# MONITORING PROGRAM MANAGEMENT PLAN

## 1 Introduction

The Alaska Department of Environmental Conservation (DEC) has recommended natural recovery with monitoring for portions of Sawmill Cove. As a first step towards this objective, this draft Monitoring Plan provides the objectives, technical approach, and decision-making framework that form the backbone of the monitoring program. Remaining sections of this introduction provide a brief site history for Sawmill Cove, describe the basis for an area of concern (AOC) in Sawmill Cove, and discuss the scientific basis for selection of natural recovery with monitoring. Section 2 describes the environmental quality objectives for Sawmill Cove, and an adaptive management strategy for documenting progress towards those objectives. Section 3 presents the technical basis for the monitoring program, which includes a baseline survey, and three successive tiers of investigation designed to document the natural recovery process. Section 4 discusses interpretation of the monitoring data and the kinds of decisions that will be made at each stage of the program. Section 6 provides an overview of other components of the Monitoring Program Management Plans, which will be developed more detail in subsequent modifications of this draft monitoring

### 1.1 Site History

The Alaska Pulp Mill opened in 1959, and produced pulp for 34 years until it suspended operations in 1993. The pulping process used at the mill was a magnesium sulfite process in which wood chips were digested in steam-heated tanks. Sawmill Cove is the historical receiving water for effluent and stormwater discharges from the mill. The cove is located near the mouth of Silver Bay, a narrow fjord with rocky near-shore areas that drop steeply to depths up to 400 feet at its mouth. Wood solids associated with transport and pre-processing of raw wood (e.g., logs, bark, chips) or with the effluent discharge have accumulated on the seafloor in the vicinity of Outfall 001 and south towards Bucko Point.

### 1.2 Area of Concern

Based on the finding of the risk assessments and completion of expedited remedial actions (Foster Wheeler Environmental 1998a-g), DEC has determined that only benthic community risks and impacts warrant further attention in Sawmill Cove. DEC defined an area of concern (AOC) by:

- Exceedences of Washington State Sediment Quality Standards for 4-methylphenol, benzoic acid and cadmium

- Benthic toxicity measured during the field studies

- Photographs taken from within the sediments showing the presence of wood waste.

This area is approximately 100 acres in size and extends from the eastern portion of Sawmill Cove to Bucko Point.

After a thorough assessment of alternatives during which risks and impacts, cleanup times, and costs were considered, DEC determined that Remedial Action Objective 5[1] (protection of benthic communities) would best be attained by natural recovery, with long-term monitoring (DEC 1999, Foster Wheeler 1999a). Monitoring of the recovery rate of the benthic community will be an important component of the natural recovery alternative. Long-term monitoring will provide DEC with the ability to both define the existing state of recovery within the area of concern, and to measure the nature and rate of this recovery within the AOC.

### 1.3 Monitoring – Scientific Support

Scientific support for DEC's decision to implement natural recovery and monitoring is provided in several of the field surveys conducted during the Remedial Investigation. Evidence of colonization of the seafloor is provided by a sediment photographic survey (July 1997) of benthic infaunal[2] communities in the western portion of Sawmill Cove. Sediment photographs show three broad benthic infaunal zones:

- An organically-enriched area with minimal evidence of life within the sediments;
- A transitional zone dominated by surface and near-surface depositing feeding worms;
- A relatively undisturbed benthic zone characterized by brown muds and a diversity of infaunal species.

A recent video survey (January 1999) of the nearshore subtidal area shows that epibenthic[3] biological activity in the area near the outfall may have increased since the 1997 survey. Species present include areas covered by a white microbial mat (the sulfur bacteria *Beggiatoa* sp.) and areas colonized by a variety of other organisms. The sediment-water interface contains sufficient oxygen for these species to live. The predominant macroinvertebrates consist of a variety of species of sea anemones, polychaete worms, nudibranchs (shell-less snails), ascidians, crabs, shrimp, and starfish. The *Beggiatoa* have caused the system to start recovering by removing hydrogen sulfide,

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[1] RAO 5 is described in Section 2.2 (Environmental Quality Objectives).

[2] Infaunal refers to animals that remain permanently in the sediments, and may be either free-living burrowers or live within tubes.

[3] The epibenthic habitat occurs at the sediment-water interface. Epibenthic organisms live on the surface of the sediments, and can make excursions up or down by swimming into the overlaying seawater or burrowing into the underlying sediments.

and, thereby preparing the near-surface sediments for colonization by surface-dwelling organisms.

These observations are indicators of the chemical, microbial, and biological processes of ecological succession, and are consistent with those documented for organically enriched benthic systems in other parts of the world (see Foster Wheeler Environmental 1998d; 1999b,c). These studies have shown that benthic ecosystem recovery readily occurs once source control is achieved. Should DEC find in the future an absence of appropriate recovery or an insufficient rate of recovery, the agency could re-evaluate other existing or new alternatives for possible implementation (see Section 5.2 – Contingency Plan).

# 2 Program Organization and Objectives

## 2.1 Organizational Roles and Responsibilities

The City and Borough of Sitka will act as the site manager and trustee. The City will be responsible for implementing the remedial action identified for the AOC in Sawmill Cove (i.e., natural recovery and long term monitoring). The City will document progress towards natural recovery through a monitoring program. This program will be based on the recommendations presented in the Feasibility Study for the site (Foster Wheeler Environmental 1999a) and the Proposed Plan (DEC 1999). Once a monitoring program is approved by DEC, the City will be responsible for its implementation. DEC will maintain the decision-making authority for the site. DEC will approve the monitoring program, assist in evaluating monitoring data and work with the City to adapt or change the monitoring program as necessary based on the monitoring data. Based on the monitoring data results, DEC will also make decisions about site closure. DEC may also solicit input or feedback from other agencies or entities in its decisions.

## 2.2 Environmental Quality Objectives

Only one remedial action objective (RAO) was identified for the area of concern in Sawmill Cove. The RAO for the area of concern is to:

> Reduce ecologically significant adverse effects to populations of bottom-dwelling life from hazardous substances, including wood waste degradation chemicals, to acceptable levels.

As indicated above, DEC believes that this objective can be achieved through natural recovery processes, which will be documented through a monitoring program. The proposed performance measure for this RAO is the observable succession of benthic species (living both on and in the sediments) that will result in balanced, stable[4] communities as assessed by measures of abundance and diversity at various locations over time.

[4] "Balanced and stable" refers to equilibrium type communities as discussed below in Section 3.

The time required for natural recovery and benthic community succession cannot be precisely predicted. Due to the uncertainties associated with the duration of recovery, DEC has developed management milestones in the proposed plan (**Table 1**) to evaluate progress of ecological succession in Sawmill Cove. The milestones are based on realistic time frames for recovery observed in other stressed marine environments (Foster Wheeler 1999a-c). Progress towards these goals will be assessed through the monitoring program.

## 2.3 Adaptive Management Strategy

The National Research Council's (1990) conceptual model of marine environmental monitoring will be used to evaluate progress towards the environmental quality objectives identified in Section 2.2 above. Site monitoring will follow an adaptive management strategy that will:

- Focus the monitoring program and ultimate site closure on clearly articulated goals and objectives;
- Support a tiered sampling and analysis scheme to facilitate efficient, cost effective evaluation of site conditions and to ensure the generation of appropriate quantities and types of data based upon those conditions; and
- Provide flexibility to periodically re-evaluate goals and modify monitoring activities to reflect changing site conditions and needs.

**Table 2** lists key chemical and biological parameters that are proposed for monitoring chemical and biological succession. **Figure 1** and **Figure 2** provide a conceptual framework that describes how these parameters would be used in a tiered monitoring program. In general, this framework includes the establishment of baseline conditions in the first year by conducting all studies proposed for replication in successive tiers. After baseline conditions are established, three tiers of sampling are proposed to evaluate and document progress towards natural recovery. A description of each of these tiers and the parameters that would be measured is provided in Section 3 below (Technical Approach). How the various parameters and tiers will be used to make site management decisions is discussed in Section 4 (Decision Making).

## 2.4 Re-evaluation of the Monitoring Program

The adaptive management strategy requires frequent re-evaluation to ensure that site closure decisions are based on adequate, scientifically sound, and relevant information that demonstrates progress towards the program's milestones and objectives. The monitoring program will initially be re-evaluated at the end of each sampling round to determine whether natural recovery is progressing satisfactorily and whether adjustments to the program are needed. The goal of any modifications to the program will be to efficiently obtain the appropriate data to concisely monitor and evaluate natural recovery processes occurring in the cove. After the initial rounds of monitoring, it may become clearly apparent that natural recovery is occurring; however, the rate of that recovery may not warrant such frequent monitoring. The re-evaluation process will allow identification of these possibilities and review of alternative objectives, goals, and milestones as appropriate to site-specific conditions. Re-evaluation of the program may also include consideration of other alternatives in the event that satisfactory progress towards natural recovery is not occurring and is unlikely (see Section 5.2 - Contingency Plan).

# 3 Technical Approach

Recovery should follow the classical patterns of colonization and recovery documented for organically enriched areas (Pearson and Rosenberg 1978) and dredged material disposal areas (Rhoads et al., 1977 and 1978; Rhoads and Boyer 1982). Those patterns include initial colonization by “pioneering” species, subsequent modification of physical/chemical characteristics, and final colonization by deeper dwelling “equilibrium” species. In general, equilibrium species are associated with well-oxygenated surficial sediments where the redox potential discontinuity (RPD) commonly reaches depths of over 10 cm (Rhoads and Boyer 1982). The earliest benthic communities in the recovery process tend to consist of large numbers of a few species, whereas the equilibrium communities are characterized by a greater number of species and a more even distribution of individuals among species. In general, benthic community succession follows well recognized spatial and temporal patterns of diversity and abundance of benthic invertebrates (Foster Wheeler 1999b). This process of succession is an important and widely recognized characteristic of benthic community function, and forms the basic indicator of success for remedial action. Hence, documentation of both the chemical and biological aspects of the successional process is the cornerstone for monitoring site recovery.

## 3.1 Baseline Survey

- Consider whether some or all of the elements of Tiers 1, 2, and 3 will be included: conventional chemistry, sediment profile photography, toxicity testing, an epifaunal photographic survey, and benthic community analysis. Consider whether and how RI data can be incorporated into the baseline (**Figure 5**).

- Proposed methods: See individual tiers.

- Timing and location of sampling for individual parameters

- Purpose: optimize flexibility, link to past, support trends analysis in future

## 3.2 Tier 1 (if needed)

- Screening survey and site tracking based on appropriate indicators of microbial and ecological succession.

- Organic degradation vs. oxygen availability

- Detailed methods in Sampling, Analysis, and Quality Assurance Plan (see Section 5.1 below)

### 3.3 Tier 2

- Includes some or all of the following parameters: Screening indicators, photographic surveys of the epibenthos, and sediment profile imaging (SPI)
- Screening indicators (see Section 3.1)
- Epibenthic photosurvey – Which photographic method to use? Sampling strategy transect, grid, photoquadrat?
- Sediment profile imagery (SPI)(Rhoads and Germano 1982) – Substrate limitations to SPI methods. Qualitative or quantitative image analysis?
- Detailed methods for epibenthic photo and SPI surveys provided in the Sampling, Analysis, and Quality Assurance Plan (see Section 5.1 below).
- Optional verification round based on degree of certainty in available information, and consideration of confirmation analysis of benthic communities.

### 3.4 Tier 3 (Confirmation Sampling)

- Includes some or all of the following parameters: Screening indicators, confirmatory benthic infaunal community analysis, optional toxicity testing.
- Screening indicators – Discussed in Tier 1 (Section 3.2)
- Benthic community analysis – Timing (phased or stratified approach); appropriate guidance; level of replication; selection of measures of community structure and function; use of classification analysis.
- Toxicity testing (optional) – Discussed in Baseline (Section 3.1)
- Detailed methods for toxicity testing and benthic infaunal analysis provided in the Sampling, Analysis, and Quality Assurance Plan (see Section 5.1 below).

### 3.5 Monitoring Locations

- Strategy for station locations needed.
- Stratified approach?
- Representative locations within strata?
- Variable locations to identify key transitional areas (boundary definition)?
- Coordination and co-location among sampling parameters
- Internal reference needed to control inter-annual variability?

- Re-allocation of station locations within the AOC as part of the Adaptive Management Strategy?

# 4 Decision Making

## 4.1 Technical Interpretation

The graphical organic enrichment model (**Figure 3**) of Pearson and Rosenberg (1978), representing both spatial and temporal gradients, uses the basic quantitative parameters measured in almost all benthic ecological investigations: the number of species, their abundance, and their biomass. This model will form the basis for judging progress towards natural recovery. The model predicts that in the absence of organic enrichment or disturbance an equilibrium (or Stage 3) community is typically present. Slight to moderate organic enrichment results in a slight increase in the number of species, overall abundance, and biomass of benthic communities, while species composition remains essentially unchanged. However, as organic enrichment and wood solids accumulation increases, the number of species declines because less tolerant species are eliminated. The total abundance of organisms increases, as a few species adapted to disturbed environments or high organic content of the sediments become very abundant and overwhelmingly dominate the benthic community (i.e., they reach the "peak of opportunists" in **Figure 1**). Although the individual taxa may vary regionally or seasonally, the changes in community composition, life-history attributes, and functional relationships to the associated sediment appear to be universal. A conceptual representation of these relationships is shown in **Figure 4**.

Early successional stages (Stage 1) consist of initial colonization of sediments by pioneering or opportunistic taxa that tend to be surface-dwelling, productive, and are readily available to demersal[5] predators (e.g., bottom-feeding fishes). These pioneering assemblages appear as very densely aggregated small tubiculous polychaetes or oligochaetes located at the sediment surface, where they feed on detritus. Capitellid or spionid polychaetes are commonly encountered members of this Stage 1 assemblage (Rhoads and Germano 1986; Pearson and Rosenberg 1978; Rhoads et al. 1978). The feeding and bioturbation[6] zone (the depth where biological mixing occurs) is thin, so consequently, the thickness of the apparent RPD is also thin or may even be absent in habitats where dissolved oxygen is low (Rhoads and Germano 1986). The physical/chemical characteristics of the sediment continue to undergo degradation due to the natural physiochemical processes taking place in the sediments. However, the physical/chemical characteristics of the sediments are also modified by the activities of the Stage 1 species, which in combination with the natural degradation processes allows for eventual colonization by transitional (Stage 2) and deeper dwelling "equilibrium"

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[5] Demersal usually refers to fishes that live at or just above the bottom.

[6] Bioturbation is the process by which benthic organisms mix surface sediments through their feeding or burrowing activities.

(Stage 3) species. These kinds of natural recovery processes have already been documented for portions of the site (Foster Wheeler 1999b) and are shown in **Figure 6**.

## 4.2 Criteria for Tiered Approach and Site Closure

The following sections describe the decision framework for each Tier of the proposed monitoring program. A number of physical, chemical, and biological monitoring variables are proposed for the various sampling tiers. How these variables are related to the general recovery model described above, and how they can be used to make site management decisions is discussed for each tier.

### 4.2.1 Baseline

- Purpose – Spatial characterization of physical, chemical, and biological conditions; foundation for inter-annual comparisons to gauge the progress of natural recovery;
- Establish need for stratified approach based on presence of benthic infauna
- Decisions for next round of sampling – Tier 1 may not be necessary.

### 4.2.2 Tier 1 (if needed)

- Frequency of sampling
- Decision criteria based on screening indicators and conditions that are conducive to invertebrate colonization
- Decisions should consider site heterogeneity and weight of evidence provided by supporting information
- Optional verification round based on degree of certainty in supporting information.

### 4.2.3 Tier 2

- Screening indicators – Discussed in Tier 1 (Section 4.2.2)
- SPI Quantitative methods – Organism-Sediment Index (OSI). Select appropriate OSI value from baseline data. GIS mapping and temporal trends (e.g., an update of **Figure 6**).
- Photographic surveys of epibenthic organisms – Methods and criteria need to be defined.
- Progress towards natural recovery indicated by
    - Continued decreasing trends in screening indicators

- Substantial positive changes in the OSI index or individual parameters identified by the SPI data

- Decreasing coverage of bottom substrate by sulfur bacteria or increasing abundances of epifaunal organisms within an area

- Weight of evidence for Management Team decisions for site closure or Tier 3 analysis.

- Optional verification round based on degree of certainty in available information, and consideration of confirmation analysis of benthic communities in Tier 3.

#### 4.2.4 Tier 3

- Tier 3 sampling may be eliminated or modified under the adaptive management plan if recovery can be demonstrated in earlier stages of the program (Baseline, Tier 1, Tier 2).

- The benthic data will be used to identify spatial and temporal gradients.

- Alteration of these spatial patterns towards greater areal coverage by transitional or equilibrium assemblages will be an indication of progress towards natural recovery.

- Solid-phase sediment toxicity tests if necessary – Decisions consider toxicity measurements, interpretative framework, and mitigating mechanisms.

### 4.3 Stakeholder Involvement

A number of agencies will likely be involved in the development of the monitoring management plans because of their various roles in the permitting and approval process for this remedial action. The likely agencies will include Alaska Department of Environmental Conservation, the U.S.EPA, the U.S. Fish and Wildlife Service, the City and Borough of Sitka, and the Sitka Tribe. Because of the need for a coordinated decision-making process and a focus of responsibility, it is likely that DEC will make final decisions under the terms of the consent decree, given their past lead responsibilities. Their decisions would likely be subject to a consultation process, with other agencies having an advisory role. It is also likely that the process will continue to include input from the general public, or environmental advocacy groups such as the Sitka Conservation Society. In the event of a dispute among the stakeholders and DEC, it is likely that a judge will review the situation and make the ultimate decision.

## 5 Other Components of the Monitoring Management Plans

In addition to the Work Plan, the other components of the Monitoring Management Plans include the Sampling, Analysis, and Quality Assurance Plan; a Contingency Plan; and a Health and Safety Plan. A brief description of each of these plans is provided below.

### 5.1 Sampling, Analysis, and Quality Assurance Plan

The SAP/QAPP will provide the specific details on how the monitoring plan will be implemented. The specific approach to each element of each Tier will be discussed and defined. The measures of success and the method used to assess the element will be explicitly defined. A brief outline of the SAP/QAPP is provided as **Table 3**.

### 5.2 Contingency Plan

This plan will describe how the agencies and the responsible parties will implement a contingency planning process should the natural recovery alternative not perform as expected. It is likely that the contingency planning procedures would follow procedures similar to those used at other sites. The contingency planning procedures may consist of four parts: 1) screening process, 2) contingency planning, 3) contingency response, and 4) expedited review. Each of the four contingency planning parts are discussed below.

#### 5.2.1 Screening Process

The purpose of the screening process is to identify potential problems early enough to conduct a rational and deliberate process to determine whether there is in fact a problem, and if so, how serious the problem may be. The screening process will enable the agencies and responsible parties to determine what kinds of data verification or response is appropriate, so that contingency planning or response actions are based on proper assumptions.

#### 5.2.2 Contingency Planning Process

The purpose of the contingency planning process is to develop plans for contingency actions that may become necessary depending on future monitoring results. The monitoring plan will be designed to detect biological recovery processes. Should the monitoring data indicate that potential problems exist, then plans, developed per the contingency planning process would be prepared to correct or mitigate or otherwise address the situation.

The contingency planning process could result in an approved contingency response action to be implemented in accordance with an approved schedule. It could also result in agreement on a conceptual approach or a set of criteria for taking further action, pending the results of future monitoring. The process would incorporate applicable permit requirements, interagency consultation, and public review of contingency plans prior to approval.

#### 5.2.3 Contingency Response Process

The purpose of the contingency response process is to implement approved plans for contingency actions. This includes agreement on a final schedule, any amendments to the consent decree if necessary, and completion and monitoring of the response action.

### 5.2.4 Expedited Review Process

The purpose of the expedited response process is to allow the parties to shorten the time frame of the standard process or to implement one or more of the above steps simultaneously when reliable early warning data indicate that a problem warrants immediate action.

## 5.3 Health and Safety Plan

The monitoring program will involve the use of chemicals and specialized sampling equipment on a small vessel. Consequently, there would be a short-term hazard to the crew and scientific staff during each phase of field and vessel operations. These hazards would be mitigated at the planning stage through development of a project-specific risk management plan, and would be further managed during actual operations by implementation of a site-specific Health and Safety Plan. An outline of a typical health and safety plan is provided in **Table 4**.

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## Table 1. Ecological Recovery Management Milestones

| Area | Time (years) | Successional Status |
| --- | --- | --- |
| >75 % coverage of the AOC | 5-10 | Decomposers and primary producers |
| >75 % coverage of the AOC | 10-20 | Primary Consumers and Detritovores |
| >75 % coverage of the AOC | 20-40 | Secondary Consumers |
| >75 % coverage of the AOC | >40 | Climax (equilibrium) community |

Reference: Proposed Plan (DEC 1999).

**Table 2. Natural Recovery Monitoring Framework: Measurement Parameters.**

| | Relationship to RAO & Measure of Success | | | |
|---|---|---|---|---|
| **Parameter** | **Reduce Toxicity[a]** | **Benthic Habitat[b]** | **Increase Diversity[c]** | **Increase Abundance[d]** |
| Benthic Epifauna Survey | | ❐ | ❐ | |
| SPI Surveys | | ❐ | ❐ | |
| Benthic Infauna Analysis | | ❐ | ❐ | ❐ |
| TOC | | ❐ | | |
| Grain Size | | ❐ | | |
| Ammonia | ❐ | | | |
| COD | | ❐ | | |
| BOD | | ❐ | | |
| AVS/Sulfides | ❐ | | | |
| *Rhepoxynius* (Acute Toxicity)[e] | ❐ | | | |

[a] These parameters are indicators of adverse effects of hazardous substances and degradation chemicals.
[b] These parameters are measures of chemical succession and benthic habitat quality.
[c] Diversity (numbers of species) is a measure of success.
[d] Abundance (numbers of organisms) is a measure of success.
[e] Toxicity testing will be conducted in the Baseline Survey, but will be an option in Tier 3.

## Table 3. Outline for Sampling, Analysis, and Quality Assurance Plan

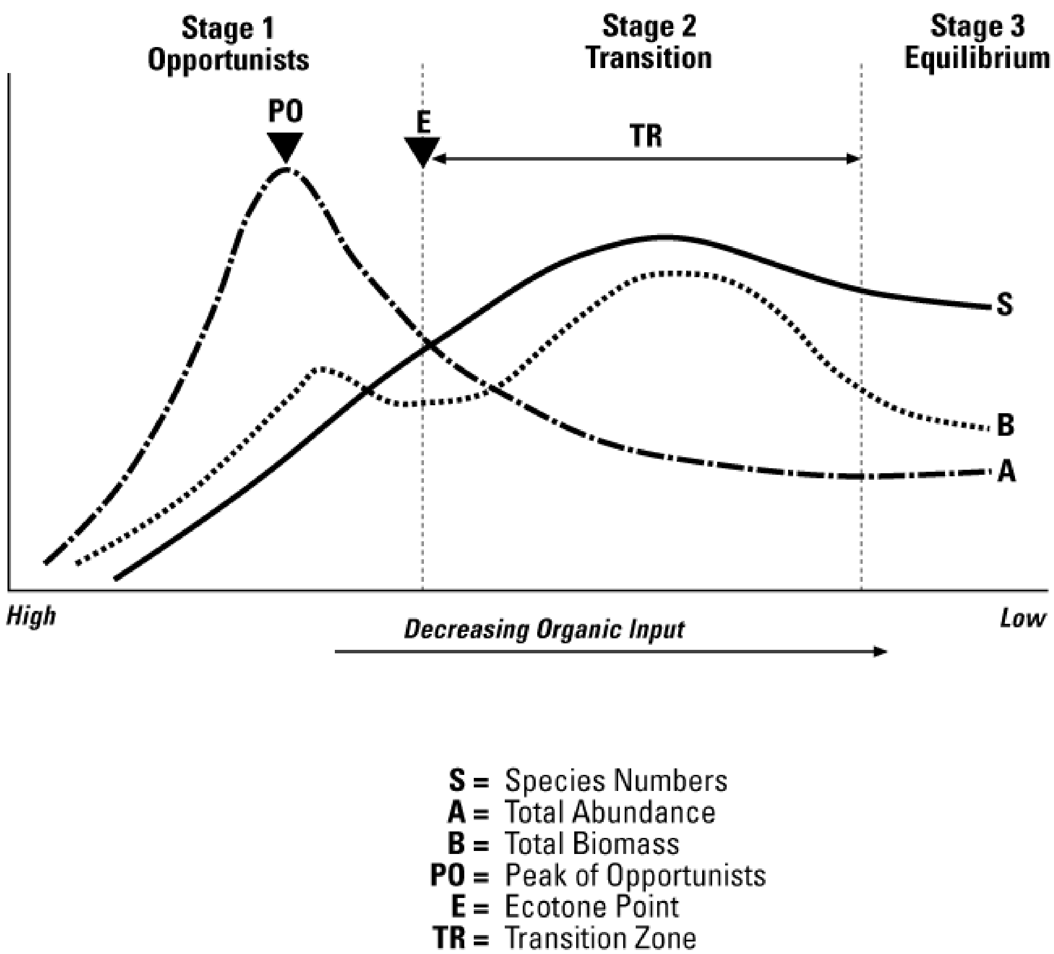
## Table 4. Outline for Site Health and Safety Plan

**Figure 1. Adaptive Management Strategy for the Natural Recovery Process.**

[Reserved]

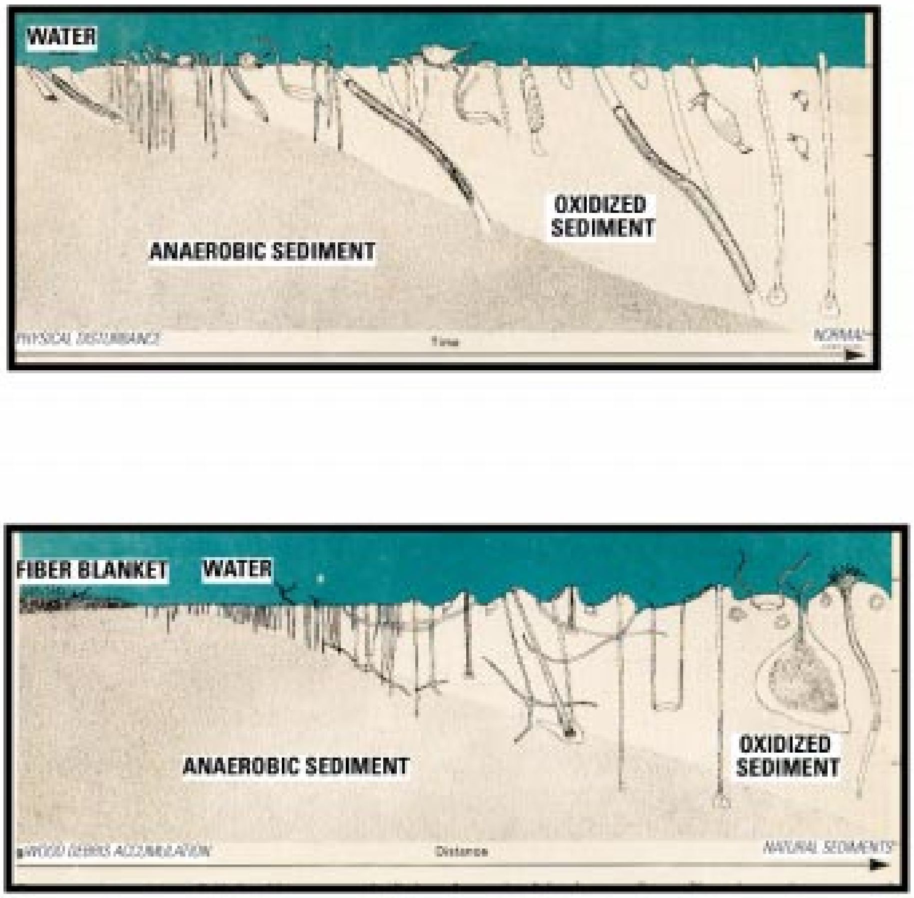
**Figure 2. Continuation of Adaptive Management Strategy.**

[Reserved]




Reference: Adapted from Figure 2 of Pearson and Rosenberg (1978)

**Figure 3**
Generalized Changes in the Number of Species, Total Abundance, and Total Biomass Along a Gradient of Organic Enrichment in Benthic Habitats




*Source: Adapted from Rhoads et al. (1978)*

**Figure 4**
Conceptual Model for Alteration and Recovery of Benthic Community

**Figure 5. Wood Deposition Zone Distribution in Sawmill Cove.**

[This figure is available in a paper format. See faxed attachment].

**Figure 6. Conceptual Model for Alteration of Benthic Community in the Wood Deposition Field**

[This figure is available in a paper format. See faxed attachment].