria, reference results will be substituted for control in the interpretive criteria formula. When a reference sediment is used, and control, reference and test sediments all have similar physical characteristics, a hit is defined when (1) the test sediment response relative to both negative control and reference exceeds the bioassay specific guidelines; and (2) the difference between test and both control and reference is statistically significant.

Bioassay failure requires statistical significance between test and control/reference at $p = 0.05$.

The control performance standard for the 20 day test (0.60 mg/individual) is more stringent than for the 10 day test and the agencies may consider, on a case-by-case basis, a 20 day control has met QA/QC requirements if the mean individual growth is at least 0.48 mg/individual.

Final Paper August 14, 2015

DMMP Clarification Paper
Modifications to Ammonia and Sulfide Triggers for Purging and Reference Toxicant Testing for Marine Bioassays

Prepared by Laura Inouye (Ecology), Erika Hoffman (EPA) and David Fox (Corps) for the DMMP agencies

INTRODUCTION

The potential for ammonia and sulfides to complicate bioassay evaluations of dredged material has been addressed in the following DMMP clarification papers:

- DMMP (1993) The *Neanthes* 20-day Bioassay – Requirements for Ammonia/Sulfides Monitoring and Initial Weight,
- DMMP (2001) Reporting Ammonia LC_{50} data for Larval and Amphipod Bioassays,
- DMMP (2002) Ammonia and Amphipod Toxicity Testing, and
- DMMP (2004) Ammonia and Sulfide Guidance Relative to *Neanthes* Growth Bioassay.

In addition, the DMMP agencies drafted a clarification paper for the 2013 SMARM with guidelines for addressing potential non-treatment effects from ammonia and sulfides. That paper elicited constructive comments from consultants and bioassay labs that resulted in the agencies postponing implementation of the guidelines until more work could be done. Since then, the Corps of Engineers has had additional ammonia and sulfides testing done for four federal navigation projects.

This clarification paper addresses issues raised by commenters in 2013 (Gardiner and Hester, 2013; Caldwell and Thompson, 2013) and reflects the advancement in knowledge gained through testing done by Analytical Resources and Port Gamble Environmental Sciences (now Environ) for the federal navigation projects (DOF/SEE, 2014, 2015a, 2015b; Herrera/NewFields, 2014; PGES, 2014) and research by Northwestern Aquatic Sciences (Caldwell and Irissarri, 2015). Those portions of the 2013 draft clarification paper that did not elicit comments have not been revised. This includes the 'Problem Identification', 'Literature and Data Review' and 'Derivation of Purging Triggers' sections.

PROBLEM IDENTIFICATION

Ammonia and sulfides are potential non-treatment factors that may affect the results of bioassays. Despite the numerous clarification papers addressing these chemicals, there remain data gaps and inconsistencies in the existing guidance that limit the DMMP agencies' ability to adequately interpret the effects of these non-treatment factors or prevent them altogether. Existing deficiencies in the DMMP guidance can be categorized as follows:

Ammonia:

Threshold concentrations that would trigger purging and/or reference toxicant (Ref Tox) testing have been established for the amphipod and *Neanthes* bioassays, but not for the larval test.

Hydrogen Sulfide:

Threshold concentrations that would trigger purging[1] have been established for the *Neanthes* bioassay, but not for the amphipod and larval bioassays.

Predicting Non-treatment Effects:

The DMMP agencies currently rely on the concentration of sulfides and ammonia in bulk sediment samples to predict potential problems in the bioassays due to these chemicals. There are two flaws in this approach. First, the bulk sediment tested for sulfides and ammonia may not be representative of the sediment that will eventually be used for bioassays, due to differences in holding times and conditions. Second, with the exception of ammonia for *Neanthes*, there are no established triggers based on bulk sediment concentrations. The other established triggers are based on water measurements; comparisons can only be made after ammonia and sulfide measurements are taken at the beginning of the bioassays themselves, at which point it is typically too late to initiate a purging procedure and prevent non-treatment effects from occurring.

Effects Level of Purging Triggers:

There is a discrepancy in the effects levels currently used to trigger purging. For the amphipod bioassay, the purging trigger is set at the no-effects level, while for *Neanthes* it is set at the minor-effects level. If purging is not conducted until the minor-effects level is reached, non-treatment effects can be expected to occur for concentrations above the no-effects level but below the purging trigger. For example, the ammonia trigger for purging in the *Neanthes* test is set at a concentration that could be expected to result in mortality of 20% and a growth reduction of 31-35% relative to the controls (DMMP, 2004). While within-batch Ref Tox tests can provide evidence of toxicity due to ammonia, the length of the Ref Tox test is much shorter than that of the amphipod and *Neanthes* bioassays. Therefore, quantifying the contribution of ammonia to toxicity in these bioassays based on the results of Ref Tox tests is extremely difficult. With respect to sulfides, it is not practical to even run Ref Tox tests, so setting the purging trigger at the minor-effects level is even more problematic.

LITERATURE AND DATA REVIEW

In order to evaluate the validity of existing triggers and establish new triggers where missing, ammonia and sulfide toxicity data for standard test organisms were collected from published studies, poster presentations at various toxicological meetings, and reference toxicity studies

[1] Ref Tox testing for hydrogen sulfide is not practical due to difficulties in maintaining stable concentrations of this volatile compound during the test.

from laboratories. Data were expressed as endpoints including No Observable Effect Concentrations (NOECs), Lowest Observable Effect Concentrations (LOECs), and the concentration at which 50% of the population was impacted - exhibited as either abnormal development (effective concentration or EC_{50}) or mortality (lethal concentration or LC_{50}). All collected data are presented in Appendix A for ammonia and Appendix B for sulfides.

Aside from the *Neanthes* bioassay, for which there is a single definitive study evaluating the sensitivity of this species to ammonia and sulfide (Dillon, 1993; DMMP, 2004), there was a great deal of variation in the number of studies, endpoints, and concentrations reported in the literature for the various test species. In some cases, variability in the NOECs and LC/EC_{50}s was high and resulted in overlap in these values within the same species.

DERIVATION OF PURGING TRIGGERS

The DMMP agencies entered into extensive discussions with regard to the effects level and measurement basis to be used in the derivation of purging triggers. After careful deliberation, the agencies elected to set triggers for unionized ammonia and hydrogen sulfide at the lowest NOEC. The following are factors which were considered in making this decision:

- The NOEC, LOEC and LC_{50}/EC_{50} values for *Neanthes* and the amphipod species are based on exposures of shorter duration than those used in the DMMP bioassays. Setting the purging triggers at the LOEC or LC_{50}/EC_{50} would likely result in effects levels in the longer-term DMMP tests even higher than those predicted from the shorter-term research tests.
- While use of the lowest NOEC to trigger purging could result in this procedure being performed for ammonia/sulfide concentrations that are nontoxic in some cases, allowing non-treatment effects to occur by setting the purging trigger at higher concentrations could result in bioassay data that are rejected for use or difficult to interpret.
- NOEC and LC_{50}/EC_{50} values from various studies sometimes overlap each other within the same species. Only by adopting the lowest NOEC can non-treatment effects be reliably negated.
- Most of the ammonia and sulfide toxicity data compiled in the evaluation were expressed in terms of unionized ammonia and hydrogen sulfide as these represent the predominant toxic forms of these two chemicals.

PROPOSED CLARIFICATION

Unionized Ammonia and Hydrogen Sulfide Triggers:

The DMMP agencies propose using the lowest available NOEC as a trigger for purging bioassay containers prior to testing. Further, it is proposed that triggers be established for only the most toxic constituents - namely unionized ammonia and hydrogen sulfide - rather than for total ammonia and total sulfides. For ammonia, half the NOEC is proposed as a trigger for Ref Tox testing. The new and revised trigger concentrations are presented in Table 1.

Table 1. Ref Tox and Purging Triggers for the various bioassays.

Trigger	Bedded sediment tests				Larval tests	
	Neanthes	*Ampelisca*	*Eohaustorius*	*Rhepoxynius*	Bivalve	Echinoderm
Unionized Ammonia (mg/L) Ref Tox	0.23	0.118	0.4	0.2	0.02	0.007
Unionized Ammonia (mg/L) Purge	0.46	0.236	0.8	0.4	0.04	0.014
Hydrogen Sulfide (mg/L) Purge	3.4	0.0094	0.122	0.099	0.0025	0.01

The proposed triggers are expressed in terms of unionized ammonia and hydrogen sulfide. Unionized ammonia and hydrogen sulfide concentrations must be derived from measurements of total ammonia and sulfides using test-specific pH, temperature and salinity measurements.

Determining the Need for Purging or Ref Tox Testing:

The DMMP agencies recommend determining the need for purging or Ref Tox testing PRIOR to the commencement of actual bioassay testing. Following are details of the recommended procedure:

1. Bulk ammonia measurements should continue to be done by the chemistry lab on composited sediment representing each DMMU. For total sulfides, rather than conducting bulk analysis on sediment from a single core prior to compositing, the DMMP agencies recommend analyzing total bulk sulfides on composited sediment. This change will provide a more realistic assessment of the concentration of total sulfides in sediment archived for bioassays. Exceptions to this revised procedure for total sulfides might need to be made for sediment testing performed for both cleanup and DMMP characterization; and for projects where wood waste in new surface material may be an issue. In those cases, total sulfides should continue to be performed on single cores.

2. While bulk measurements made by the analytical laboratory can provide an early warning of potential non-treatment effects in bioassays, these measurements are not always predictive of the ammonia and sulfide concentrations to which bioassay organisms will actually be exposed. Aqueous concentrations measured by the bioassay lab are more meaningful in this regard. For bedded sediment tests using *Neanthes*, *Eohaustorius* and *Rhepoxynius,* porewater is the medium of exposure. For the tube-building amphipod *Ampelisca*, as well as the bivalve and echinoderm species used in the larval development test, the overlying water is the medium of exposure. Therefore, for those DMMUs that will undergo bioassays, ammonia and sulfides need to be measured in the medium of exposure prior to running the bioassays.

This can be accomplished by the bioassay lab for *Neanthes*, *Eohaustorius, Rhepoxynius* and *Ampelisca* by setting up a single beaker for each DMMU in the manner that would be done for the amphipod and juvenile infaunal bioassays. 175 ml of sediment are placed in a beaker, with seawater added to bring the total volume up to 950 ml. The beaker is aerated and allowed to equilibrate for 24 hours. Total ammonia, total sulfides, pH, temperature and salinity are then measured in the porewater (for *Neanthes*, *Eohaustorius* and *Rhepoxynius*) and the overlying water (if *Ampelisca* is used).

For the larval test, a single beaker for each DMMU is set up as it would be for the bioassay. 18 ml of sediment are placed in a beaker along with 900 ml of seawater. The sediment is suspended by shaking vigorously for 10 seconds and then allowed to settle for 4 hours. Total ammonia, total sulfides, pH, temperature and salinity are then measured in the overlying water.

During bioassay testing, temperature and salinity are maintained within standard ranges. In contrast, pH is monitored but not adjusted. Using the temperature and salinity that will be maintained during each of the bioassays, plus the pH measured in the overlying water and porewater, calculate the unionized ammonia and hydrogen sulfide concentrations.

3. If unionized ammonia and hydrogen sulfide concentrations in the interstitial water are below the purging triggers in Table 1, or if any of the chemicals of concern exceeding SL are subject to significant loss or alteration of bioavailability during purging (to be determined in consultation with the DMMP agencies), set up the bioassays normally, without sacrificial beakers or purging. Run the ammonia reference toxicant test concurrently with a bioassay if the Ref Tox trigger is exceeded for the test organism being used.

4. If a purging trigger is exceeded for the species being used – and contaminant loss or alteration of bioavailability due to purging has been determined not to be a significant issue – prepare for purging.

Purging methods:

For sediment toxicity testing, there are a variety of approaches used by regulatory agencies, project proponents and laboratories to purge samples. Purging is most often performed either by replacing overlying water twice a day plus continuous aeration, or by aeration alone. Once the unionized ammonia and/or hydrogen sulfide concentrations are below the trigger levels in Table 1 for all test samples (labs should use the minimum purging required to bring concentrations below the NOEC), the bioassay may be initiated. Each batch of test sediments must have associated and similarly purged control and reference sediments.

For *Neanthes*, *Eohaustorius* and *Rhepoxynius*, the bioassay is set up with a sufficient number of sacrificial beakers to monitor ammonia/sulfides in interstitial water during purging. Ammonia/sulfides are also monitored in the overlying water. For *Ampelisca*, the bioassay may be set up without sacrificial beakers and ammonia/sulfides monitored in only the overlying water during purging.

For the larval test, purging via water exchanges after bioassay setup may result in loss of colloids/suspended sediments that are a critical part of the sediment evaluation. Thus, if purging is to be conducted for the larval test using water replacements, it must be conducted prior to test beaker setup. This can be accomplished by placing enough material for bioassay setup (five test beakers plus a water-quality beaker) into a single "combined" beaker and purging that beaker. Ammonia/sulfides are measured in the overlying water of the combined beaker. Purging by water replacement resulted in a loss of only 0.04% of the total wet weight of sediment used in a purging experiment performed for a federal navigation project (Herrera/Newfields, 2014). The DMMP agencies consider this a de minimis loss. At the end of the purging period, the sediment from the single combined beaker would be distributed to the individual test and water quality beakers and the larval test would commence.

If purging for the larval test is conducted by aeration alone, the test and water quality beakers are set up as they would be for the bioassay, but without the test organisms being introduced. Aeration is applied until the ammonia/sulfides concentrations in the overlying water fall below the NOEC.

Ammonia and sulfides can continue to be generated in sediment during the bioassays themselves. Therefore, if the water replacement method is used for purging, water exchanges may need to continue during the bioassay. This may be done for bedded sediment bioassays in which exposure to porewater is a critical factor. This includes the *Neanthes* test, and the amphipod test using *Eohaustorius* or *Rhepoxynius*. *Ampelisca* would only require continued water exchanges if concentrations of ammonia or sulfides in the overlying water rise above the NOEC. Continued water exchanges are not possible for the larval test. Due to the small volume of sediment used for this bioassay, aeration alone will typically be sufficient to maintain ammonia/sulfides concentrations below the NOEC.

The above describes the general approach. However, should purging be pursued for a project, there are many ways to execute the details of the purging protocol. The DMMP policy is to minimize purging to the extent practical. Purging time will be based on the range of ammonia or sulfide values measured for the test samples. Laboratories with purging experience can generally estimate, based on initial interstitial ammonia or sulfide values, the purging time required to reduce concentrations below the NOEC.

Standard Reporting of Data:

Reporting must include the following:

- All interstitial and overlying ammonia and total sulfides measurements made during pre-tests, purging and bioassay testing
- pH, temperature and salinity measurements (to be taken concurrently with all ammonia and sulfides measurements)
- calculated unionized ammonia and hydrogen sulfide concentrations for all measurements made during pre-tests, purging and bioassay testing
- dates and times of all measurements
- equations used to calculate unionized ammonia and/or hydrogen sulfide
- all ammonia Ref Tox test data
- a detailed description of the purging procedure

Case-by-case Determination to Allow Purging:

The purging process may cause loss of more volatile/less hydrophobic COCs (Ferretti, 2000; Burgess et al 2003) while less volatile compounds with a higher log K_{ow} are expected to remain associated with particles and dissolved organic matter. In addition, metals bioavailability and toxicity can be influenced by purging. In order to better understand the potential for contaminant loss from the purging process due to volatilization, Seattle District conducted pre- and post-purging chemical analysis (Herrera/NewFields, 2014) for the water replacement and aeration-only methods for the larval test. There was no systematic loss of contaminants apparent in either method. While this limited testing provided evidence that contaminant loss due to volatilization may not be an issue for the purging methods described in this paper, the DMMP agencies will continue to consider the specific contaminants triggering biological testing in decisions regarding purging. If contaminants may potentially be lost or their toxicity altered while purging for ammonia or sulfides, then purging may be disallowed or restricted in duration. Also, in some cases, ammonia or sulfides themselves may be contaminants of concern (e.g. new surface material containing wood waste) and purging may not be allowed. Purging is also not allowed for cleanup evaluations. For projects that include both cleanup and DMMP evaluation, side-by-side testing of both purged and non-purged sediments may be required.

Applicability of these Recommendations:

The intent of these recommendations is to reduce the incidence of non-treatment effects from ammonia and sulfides in DMMP bioassays and to generate supplemental data to facilitate interpretation of bioassay results when non-treatment effects cannot be totally eliminated. While not required, the dredging proponent assumes the risk of dredged material being found unsuitable for open-water disposal if potential effects of ammonia and sulfides are not proactively addressed. Proactively addressing ammonia and sulfides requires advanced planning. Sufficient volumes of sediment must be collected for sacrificial beakers; the pretesting and purging procedures must be included in the sampling and analysis plan; and holding times must be considered. The dredging proponent will need to balance the cost of these procedures against the cost of upland disposal of dredged material that fails toxicity testing due to non-treatment effects from ammonia/sulfides.

Ammonia and sulfides are more likely to be present in deeper sediments or sediments containing a significant fraction of organic material such as wood waste. Therefore, the type of sediment being tested will need to be assessed to determine the likelihood for elevated ammonia and sulfides. Initial bulk ammonia and sulfides testing by the analytical lab will also provide valuable information in this regard.

Alternative procedures from those discussed in this paper may be proposed on a project-specific basis. Justification for the selected procedures must be clearly articulated in the sampling and analysis plan.

Coordination with the DMMP Agencies:

It is critical that close coordination with the DMMP agencies be maintained throughout the process, from development of the pre-bioassay testing procedures in the sampling and analysis

plan, to decision-making about purging and details of the purging procedure itself. All procedures must be approved by the agencies before the procedures may be performed.

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Appendix A. Ammonia Literature Summary

Literature values for Effects of Ammonia on Bivalve Larval tests (all NH3 mg/L)(all water-only exposures)

Reference	NOEC	EC50	Species	
PSDDA Refinements (1993)	0.1	0.13	*C. gigas*	
Geffard et al. (2002)		0.019	*C. gigas*	This is an EC20 value from unpublished study by author referenced in 2002 paper (and converted from umole to unionized by McDonald (2005)
McDonald (2005)		0.036	*M. gallo*	Ref tox EC20 from same study = 0.028 mg/L NH3; no NOEC given for ref tox.
Phillips et al.(2005)	0.09	0.12	*M. gallo*	Also gives LOEC = 0.152 mg/L
Tang et al. (1997)	0.097	0.231	*M. gallo*	From 1997 SETAC poster abstract PMP107
Nicely (2000)	0.09		*M. gallo*	From SETAC Presentation/Poster Referenced in Phillips et al 2003.
NewFields ref tox data (2013)	0.04	0.063	*M. gallo*	Summary of LC50 data compiled by lab. Provided by Bill Gardiner 3/21/13
Greenstein et al. (1996)	0.06	0.096	*S. purpuratus*	pH 7.7 data from Table 2
Bay et al. (1993)	0.057		*S. purpuratus*	Referenced in Phillips (2005) summary table - Primary ref in book not available to DMMP
Tang et al. (1997)	0.012		*S. purpuratus*	From 1997 SETAC poster abstract PMP107
PSDDA Refinements (1993)	0.04		*S. purpuratus*	
NewFields ref tox data (2013)	0.062	0.07	*S. purpuratus*	Summary of LC50 data compiled by lab. Provided by Bill Gardiner 3/21/13
NewFields ref tox data (2013)	0.023	0.032	*Dendraster*	Summary of LC50 data compiled by lab. Provided by Bill Gardiner 3/21/13
PSDDA Refinements (1993)	0.014	0.03	*Dendraster*	Report recommends NOEC as warning level indicating that additional ammonia monitoring during test is required. EC20 value.

Literature values for Effects of Ammonia for Amphipod tests (all mg/L)

	NOEC		LC50			
Reference	TAN	NH3	TAN	NH3	Species	
Kohn et al. (1994)	14.6	0.236	49.8	0.83	*Ampelisca*	(Seawater-only exposures)
Burgess et al. (2003)			132	0.76	*Ampelisca*	interstitial water (Sediment exposure)
Burgess et al. (2003)			78	1.54	*Ampelisca*	Overlying water (Sed exposure)
SAIC (1992)			31	1.24	*Ampelisca*	Overlying water (spiked water - sed exposure)
SAIC (1992)			28	0.21	*Ampelisca*	Pore water (spiked water - sed exposure)
SAIC (1992)			28	1.09	*Ampelisca*	Overlying water (spiked sed exposure)
SAIC (1992)			66.5	0.95	*Ampelisca*	Porewater (spiked sed exposure)
MEC (1992)			48.7	0.74	*Ampelisca*	extracted porewater
EPA (1993)		0.4			*Ampelisca*	Overlying water (sediment exposure); Based on BPJ of EPA researchers developing the standard amphipod protocols
Kohn et al. (1994)	67.1	1.298	125.5	2.49	*Eohaustorius*	Seawater-only exposures
EPA (1993)		0.8			*Eohaustorius*	Overlying water (sediment exposure); Based on BPJ of EPA researchers developing the standard amphipod protocols
Kohn (1994)	36.3	0.677	79	1.6	*Rhepoxinius*	Seawater-only exposures
EPA (1993)		0.4			*Rhepoxinius*	Overlying water (sediment exposure); Based on BPJ of EPA researchers developing the standard amphipod protocols

Literature values for Effects of Ammonia for Neanthes tests (all mg/L)

	NOEC		"Adverse effects" (LC/EC20)	
Reference	TAN	NH3	TAN	NH3
Dillon et al. (1993)	10	0.461	20	0.68

Lowest NOEC highlighted in red

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Appendix B: Sulfide Literature summary

Literature values for Effects of Sulfides on Larval tests (H_2S, ug/L)

Reference	Dose range	NOEC	LOEC	EC50/LC50	Species
Knezovich et al. (1996)	1 to 64	5.0	9.0	10.0	*Mytilus*
Westin (2006)	2.1 to 13.3	2.5	6.3	7.0	*Mytilus* , static renewal average of two test
Knezovich et al. (1996)	1 to 64	10.0	13.0	19.0	*Strongylocentrotus*

Literature values for Effects of Sulfides on Amphipods (H_2S, ug/L)

Reference	Dose range	NOEC	LOEC	EC50/LC50	Species
Knezovich et al. (1996)	32 to 250	99	147	160	*Rhepoxynius*
Knezovich et al. (1996)	35 to 435	122	192	332	*Eohaustorius*
Westin (2006)*	1.4 to 66.4	9.4	22	40.2	*Ampelseca*

Literature values for Effects of Sulfides on *Neanthes* (H_2S, ug/L)

Reference	Dose range	NOEC	LOEC	EC50/LC50
Westin (2006)	0.5 to 123	no effects at any dose		
Dillon et al. (1993)	1400 to 15,000	3400	5500	close to 5500

Notes:

Knezovich et al., 1996 conducted sealed, flow-through, 48-h, water only exposures

Westin 2006 conducted continuous flow, 96-hr exposures for amphipods and *Neanthes* , and 48-h exposures for larval species.

Dillon et al., 1993 conducted static 96-hr, water only exposures

* *Ampelesca* tests repeated in this series. Test 1 data shown; test 2 had LOEC = LC50 which was >55.7 ug/L H2S; this test had poor control survival and high variability

proposed guidance for purging highlighted in blue.

Appendix B References

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