REVISIONS TO DMMP SCREENING AND MAXIMUM LEVEL GUIDELINES

AN ISSUE PAPER prepared for the CSMP agencies by Tom Gries (Department of Ecology)

INTRODUCTION

Apparent Effects Threshold values (AETs) are the main basis for establishing DMMP maximum and screening level guidelines (MLs and SLs). Most ML values, but not all, were initially set equal to the level of the highest AET (HAET). SLs were then defined as one-tenth of the ML or the lowest AET (LAET), whichever is lower. The current DMMP guidelines are based on 1988 AETs ***(1)***, most of which are calculated from synoptic sediment quality data collected from throughout Puget Sound prior to 1986. In an effort to update the guidelines, the Department of Ecology (Ecology) compiled newer data through a cutoff date in early 1993, and following essentially the same methodology, calculated new amphipod and sediment larval AETs. On behalf of the DMMP agencies, Ecology next:

- presented early results and outlined future work ***(2, 3, 4, 5)***
- prepared a draft report on "Progress Re-evaluating Some Puget Sound AETs" and released it for internal and peer review ***(6)***
- suggested the new AET values were a valid basis for revising SLs and MLs
- identified the tasks which still needed to be addressed before new AETs could be used to revise the guidelines ***(7, 8)***

PROBLEM IDENTIFICATION

Competing priorities and limited resources prevented Ecology from completing all of the tasks identified during the 1994 and 1995 annual review meetings. A second draft report which addressed many agency and peer comments was not released for public review until the 1996 Sediment Management Annual Review Meeting (SMARM) ***(9)***. At that meeting, stakeholders identified a number of concerns about technical aspects of the AET re-evaluation effort ***(10)***. They also questioned the process for integrating new information into DMMP guidelines in a timely fashion.

The Ecology and DMMP response to stakeholder concerns was to undertake a key remaining task -- to convene a Regulatory Work Group (RWG) to make specific recommendations to the DMMP agencies on how new AETs should be used to revise SLs and MLs. The RWG, composed of some 15 experts with extensive technical and policy expertise in sediment quality issues, met five times between November 1996 and February 1997.

Regulatory Work Group (RWG) Process and Recommendations

The Puget Sound Water Quality Action Team facilitated the five RWG meetings in order to promote making consensus recommendations in a short time frame. Members also agreed to offer their own professional expertise only and not represent the interests of their respective agency or company. The group next redefined its purposes as follows.

- To establish a procedural feedback loop in the DMMP program by which predictive reliability of SLs can be evaluated
- To develop a process for evaluating data sets which indicate that ML values may be too low

The RWG agreed to three objectives:

- To re-evaluate assumptions underlying the AET approach, methods and numbers
- To recommend revisions to DMMP guideline values, if justified
- To recommend actions to streamline the process for re-evaluating AETs or guidelines

In order to address these purposes and objectives, the RWG identified and prioritized 13 issues for discussion during the course of the meetings. Discussions resulted in numerous consensus recommendations which were forwarded to the DMMP agencies for their consideration ***(11)***. These were grouped according to the anticipated level of effort needed to conduct the supporting analyses and prepare necessary issue papers for the annual review process. Short-term recommendations were for changes to the DMMP program which the agencies should propose at the 1997 SMARM, and for implementation during DY 1998. The short-term recommendations relating to revising DMMP guidelines are listed below.

1. *DMMP should not derive SLs from MLs, e.g. 10% of ML values*
2. *DMMP should set SLs equal to the lowest AET (LAET), when appropriate*
3. *DMMP should use environmentally relevant indicators of biological effects to set SLs*
4. *DMMP should set new SLs based on the LAETs from among 1986 benthic abundance AETs, 1986 Microtox luminescence AETs, 1988 and 1994 amphipod mortality AETs, and a 1994 sediment larval AET derived from combining the 1986 oyster and 1994 echinoderm abnormality data*
5. *DMMP should conduct a chemical quality assurance review at the "QA2" level for all data sets containing samples setting new AETs*
6. *DMMP should not propose at the 1997 SMARM to lower SLs below the current values*
7. *DMMP should set maximum level values (MLs) equal to the highest AET (HAET), when appropriate*
8. *DMMP should determine the HAETs from among 1986 benthic abundance AETs, 1986 Microtox luminescence AETs, 1988 and 1994 amphipod mortality AETs, and a 1994 sediment larval AET derived from 1986 oyster and 1994 echinoderm abnormality data*
9. *Ecology should evaluate any MLs which increase for their bioaccumulation and biomagnification potential*
10. *DMMP should not automatically change the bioaccumulation trigger level guidelines (BTs) as a result of changes to MLs*
11. *DMMP should consider other rationale, including cost, in cases where ML values decrease*

12. *DMMP should normalize SL and ML values to TOC for non-polar organic contaminants of concern*
13. *DMMP should follow the most recent TOC-normalization guidelines or policies developed by the Sediment Management Standards (SMS) program when implementing the new SLs and MLs*

Additional short-term recommendations of the RWG are addressed in a separate clarification paper, "AET METHODOLOGY: CLARIFICATION AND MINOR REVISIONS."

ANALYSIS AND DISCUSSION

The DMMP agencies acknowledge the need to use new AETs and other recent information to revise SL and ML values. The reason the agencies convened an independent RWG was to ensure that any major revisions to guideline values and policies would be based on sound technical information, accepted procedures and objective recommendations. We appreciate the technical and policy review and recommendations provided by the RWG. After weighing earlier discussions and the short-term recommendations listed above, we have prepared this issue paper discussing the RWG recommendations below, and proposing changes to guideline values in the section on proposed actions/modifications.

Revising Screening Level Guidelines (Recommendations 1-6)

The DMMP agencies strongly concur with most of the final RWG recommendations, especially the recommendation to set SLs equal to the LAET and to delink them from MLs or the HAET. Establishing SLs by this means is more technically sound and better reflects the management objective, which allows minor adverse effects at the disposal sites stated in the original DMMP guidance documents ***(12)***. In addition, this definition of SLs is conceptually consistent with Sediment Quality Standards (SQS) values used in Ecology's SMS cleanup and source control programs.

The RWG deliberated about which groups of AETs to use in determining new LAETs. Their consensus recommendation was that 1994 amphipod mortality and echinoderm abnormality AET values should be included in determining new LAETs. This supports the long-standing belief that 1994 AETs are technically sound, in part, because they were calculated using essentially the same methods as used in 1988 to set AET values.

However, the DMMP agencies are not convinced that it is appropriate to arithmetically combine the 1986 oyster and 1994 echinoderm larval data into a single group of sediment larval abnormality AETs, as recommended by the RWG. The evidence that bivalve and echinoderm larval species respond equally to standard reference toxicants and sediment exposures remains equivocal. There is still disagreement on this point among marine sediment larval experts who are familiar with standard toxicity testing protocols. This is reflected in one of the medium-term RWG recommendations: to convene a workshop for regional sediment larval experts.

In addition, Ecology has only partly characterized the predictive reliability of separate

1986 oyster and 1994 echinoderm AETs, and has not evaluated the reliability of 1986 oyster and 1994 echinoderm AETs when the values are combined. Larval AET values derived in this manner are expected to be higher than if the two groups of larval AETs are used separately. Higher larval values, in turn, are relatively less predictively sensitive and more efficient . Screening levels, by virtue of their purpose (to screen for possible biological effects and possible biological testing), should be relatively more sensitive than efficient.

For the reasons cited above, the agencies believe it is preferable to consider bivalve and echinoderm larvae separate and distinct for the short-term purpose of determining new LAETs and SLs for implementation.

The DMMP agencies recognize that determining new LAETs using the 1994 echinoderm AETs as a fifth group of AET values would decrease LAET values for 22 chemicals of concern. Therefore, many SLs would also decrease. This conflicts with the RWG recommendation that the DMMP should not lower any SLs because there is no evidence from monitoring any Puget Sound disposal site (using current site monitoring guidelines and site evaluation tools) that disposal activities have caused more than minor adverse effects.

There is no compelling reason, however, to propose only increasing SL values if some new LAETs decline and others increase. This issue was carefully considered by the DMMP agencies, who subsequently rejected the RWG recommendation. The DMMP decided that SLs should be objectively set by the lowest AET, whether higher or lower than the existing SL. As a short-term compromise, the agencies will defer using the 1994 echinoderm AETs as one basis for new SLs until they can evaluate expert recommendations from the larval workshop held recently. In the meantime, the agencies will use 1994 amphipod, 1988 benthic, 1986 Microtox and 1986 oyster AETs to determine LAETs. Under this scenario, only one SL decreases.

Revising Maximum Levels (Recommendations 7-11)

The DMMP agencies concur with the RWG short-term recommendation to set all ML values equal to the new HAETs. Adopting this recommendation will increase some of the current ML values and lower others. We believe that doing so will clarify the conceptual basis for MLs overall; MLs based on the highest of four (or more) AETs represent "cross bars" above which numerous significant adverse biological effects are predicted to occur. Sediments exceeding such MLs should seldom be suitable for open water disposal.

Finally, the agencies agree that BT levels should not automatically change in response to new MLs; none of the current suite of Puget Sound AETs is based on bioaccumulation potential. But to avoid programmatic conflicts, the agencies will need to raise some of the existing BT values to equal the new SLs and lower others to equal the new MLs. However, the RWG recommendation does not preclude future changes to BTs based on new human health-based risk information, for example. In fact, the agencies have begun re-evaluating technical guidance on bioaccumulation. This evaluation process will revise

chemicals of concern, and establish sediment bioaccumulation triggers as well as effects-based tissue interpretation guidelines.

It will be important for the DMMP agencies to evaluate whether or not significant changes to MLs (SLs or BTs) could place the DMMP disposal sites at risk. This will be assessed as part of future monitoring efforts.

Normalizing DMMP Guidelines to TOC (Recommendations 12-13)

The DMMP agencies initially believed it appropriate to TOC-normalize SL and ML guidelines for non-polar organic chemicals of concern. The EPA Science Advisory Board made the same recommendation in 1989 ***(13)*** based on the presumption that biological availability of non-polar organic contaminants is related to their form in sediment. However, the agencies also found that 1988 TOC-normalized AETs were only marginally more predictive of biological effects in Puget Sound than comparable dry weight-normalized AETs. Therefore, before proposing and adopting new TOC-normalized guidelines, which would increase the complexity of data analysis and interpretation, it will be important to determine whether or not these would have a greater or lesser predictive reliability than guidelines based on dry-weight normalized values.

PROPOSED ACTIONS/MODIFICATIONS

Since 1995, the DMMP agencies have had technically sound new AET values which provide us the basis to revise SL and ML guidelines. The agencies are committed to making changes to current guidelines which are scientifically defensible and practicable, as well as streamlining the process for making future changes.

In the short-term, the agencies are using 1994 amphipod mortality, 1986 benthic abundance, 1986 Microtox and oyster larval abnormality AETs to identify new LAET and HAET values.

Because the agencies have yet to compare the reliability of TOC-normalized LAETs to dry weight-normalized values, we are adopting dry weight SLs equal to the new LAET values, and dry weight MLs equal to the new HAET values. **The new SLs and MLs are presented in Table 1.**

The DMM P agencies are also adopting seven new BT values. Three result from increasing SLs: antimony BT = 150 ppm (formerly 146 ppm), silver BT = 6.1 ppm (formerly 4.6 ppm) and dimethylphthalate BT = 1,400 ppb (formerly 1168 ppb). Four BT values decrease to the level of new, lower ML values: Nickel BT = 370 ppm (formerly 1,022 ppm), benzo(a)pyrene BT = 3,600 ppb (formerly 4,964 ppb), 1,4-dichlorobenzene BT = 120 ppb (formerly 190 ppb), and N-nitrosodiphenylamine BT = 130 ppb (formerly 161 ppb). These changes are reflected in the revised PSDDA User's Manual (Table 5).

Summary of implications

To evaluate the implications of adopting the new guideline values, the Corps and Ecology conducted the following analyses.

- Compared a large group of samples from urban bays throughout Puget Sound to current and proposed dry weight-normalized SL/ML guidelines
- Compared a large group of samples from past DMMP projects to those same guidelines
- Compiled the fraction of samples from past DMMP projects for which toxicity testing would not have been necessary if the proposed SLs were in effect. In other words, what is the relative fraction of past DMMP samples which would no longer exceed any SL value?
- Evaluated the fraction of samples no longer requiring toxicity testing which actually showed significant adverse effects (false negative results under the new guidelines)
- Compiled the fraction of samples from past DMMP projects which no longer exceed any proposed ML value

Using results from over 4400 samples and subsamples taken from urban bays throughout Puget Sound, the agencies found 59% fewer exceedances of new SL values compared to existing ones. An evaluation of nineteen dredging projects tested over the past eight years (347 samples) revealed 72 samples with no SL exceedances under the old guidelines but 120 samples with no SL exceedances under the new guidelines. This represents a potential net reduction in required biological testing of around 14%. Only eight of these 120 samples, which all underwent toxicity testing, showed significant adverse effects. This is equivalent to a false negative response rate of around 7% for the data set.

Using the same 4400+ sample and subsample results, the agencies found a 43% reduction in the number of exceedances of the new MLs compared to existing ones. Similarly, using the same 19 dredging projects and 347 total samples, 36 samples exceeded at least one of the old ML guidelines compared to 25 samples exceeding new guidelines. This corresponds to a net reduction of 31% in ML exceedances and, assuming some of the samples would be found suitable for unconfined open-water disposal after undergoing toxicity testing, a potentially significant cost savings to dredging applicants.

The DMMP agencies consider the results of these analyses to validate the program's dredged material evaluation procedures and to represent an acceptable, minimal additional risk to the disposal sites. However, the agencies will remain vigilant to ensure that the potential for additional contaminant loading to the disposal sites, resulting from raising some SL and ML values, does not cause the disposal sites to exceed Site Condition II or SMS criteria, and will evaluate these changes during future site monitoring efforts.

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Table 1. Revised DMMP Screening and Maximum Level Guidelines.

AET Group(s)	OLD SL	1998 SL	OLD ML	1998 ML
Biol. Effects Indicators	**Dry Wt.**	**Dry Wt.**	**Dry Wt.**	**Dry Wt.**
Metals (mg/kg)				
Antimony	20	150	200	200
Arsenic	57	57	700	700
Cadmium	0.96	5.1	9.6	14
Chromium				
Copper	81	390	810	1,300
Lead	66	450	660	1,200
Mercury	0.21	0.41	2.1	2.3
Nickel	140	140	--	370
Silver	1.2	6.1	6.1	8.4
TBT				
Zinc	160	410	1,600	3,800
Organic Compounds				
Low molecular weight PAH (ug/kg)				
LPAH	610	5,200	6,100	29,000
2-Methylnaphthalene	67	670	670	1,900
Acenaphthene	63	500	630	2,000
Acenaphthylene	64	560	640	1,300
Anthracene	130	960	1,300	13,000
Fluorene	64	540	640	3,600
Naphthalene	210	2,100	2,100	2,400
Phenanthrene	320	1,500	3,200	21,000
High molecular weight PAH (ug/kg)				
HPAH	1,800	12,000	51,000	69,000
Benz[a]anthracene	450	1,300	4,500	5,100
Benzo[a]pyrene	680	1,600	6,800	3,600
Benzofluoranthenes	800	3,200	8,000	9,900

Benzo[ghi]perylene	540	670	5,400	3,200
Chrysene	670	1,400	6,700	21,000
Dibenzo(a,h)anthracene	120	230	1,200	1,900
Fluoranthene	630	1,700	6,300	30,000
Indeno(1,2,3-c,d)pyrene	69	600	5,200	4,400
Pyrene	430	2,600	7,300	16,000
Chlorinated organic compounds (ug/kg)				
1,2-dichlorobenzene	19	35	350	110
1,2,4-trichlorobenzene	13	31	64	64
1,3-dichlorobenzene	170	170	--	--
1,4-dichlorobenzene	26	110	260	120
Hexachlorobenzene	23	22	230	230
Phthalates (ug/kg)				
Bis[2-ethylhexyl] phthalate	3,100	>8,300	--	--
Butyl benzyl phthalate	470	970	--	--
Diethylphthalate	97	>1,200	--	--
Dimethylphthalate	160	>1,400	--	--
Di-n-butyl phthalate	1,400	>5,100	--	--
Di-n-octyl phthalate	6,200	6,200	--	--
Phenols (ug/kg)				
2-methyl phenol	20	63	72	77
2,4-dimethyl phenol	29	29	50	210
4-methylphenol	120	670	1,200	3,600
Pentachlorophenol	100	400	690	690
Phenol	120	420	1,200	1,200
Miscellaneous Extractables (ug/kg)				
Benzoic acid	400	650	690	760
Benzyl alcohol	25	57	73	870
Dibenzofuran	54	540	540	1,700
Hexachlorobutadiene	29	29	290	270

Hexachloroethane		1,400		14,000
Hexachloroethane*	**1,400**	**1,400**	**14,000**	**14,000**
N-Nitrosodiphenylamine	28	28	220	130
Volatile organics (ug/kg)				
Ethylbenzene	10	10	50	50
Tetrachloroethene	14	57	210	210
Trichloroethene*	**160**	**160**	**1,600**	**1,600**
Xylene, Total	12	40	160	160
Pesticides and PCBs (ug/kg)				
Aldrin	10	10	--	--
Chlordane	10	10	--	--
Dieldrin	10	10	--	--
Heptachlor	10	10	--	--
Lindane	10	10	--	--
Total DDT	6.9	6.9	69	69
Total PCBS	130	130	2,500	3,100

* guideline values derived through equilibrium partitioning