TIERED OCEAN DISPOSAL MONITORING WILL MINIMIZE DATA REQUIREMENTS

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ABSTRACT
EPA has developed guidance for a tiered approach to ocean disposal monitoring that includes the following major elements:

1) A hierarchy of monitoring tiers including compliance, nearfield, farfield, marine resources, and ocean processes,
2) Regulatory and environmental endpoints and related null hypotheses for each tier,
3) An iterative process of predicting and field testing disposed waste transport, fate, and effects,
4) A quality assurance plan, and
5) A data management and reporting plan

1. INTRODUCTION
EPA is responsible under the Clean Water Act (CWA, PL 95-217) and the Marine Protection, Research, and Sanctuaries Act (MPRSA, PL 92-532) for ensuring that man's activities, specifically ocean disposal, do not unreasonably degrade coastal or open ocean waters. This responsibility includes monitoring environmental and human health effects of ocean discharges, ocean dumping of dredged material, and ocean incineration. The purpose of this paper is to describe EPA's strategy for developing and implementing cost-effective ocean disposal monitoring plans.

EPA administers its ocean disposal regulatory responsibilities through issuance of ocean discharge permits under the CWA and ocean dumping permits under the MPRSA. The Agency has developed requirements for permit issuance and standards for ocean disposal management which allow only limited environmental effects during individual operations as well as limited accumulative effects from multiple or continuing dumping activities. For example, EPA's ocean dumping regulations and permits require that limiting permissible concentrations (LPC) of toxic constituents must be met at ocean disposal boundaries at all times, also, that the LPCs must be met everywhere four hours after ocean dumping (40 CFR 227.29). In addition, EPA's regulations (40 CFR 228.10) list several ocean dumping effects (standards) which must be considered when determining whether a designated disposal is being unreasonably degraded. EPA presumes that compliance with these kinds of permit requirements and disposal management standards will protect the marine environment from unreasonable degradation as mandated by the MPRSA.

The goal of EPA's ocean monitoring program is to provide program managers with reliable information, in a cost-effective manner, on ocean disposal effects on the marine environment. Such information is needed for decisions on permit reissuance and disposal designation modifications, also, in response to public concerns about human health and environmental protection. Consistent with this goal, the Agency's first monitoring priority is to provide reliable, low-cost information on compliance with permit requirements and disposal management standards. Our second priority is to verify the above-stated presumption that compliance with permit requirements and disposal management standards does, in fact, protect the marine environment from unreasonable degradation.
EPA's ocean monitoring strategy is directly responsive to the above-stated goal and priorities. None of the several major elements of EPA's ocean monitoring strategy, as described below, is new. What is new is the way we have packaged the several elements into a cohesive, logical strategy. EPA's ocean disposal monitoring strategy applies directly to ocean dumping of M&I wastes, ocean dumping of dredged materials, and ocean incineration. The strategy also applies in principle to ocean discharges under §§301(h) and 403(c), CWA.

2. TIERED MONITORING STRATEGY OVERVIEW

Because EPA fully supports the need to impose time and resource constraints on major activities, our ocean monitoring strategy is intended to generate only that information which is needed by program management for decision-making. With this in mind and from our review of traditional monitoring activities and existing concepts, we have decided to apply a tiered approach as the logic framework for our strategy. (Please note that, as shown on Figure 1, the so-called "higher tiers" on the monitoring pyramid are the lower numbered tiers and vice versa.) Within this framework, all EPA ocean disposal monitoring plans should have the following major elements:

1) regulatory and/or environmental objectives, endpoints, and null hypotheses (H0) in each tier,

2) an iterative process of predicting and field-testing discharged waste transport, fate, and effects,

3) a hierarchy of monitoring tiers (as shown, for example, on Figure 1),

4) a quality assurance plan, and

5) a data management and reporting plan.

Each of these major elements is discussed briefly below.

3. OBJECTIVES, ENDPOINTS, AND NULL HYPOTHESES

Although a hierarchy (pyramid) of tiers provides the logic framework for EPA's ocean monitoring strategy, explicitly stated monitoring objectives, endpoints, and null hypotheses (H0) are the real substance of the strategy. This is because, once we have achieved the monitoring objectives of a tier, requirements for additional data in that tier may be substantially reduced. Therefore, it is essential that all analyses and field or laboratory studies of each tier be responsive to one or more, explicitly stated regulatory or environmental protection objectives. Short-term (or nearfield) ocean dumping monitoring activities, for example, would likely focus on assessment of compliance with LPC requirements within the dumpsite and at the dumpsite boundary. Such a regulatory objective is directly responsive to EPA's monitoring goal. Nearfield monitoring activities may also focus on assessment of sediment deposition and composition within the dumpsite (40 CFR 228.10(b) (4)) as a dumpsite management (or environmental protection) objective.

More specifically, the stated objective(s) of each tier should focus on regulatory or environmental protection endpoints against which predicted and measured effects can be compared. Such endpoints may be either quantitative or qualitative. LPC requirements, for example, are quantitative endpoints against which predicted and measured pollutant concentrations may be compared. A qualitative endpoint, on the other hand, could be that waste pollutants must not accumulate within a dumpsite to such an extent that major uses of the site and adjacent areas are significantly impaired. Definitive endpoints such as these will help to minimize data requirements if all field and laboratory studies of each tier in an individual monitoring plan are responsive to the regulatory or environmental protection endpoints of that tier.

Finally, each tier must have H0's directed at each of the regulatory or environmental protection endpoints. H0's are statements or conclusions about compliance with endpoints that may be tested in the field. The rationale for this requirement is simple. Once an H0 has been demonstrated to be true within an acceptable range of uncertainty, related field studies may be reduced to a level that will continue to verify that the H0 is true under varied waste characteristics and disposal conditions. A typical H0 may be: "Toxic concentrations at the dumpsite boundary do not exceed the LPC for the most sensitive indigenous species."
5. MONITORING TIERs

Figure 1 shows an example of a comprehensive, five-tiered monitoring pyramid that includes: (1) source characterization, (2) short-term (nearfield) monitoring, (3) long-term (farfield) monitoring, (4) biologic effects and/or marine resources monitoring, (5) and ocean process monitoring. Again, note that the so-called higher tiers have lower numbers. As indicated on Figure 1, each of these tiers has a spatiotemporal context ranging, for example, from relatively instantaneous sampling of wastes from a barge for physical and chemical analysis to very long-term study and analysis of the effects of major ocean currents and water mass movements on ocean disposal transport, fate, and effects.

Simply put, EPA's tiered monitoring strategy... and the individual ocean disposal monitoring plans that will flow from this strategy... tend to answer simple, regulatory questions first, i.e., in the higher tier(s). More complex environmental or program-related questions are answered in the lower tier(s). In other words, the analyses and studies become more complex as you move from higher to lower tiers. Also, as explained below, the detailed design of lower tier studies will depend on the results of higher tier studies and analyses. In fact, as indicated in the above discussion on \( H_0 \)'s, the results of higher tier studies may often justify a decision not to conduct the more complex, lower tier studies. Each of the tiers of our example monitoring pyramid on Figure 1 is described briefly below.

Source characterization in Tier 1 would include sampling and physical/chemical analysis of wastes being disposed (e.g., being dumped from a barge), also, a determination of the disposal rate. When Tier 2, short-term (nearfield) studies are being conducted, waste sampling and disposal rate determinations must be done coincident with such studies. It is because the data on waste characteristics and disposal rates from Tier 1 sampling and analyses will provide input to predictions of short-term/nearfield transport, fate, and effects which must be verified by field studies in Tier 2. Also, the Tier 1 source characterization data may be compared with permit descriptions and permit requirements for compliance purposes.

The Tier 2, short-term studies would include the nearfield determination of transport and fate of discharged wastes, specifically, plume tracking studies and sampling within the plume for physical and chemical analysis. Depending on waste and dumpsite characteristics, Tier 2 studies may include short-term biological effects. Alternatively, biological effects monitoring may be paired with marine resources monitoring at a lower tier (e.g., Tier 4 in Figure 1).
As in Tier 2, the Tier 3, long-term (farfield) studies would include transport and fate of discharged wastes and may include long-term biological effects. Tier 3 studies may be complicated by difficulty in "locating" the diluted waste field, i.e., many of the waste constituent concentrations may be close to or below chemical analysis detection limits. Hence, tracer chemicals may be required in the long-term studies to "track" the waste field. Alternatively, drifters and/or satellite imagery data on water mass movements may be used at deepwater dumpsites for tracking the waste field. As in Tier 2, the Tier 3 field data on waste constituent fate and concentrations (also, marine organism toxic effects and body burdens, if biological effects are included) will be used to verify transport, fate (and biological effects) predictions. Unlike Tier 2 studies, which may span hours or days, the Tier 3 studies will normally span days or weeks, even months and years if biological effects are included.

The Tier 4 studies on Figure 1 would focus on long-term ocean disposal effects on marine commercial and recreational fisheries; sensitive biological communities, such as coral reefs and kelp beds; shorelines and swimming beaches; and any other marine resource(s) of social or economic value. As indicated above, the marine resource studies may be paired with short-term and long-term biological effects, depending on waste and dumpsite characteristics.

At Tier 5 of Figure 1, the studies would focus on very long-term relationships between discharged waste transport and fate and large scale ocean current patterns and water mass movements. Such factors may be important if concerns arise about the effects of long-term changes in ocean currents and background water quality at the dumpsite.

As you consider the example pyramid of monitoring tiers on Figure 1 and description of each tier, the statement made earlier regarding "moving from less complex questions in the higher tiers to more complex questions in the lower tiers" becomes more clear. Source characterization and short-term studies are conceptually simpler and much less costly than long-term marine resource studies or ocean process studies.

It is important to note here that, although we will expect all ocean disposal monitoring plans to be tiered, we will not expect all the plans to look like Figure 1. Many monitoring plans, such as for dredged material dumpsite monitoring, may only have three tiers and, possibly, only two tiers, if source characterization is combined with the short-term studies. Nominally, the number of monitoring plan tiers will depend on the potential for long-term, farfield environmental effects and on the predictability of such effects.

6. QUALITY ASSURANCE PLANS

Ocean disposal management decisions require good quality data; unreliable data may be worse than no data at all. Also, the range of uncertainty associated with predictions of waste transport, fate, and effects depends on the quality of data used in the predictive models. In fact, it is often reported that the credibility of such predictions depends more on the quality of data inputs than on inherent uncertainty of the mathematical models. Consequently, laboratory and field studies must be designed and conducted to minimize uncertainty of the resulting data. In this regard, preparation and conduct of an EPA-approved quality assurance plan will be critical for minimizing data quality problems and, thereby, minimizing data collection requirements.

7. DATA MANAGEMENT AND REPORTING PLAN

All too often, monitoring data are collected and "stored" but not used to answer relevant questions. Any data that are not used to answer regulatory, program management, or environmental protection related questions or are not available in usable form are wasted data. An efficient and practical data management and reporting plan is, therefore, essential for a cost-effective ocean disposal monitoring program. Such a plan must include the collection and review of all available, relevant data for establishing baseline information on dumpsite characteristics and marine resources as input to predictions of ocean disposal transport, fate, and effects. Also, an efficient data base management system must be used for storage and retrieval of all relevant data and should be accessible for response to related questions by future users. Finally, data reporting intervals and formats should be designed that are responsive to the needs of monitoring program scientists, analysts, and management.

8. SUMMARY STATEMENT

This ocean disposal monitoring strategy, including the five major elements described above, clearly has the potential for minimizing data collection requirements and, thereby, generating cost-effective ocean disposal monitoring plans. We have already applied the strategy in the following ways:

1) Development of a monitoring plan for the 106 mile deepwater disposal site;
2) Development of the North Atlantic Incineration Site monitoring plan; and
3) Development of guidance for dredged material dumpsite monitoring plans.
These three applications have adhered to the basic rule of including all five major elements in ocean disposal monitoring plans. The approach has also proven flexible enough to address the distinctly different circumstances of ocean dumping of M&I wastes, ocean incineration, and ocean dumping of dredged materials.

We have not yet applied the strategy to development of §301(h) or §403(c), CWA, ocean discharge monitoring plans. When we do, it is evident that the strategy should generally apply but may need to be carefully adapted to pipe discharge circumstances. In any case, it is certain that application of the tiered monitoring strategy will help us to achieve our ocean disposal monitoring objectives in the most cost-effective manner.
Figure 1: Five-Tiered Monitoring Pyramid