

DMMP Clarification Paper: New DMMP Guidelines for Phthalates

Prepared by Thomas H. Gries (Washington Department of Ecology, Toxics Cleanup Program/Sediment Management Unit) for the DMMP agencies

INTRODUCTION

Apparent Effect Threshold values (AETs) for phthalate compounds were first calculated in 1985 (1). These AET values were based on the highest no effect (“no hit”) concentration among four indices of biological effects: amphipod mortality, benthic community abundance, Microtox luminescence and oyster abnormality. These values were subsequently revised to reflect new synoptic data (2). In 1988, the Puget Sound Dredged Disposal Analysis (PSDDA) program adopted screening level guidelines based on one-tenth the highest AET (HAET/10) or the lowest AET (LAET), whichever was lower, as long as the value was greater than the concentration found at reference areas (3, 4). Screening Levels (SLs) for phthalates, however, were among the exceptions. SLs in this case were based on the HAET, mainly because these compounds were common laboratory contaminants and believed to exhibit relatively low aquatic toxicity (4). For these same reasons, PSDDA did not require toxicity testing for any sample exceeding SLs for only phthalates.

An independent Regulatory Work Group charged by the DMMP agencies with evaluating potential changes to numeric sediment quality guidelines recommended that all SL values should be set equal to LAET values incorporating newer amphipod mortality data. The majority of the group recommended that SL values should not decline because current guidelines were adequately protective of disposal site conditions and need not become more stringent (5). The DMMP agencies agreed with the former recommendation, but disagreed with the latter condition, believing that LAETs should establish the SLs. However, the agencies acknowledged the different basis for phthalate SLs and agreed, on an interim basis, to set phthalate SLs equal to the newest HAETs (6, 7).

PROBLEM IDENTIFICATION

The agencies subsequently became concerned about the possible ramifications of this and other differences between how the DMMP and Sediment Management Standards (SMS) programs evaluate risk from exposures to sediment phthalates. These differences or inconsistencies are first listed below and then described in the following paragraphs.

- 1. Different basis for screening level guidelines/criteria*
- 2. Existence of and basis for higher level regulatory values*
- 3. Different relationship to biological testing*

1. Different basis for screening level guidelines/criteria

The basis of SL values for phthalates used in the DMMP differs from that of the conceptually analogous Sediment Quality Standards (SQS) contained in the SMS rule. The former reflect dry weight-normalized HAET values while the latter reflect organic

carbon-normalized LAETs. This programmatic difference can result in conflicting interpretations of data. For example, a sample containing approximately 1000 µg bis(2-ethylhexyl) phthalate per kilogram dry weight sediment and 2% organic carbon would have 50 mg bis(2-ethylhexyl)phthalate per kilogram organic carbon. This sample would not exceed the current SL of 8,300 ppb dry weight but would exceed the SQS of 47 mg/Kg OC. Similarly, if the same sample contained 100 ug butylbenzyl phthalate per kilogram of dry weight, it would not exceed the current SL of 970 ug/Kg dry weight but would exceed the SQS of 4.9 mg/Kg OC. In this example, the DMMP agencies would judge the material to be suitable for open-water disposal without requiring biological testing (unless other SL exceedances were found). But it is also possible that the same material would degrade conditions at the disposal site and, in so doing, a) violate antidegradation policies and b) put the site at risk of being considered a sediment impact zone under Section IV of 173-204 Washington Administrative Code (WAC). One purpose of this clarification paper is to reduce, if not entirely eliminate, this programmatic difference.

2. Existence of and basis for higher level regulatory values

The original PSDDA program did not establish maximum level guidelines for phthalate compounds. The agencies were reluctant to designate dredged material containing only phthalates above MLs to be unsuitable for open-water disposal when these compounds were known to be common laboratory contaminants (4). Besides, HAETs - the basis for MLs - were already used to set SLs (see Introduction).

The DMMP agencies have twice revised guideline values for many contaminants of concern. First, several SLs that differed little from achievable analytical detection limits were raised after verifying that there was no loss in ability of the suite of SLs to predict significant adverse biological effects (8). Second, as mentioned in the Introduction, numerous guideline values were revised to reflect both the availability of newer synoptic data and the recommendations of the Regulatory Work Group (6, 7). On this latter occasion, the agencies elected to maintain maximum consistency with the original PSDDA approach and so again did not establish MLs for phthalates.

However, there are at least two separate lines of evidence indicating that elevated phthalates can be associated with and predictive of significant biological effects. Analyses of both marine and freshwater synoptic sediment databases for the Pacific Northwest region reveal that phthalates contribute substantively to the ability of a suite of sediment quality values to predict significant adverse biological effects. Either phthalates themselves or co-occurring contaminants contribute to observations of benthic community impairment (2) or toxicity (9).

Establishing MLs for phthalates would a) greatly reduced concern about phthalates as laboratory contaminants, b) reflect realistic potential for cause-effect relationships, c) provide greater programmatic consistency and d) provide useful information on which to base decisions on biological testing. Furthermore, the regulatory implications of exceeding an ML value have changed (10), so setting phthalate MLs equal to the HAET should not result in onerous testing requirements.

One concern about the DMMP establishing phthalate MLs is that they would be based dry weight-normalized HAET values, while the SMS program's Cleanup Screening Levels (CSLs) and Minimum Cleanup Levels (MCULs) criteria are based on the second lowest organic carbon-normalized AETs. This also represents a programmatic difference, but one that is perceived more than real. The implications of exceeding a phthalate ML or CSL/MCUL are very similar. Biological evaluations can be conducted and similar programmatic interpretations of the results will either confirm that the sediment requires remediation and is unsuitable for open-water disposal, or "override" the chemical evidence for unacceptable biological effects.

3. *Different relationship to biological testing*

For reasons described in the Introduction, existing DMMP guidelines do not require an evaluation of adverse biological effects, e.g., toxicity tests, if screening values only for one or more phthalates are exceeded. However, this can no longer be scientifically justified when one considers a) appropriate protocols and controls should now eliminate most concerns about phthalates as laboratory artifacts, b) published values for phthalate toxicity and potential for bioaccumulation of phthalates in marine organisms, c) the lines of evidence indicating that predictive ability is improved when sediment quality values for phthalates are included. In addition, not requiring biological evaluation of sediment exceeding a phthalate SL or ML (alone) is inconsistent with the SMS rule, where exceedance of any SQS value can trigger such.

PROPOSED CLARIFICATIONS

1.

The DMMP agencies propose replacing the existing SLs for phthalate compounds, currently based on 1998 HAET, with ones equal to the lowest 1998 dry weight-normalized AETs (amphipod, benthic, Microtox and oyster)¹. The agencies analyzed the potential implications of implementing this change and have summarized the results in Table 1 below. None of the 1137 samples from 52 past dredging projects exceeded *only* phthalate SLs based on either 1988 or 1998 HAETs. Only four of the 1137 samples (0.35%) exceeded proposed SLs that are based on 1998 LAET values. This analysis indicates that this proposal will result in greater consistency between the DMMP and the SMS program with negligible additional cost.

Furthermore, analytical methods and standard operating procedures have improved during the past 15 years to address the potential for laboratory phthalates to contaminate environmental samples, so this should no longer be a major consideration in establishing guideline values.

¹ Ecology's 1998-1999 efforts to revise Puget Sound AETs and amend the Sediment Management Standards rule using additional biological indicators, such as decreased neanthes growth, did not result in a final, technically valid suite of updated LAETs upon which new phthalate guidelines can be based.

Chemical Name	1988 SL ^a	# samples w/ detects >SL	1998 SL/ 2004 ML ^b	# samples w/ detects >SL	2004 SL ^c	# samples w/ detects >SL
Any chemical	Various	430/1137	Various	171/1137	Various	175/1137
Bis(2ethylhexyl) phthalate	3100	0/245	8300	0/245	1300	10/245
Butbenzphthalate	470	1/52	970	0/52	63	17/52
Diethylphthalate	97	0/22	1200	0/22	200	0/22
Di-n-butylphthalate	1400	0/40	5100	0/40	1400	0/40
Di-n-octylphthalate	69000	0/49	6200	0/49	6200	0/49
Dimethylphthalate	160	0/15	1400	0/15	71	0/15
Phthalates only	Various	0/430	Various	0/171	Various	4/175

Table 1. Number of samples exceeding any DMMP SL value, number of samples exceeding individual phthalate SL values, and number of samples only exceeding phthalate SLs. Dataset based on 52 past dredging project projects, 506 station locations (463 with detected chemicals of concern) and 1137 separate samples (671 with detected chemicals of concern). a) based on 1986 HAET, b) 1998 SL and/or 2004 ML both based on 1998 HAET, c) based on 1998 LAET.

2.

For the first time, the DMMP agencies propose establishing MLs for phthalate compounds based on 1998 HAET. Implications of this action also appear to be negligible (see columns 4 and 5 above).

3.

The agencies further propose requiring biological evaluation of sediment samples that exceed any phthalate SL (or ML) even if no other SL is exceeded. One-hit and two-hit guidelines for interpreting toxicity tests and benthic community effects would not change.

In summary, the DMMP agencies propose to

- *Establish 2004 phthalate SL guidelines equal to the 1998 LAET values (See Table 1, Column #6)*
- *Establish 2004 phthalate MLs equal to the 1998 HAET values (See Table 1, Column #4)*
- *Require biological evaluation of dredged material if the concentration of any phthalate compounds exceeds its SL (or ML) values, even if no other chemical SL is exceeded.*

Finally, the DMMP agencies believe strongly that best scientific information should be incorporated into evaluation, management and monitoring guidelines in a timely manner (notwithstanding limited resources). Scientific information pertaining to the evaluation of sediment quality is emerging at a rapid rate. The U.S. EPA has finalized equilibrium partitioning-based sediment benchmarks or “ESBs” (II). Ecology may eventually complete the technical work required to finalize new AETs based on a) new benthic community indices, b) decreased Neanthes growth, and c) abnormal development of

bivalve larvae, and/or d) abnormal development of echinoderm larvae. In addition, there are other approaches to calculating sediment quality guidelines, e.g., logistic regression model values (12). Taken altogether, these may lead the agencies to undertake a comprehensive revision of DMMP guidelines in the future. Any such a revision will necessarily need to consider using sediment quality values, such as AETs, in a manner that is conceptually consistent with the SMS program and criteria.

REFERENCES

1. PSDDA. 1986. Development of Sediment Quality values for Puget Sound. Volume I. Prepared for the PSDDA agencies by Tetra Tech, Inc.
2. U.S. EPA. 1988. Sediment Quality Values Refinement: Volume I. Update and Evaluation of Puget Sound AET. Prepared by PTI Environmental Services, Inc.
3. PSDDA. 1989. Management Plan Report. Unconfined Open-Water Disposal of Dredged Material, Phases I and II.
4. PSDDA. 1988. Evaluation Procedures Technical Appendix.
5. Regulatory Work Group. 1997. Recommendations Related to Future Evaluations of Apparent Effects Threshold and DMMP Guideline Values. Final Memorandum for Record.
6. Washington Department of Ecology. 1996. Progress Re-evaluating Puget Sound AETs. April 1996 Draft Report.
7. DMMP. 1997. Minutes to the 1997 Sediment Management Annual Review Meeting. [Revisions to DMMP Screening Level and Maximum Level Guidelines.](#)
8. PSDDA Annual Review Meeting, 1991. Issue Paper: Recommended Changes to Selected PSDDA Screening Levels. Management Plan Annual Report.
9. Ecology, 2003. Development of Freshwater Sediment Quality Values for Use in Washington State, Phase II Report. Prepared By Avocet Consulting and SAIC for the Washington Department of Ecology.
10. DMMP, 2000. Purpose of Maximum Level (ML) - Clarification of Use in Regulatory Program. http://www.nws.usace.army.mil/publicmenu/DOCUMENTS/ML_Clar_00.pdf
11. U.S. EPA. 2000. Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms. Various Documents.
12. Field, L. J., et al. 1999. Evaluating sediment chemistry and toxicity data using logistic regression modeling. *Environ. Toxicol. Chem.* 18:1311-1322.