Puget Sound Estuary Program

ELLIOTT BAY TOXICS ACTION PROGRAM

INTERIM WORK PLAN

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ELLIOTT BAY TOXICS ACTION PROGRAM: INTERIM WORK PLAN

by

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for

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EXECUTIVE SUMMARY

Previous studies of Elliott Bay and the lower Duwamish River have revealed extensive contamination by toxic metals such as copper, lead, zinc, and arsenic, as well as organic compounds such as petroleum products and PCBs. Some of these substances may accumulate at high concentrations in tissues of marine organisms, posing a hazard to the aquatic ecosystem. For example, toxic contamination may decrease the abundance and diversity of benthic or bottom-dwelling communities and increase the prevalence of tissue disorders such as liver tumors in fish.

The U.S. Environmental Protection Agency and the Washington Department of Ecology, working with the city of Seattle, METRO, and others, have developed an Action Program to correct the toxic problem in the Elliott Bay system. The Action Program 1) identifies existing problems of toxic contamination, 2) locates sources of toxics, 3) implements corrective actions to eliminate existing problems, 4) identifies appropriate agencies for implementing corrective actions, and 5) provides a schedule for implementing corrective actions. Corrective actions include source controls and the removal of contaminated sediments. Source controls can include permit revisions to reduce the strength or volume of discharges and management activities to reduce the contamination of surface runoff.

Priority problem areas were identified by analyzing data on contamination and biological effects. Areas received a ranking of high priority if they exhibited a particularly high level of contamination and/or biological effects such as high prevalence of liver tumors among bottom-dwelling fish, or a very low number of bottom-dwelling species. Actual and potential contaminant sources were identified for each priority problem area, and for the study area in general. This Work Plan focuses on controlling identified sources and better characterizing potential ones.

The Work Plan is unique in its approach to controlling contamination, in that it brings many regulatory and management organizations together in an Interagency Work Group to take coordinated action to address particular problem areas and specific sources of contamination. The Work Plan represents the input of many agencies and local governments; and citizen groups and users (via a Citizen's Advisory Committee). Business, industry, environmental, and citizen groups were represented in a Citizen's Advisory Committee. The Citizen's Advisory Committee was consulted to provide direct input into all stages of program development.

This Work Plan is being carried out through the existing regulatory and resource management mechanisms of agencies and local governments and by a special Action Team for Elliott Bay. The five members of the Action Team are funded by the Washington Department of Ecology and METRO with the support and participation of the city of Seattle and U.S. EPA.

The regulating and management efforts of the Interim Work Plan will focus on priority problem areas. Most of the high priority areas are located in the lower Duwamish River adjacent to Harbor Island. Others include

the Denny Way CSO area, the Seattle Waterfront near Madison Street, and Slips 1-4 in the Duwamish River. The Fourmile Rock dredged material disposal site ranked as a moderate priority. However, because of public concern, the area is included in the Interim Work Plan. Table 2 is the Site Specific Interim Work Plan for the Elliott Bay Toxics Action Program. A summary of the actions in the Work Plan follows:

- Twenty-one NPDES and state discharge permit actions, including issuance of new permits, issuance of stormwater permits, assessment of tighter controls, and site inspections
- Three RCRA permit actions, including two site closures
- Two criminal investigations and resultant cleanup actions, including the removal of severely contaminated sediment from the Florida Street storm drain
- Review of historical activities and practices at 12 sites to determine significance of past toxic contamination
- Cleanup of contamination by the removal of sediments from five drains
- Eleven groundwater contamination investigations
- CSO planning, including the removal of the lower Rainier Valley stormwater component from the Hanford CSO
- Facilities planning, including the transfer Renton sewage treatment plant effluent from the Duwamish River to a deep-water site in Elliott Bay
- Numerous sampling and analysis studies to better characterize environmental conditions and identify sources.

Because actions in this Work Plan were defined based on a review of existing environmental and contaminant source data, it is referred to as an Interim Plan. However, the plan is actually a working document designed to be refined as new data are made available. The Interagency Work Group and Citizen's Advisory Committee will be responsible for updating and implementing the Work Plan. They will meet on a regular basis (at least quarterly) to review progress made on implementation of the plan, resolve any problems, and refine the plan to reflect new information.

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The primary authors of this report were Mr. Pieter N. Booth and Dr. Robert A. Pastorok of Tetra Tech. Mr. Gary Brugger of the Washington Department of Ecology and Mr. Thomas P. Hubbard of the Municipality of Metropolitan Seattle prepared drafts of the Interim Work Plan table. Their contribution in developing specific agency actions and implementation schedules was invaluable. Dr. John Armstrong of U.S. EPA provided critical technical review and coordination with other agency activities. Ms. Joan K. Thomas of the Washington Department of Ecology and Mr. John Underwood of U.S. EPA provided managerial guidance, encouragement, and review throughout the project. Ms. Marcy B. Brooks-McAuliffe of Tetra Tech performed technical editing and supervised report production.

The Elliott Bay Action Program has benefited from the participation of an Interagency Work Group (IAWG) and a Citizen's Advisory Committee (CAC). Duties of the IAWG and CAC members included: 1) reviewing program documents, agency policies, and proposed actions; 2) providing data reports and other technical information to U.S. EPA; and 3) disseminating action program information to respective interest groups or constituencies, and to the general public. We thank the IAWG and CAC members for their past and continuing efforts. Ms. Patricia O'Flaherty of SAIC/JRB Associates provided support for the CAC activities. Mr. Hunter MacDonald of Ecology provided support to the IAWG. We are especially grateful to Ms. Joan Thomas for chairing the IAWG, to Mr. David Schneidler and Ms. Janet Anderson for co-chairing the CAC, and to the following individuals for insightful comments on technical aspects of the project; Dr. John Armstrong; Mr. Douglas Briggs; Mr. Ralph Domenowske, Mr. Thomas Hubbard and other METRO personnel; Mr. James Heil; Mr. Douglas Hotchkiss; Mr. David Jamison; Mr. Edward Long; Dr. Charles Muller; Mr. Dan Petke; Mr. James Puckett; Dr. Richard Rutz; and Mr. Frank Urabeck and other COE personnel. Members of the IAWG and CAC are listed below.

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GLOSSARY

Agency and Program Names

CAC	-	Citizen's Advisory Committee
CATAD	-	Computer Augmented Treatment and Disposal System used by METRO to control flows and locations of combined sewer overflows.
COE	-	U.S. Army Corps of Engineers
DCLU	-	Department of Construction and Land Use (City of Seattle)
DNR	-	Washington Department of Natural Resources
DSHS	-	Washington Department of Social and Health Services
Ecology	-	Washington Department of Ecology
EPA	-	U.S. Environmental Protection Agency
EPA/CID	-	EPA/Criminal Investigation Division
IAWG	-	Interagency Work Group
METRO	-	Municipality of Metropolitan Seattle
NOAA	-	National Oceanic and Atmospheric Administration
NPDES	-	National Pollutant Discharge Elimination System (EPA/Ecology)
PSWQA	-	Puget Sound Water Quality Authority
PSEP	-	Puget Sound Estuary Program (EPA/Ecology), including urban embayment action programs such as the Elliott Bay Toxics Action Program
RCRA	-	Resource Conservation and Recovery Act
SPCC	-	Spill Prevention and Control Contingency Plan
SUPERFUND	-	EPA and Ecology programs to clean up hazardous waste sites or other areas of toxic contamination
TOSCA	-	Toxic Substances Control Act

TPPS	-	Toxicant Pretreatment Planning Study (METRO)
USCG	-	U.S. Coast Guard

Chemical Names

As	-	Arsenic
Cu	-	Copper
HPAH	-	High Molecular Weight Polynuclear Aromatic Hydrocarbons
LPAH	-	Low Molecular Weight Polynuclear Aromatic Hydrocarbons
Pb	-	Lead
PCB	-	Polychlorinated Biphenyls
Zn	-	Zinc

Pollutant Source Names

CSO	-	Combined Sewer Overflow. A discharge of raw sewage diluted with storm water, which occurs whenever the hydraulic capacity of a combined sewer line is exceeded.
CSO/SD	-	Combined Sewer Overflow and Storm Drain. A combined source that discharges storm drainage during low flows and raw sewage diluted with storm water during high flows.
SD	-	Storm Drain. A source of stormwater discharge only.

Other Terms

Amphipod	-	A small organism that superficially resembles a shrimp and lives on the sea bottom. Amphipods are used in laboratory bioassays to test the toxicity of sediments.
Benthic	-	Pertaining to the bottom of a water body.
Bioaccumulation	-	Concentration of a substance in tissues of an organism. Bioaccumulation of toxic substances may lead to disease or other health problems.
Bioassay	-	A laboratory test used to evaluate the toxicity of a material (commonly sediments or wastewater) by measuring behavioral, physiological, or lethal responses of organisms.

Community	-	A group of interacting species populations found within a defined area.
Diversity	-	The number of species in a community, or a mathematical index of the variety of species that also accounts for the relative abundance of each species.
Dominance	-	An index that measures the relative distribution of individuals among species. When dominance is high, a few species are very abundant and others are rare.
Elevation Above Reference	-	An index of toxic contamination or biological effects, which is equal to the value of a variable (e.g., chemical concentration) at a study site divided by the value of the same variable at a relatively "clean" reference area.
Histopathology	-	Study of tissue disease
Infauna	-	Animals living within the bottom sediments
Invertebrate	-	Animals without backbones
Larvae	-	(singular larva) A juvenile stage with a body form that differs greatly from the adult stage (e.g., an oyster larva is a small free-floating organism).
Lesion	-	An abnormal structural change in the body due to injury or disease (e.g., a liver tumor in fish)
Loading	-	Quantity of a substance that enters a water body during a specified time interval (e.g., pounds per year)
Nonpoint Source	-	A nonspecific source of pollutants, often from a large area (e.g., stormwater drainage)
Pathology	-	Study of disease
Sediment	-	Material that settles to the bottom of a water body
Toxic	-	Relating to a poisonous substance
Toxicity	-	Poisonous quality of a substance
Toxic Contamination	-	Presence of toxic substances, often caused by releases of metals or synthetic organic chemicals to the environment

INTRODUCTION

Previous investigations of Elliott Bay and the lower Duwamish River have revealed extensive contamination by toxic metals (e.g., copper, lead, zinc, mercury, and arsenic) and organic compounds (e.g., petroleum products, PCBs). Some of these substances may accumulate at high concentrations in tissues of marine organisms, posing a hazard to the aquatic ecosystem or to human consumers of local seafood. Ecosystem perturbations associated with anthropogenic inputs of toxic substances may include decreases in abundance and species diversity of benthic (bottom-dwelling) communities and increases in the prevalence of tissue disorders (e.g., liver tumors in fish).

In cooperation with other resource management agencies, the U.S. Environmental Protection Agency (U.S. EPA) and the Washington Department of Ecology (Ecology) are developing an action program to correct toxic problems in the Elliott Bay system. Corrective actions may include, for example, source controls to reduce toxicant emissions and cleanup of contaminated sediments. The objectives of the Elliott Bay Toxics Action Program are to:

- Identify problem sites based on toxic contamination and associated biological effects
- Identify toxicant sources
- Rank problem sites and sources in terms of priority for action
- Outline actions by individual agencies and cooperative efforts among agencies to correct the identified problems.

The ultimate goals of the action program are to protect the marine and estuarine ecosystem against further degradation from anthropogenic inputs of toxic materials, to restore areas degraded previously, and to protect beneficial uses that may be affected by toxic contamination.

The action program is being developed in two phases. In the first phase, interim actions are specified for high priority problem areas based on available data. These short-term actions mainly involve source controls and field investigations planned for the 1-2 yr as part of ongoing regulatory and management programs. The Interim Work Plan described in this report serves as an immediate vehicle for interagency coordination. In the second phase, additional field data will be collected and analyzed to develop a Comprehensive Work Plan (scheduled for 1986). Companion documents for the Interim Work Plan are the following:

- Elliott Bay Toxics Action Program: Review of Existing Plans and Activities. A detailed summary of ongoing remedial action programs and plans.

- Elliott Bay Toxics Action Program: Initial Data Summaries and Problem Identification. A synthesis of available data on toxic contamination and biological effects, and a decision-making approach for ranking problem areas.

- Sampling and Analysis Design for Development of Elliott Bay Toxics Action Program. A detailed study design for further investigation of pollutant sources, sediment contamination, and biological effects to provide a complete database for development of the comprehensive action program.

The study area, the approach used to identify problem areas, and the locations of high priority problem sites are described in the remainder of this introduction.

STUDY AREA

The study area is defined as Elliott Bay east of a line drawn between West Point and Alki Point, including the Duwamish River from its mouth to the turning basin located approximately 6 mi upstream. The study area drainage basin consists of about 26 square miles of highly developed land in metropolitan Seattle (Figure 1). Basin boundaries are roughly defined by Beacon Avenue on the east side and 35th Avenue S.W. on the west side. The basin includes residential areas in the southern portions of the Queen Anne and Magnolia neighborhoods, and most of West Seattle; the industrial areas along the Duwamish Waterway; the Interstate 5 corridor from James Street to about S. Dawson Street; and the downtown business district. Public access points and recreational areas are illustrated in Map 1 (Appendix A).

Locations of storm drains, combined sewer overflow (CSO) points, and other potential sources of toxic contaminants are shown in Map 2 (Appendix A). The residential areas are generally served by partially separated storm and sanitary systems. Runoff from the business district is served entirely by combined sewers, and is transported to the West Point treatment plant via METRO's interceptor system. Runoff from Interstate 5 is collected in two large storm drains and discharged to the Duwamish Waterway at Slip 4 and Diagonal Way. The remaining industrial areas, excluding Harbor Island, are served by combined sewers, and private and municipal storm drains. Harbor Island has its own storm drainage system which discharges to the East and West Waterways.

APPROACH

The primary kinds of data used in the decision-making process are shown in Table 1. Contamination and effects data were integrated and evaluated in a decision framework based on the "preponderance-of-evidence" approach to problem area evaluation (Figure 2). Study areas that exhibited high values of environmental indicators relative to a reference site received a ranking of "high priority" for evaluation of pollutant sources and remedial action. The environmental indices are a ratio between the value of variable (e.g., concentration of PCB in sediments) at a site in the study area and the value of the same variable at a reference site (i.e., "clean" area remote from urban centers). Each ratio is called an Elevation Above Reference,

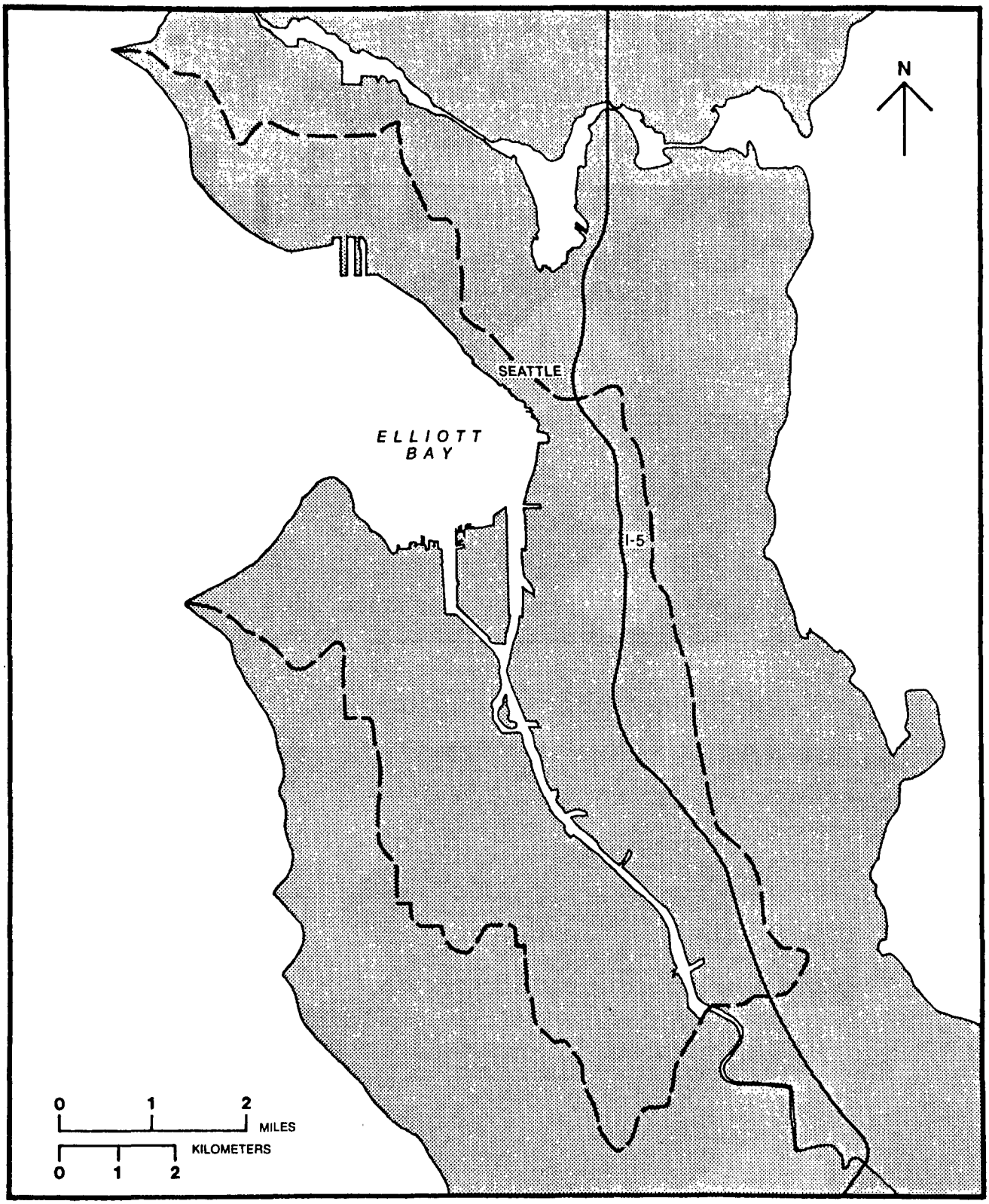


Figure 1. Study area drainage boundaries.

TABLE 1. PRIMARY KINDS OF DATA USED IN PROBLEM AREA IDENTIFICATION AND PRIORITY RANKING

General Category		Specific Indicator Variables
Pollutant source	Mass emissions	• Pollutant concentrations • Discharge flow
Habitat condition	Sediment quality	• Pollutant concentrations
Indigenous organisms	Bioaccumulation	• Contaminant concentrations in tissues of English sole and crabs
	Benthic community structure	• Total abundance • Species richness • Dominance • Amphipod abundance
	Fish pathology	• Prevalence of liver lesions in English sole and rock sole
Toxicity	Acute lethal	• Amphipod mortality
	Sublethal	• Oyster larvae abnormality

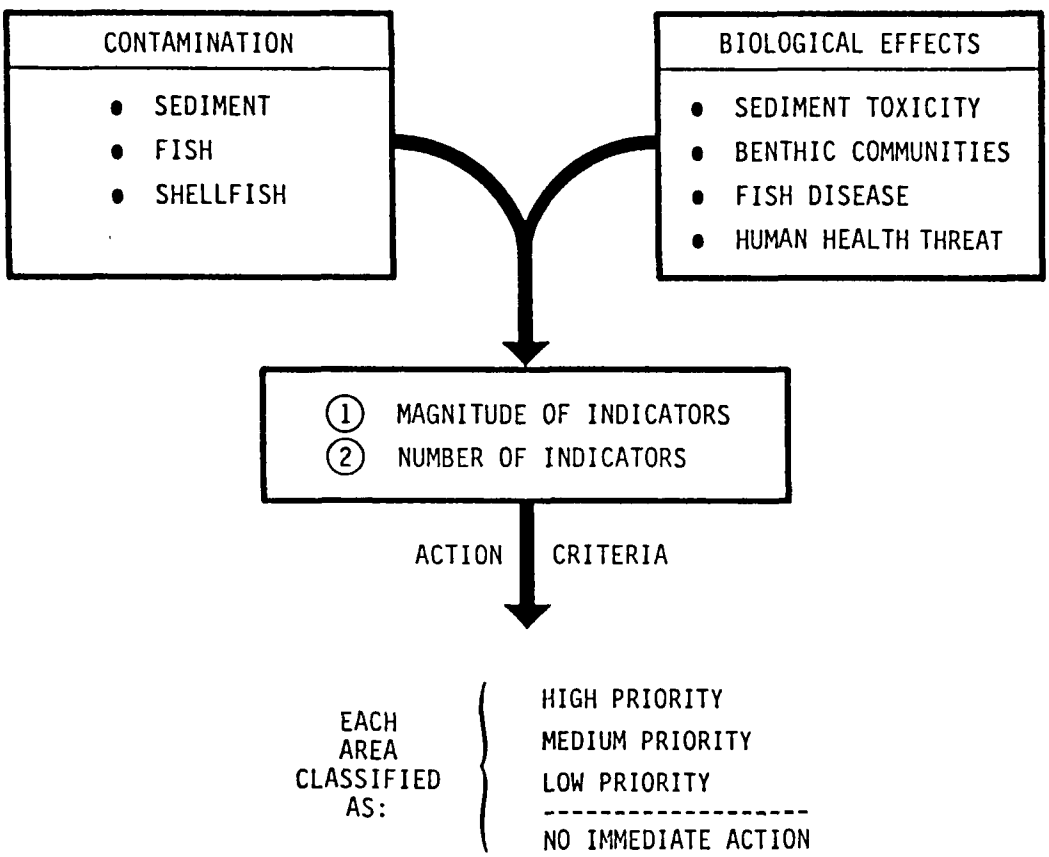


Figure 2. Preponderance-of-evidence approach to evaluation of toxic contamination problems.

because the value of the index increases as the deviation from reference conditions increases.

Contamination of sediments and biota was evaluated by examinating the following chemical concentrations:

- Low Molecular Weight Polynuclear Aromatic Hydrocarbons (LPAH): the sum of light petroleum compounds such as naphthalene, acenaphthalene, and fluorene

- High Molecular Weight Polynuclear Aromatic Hydrocarbons (HPAH): the sum of heavy petroleum compounds or combustion products such as fluoranthene, pyrene, benzo(a)pyrene, and chrysene

- Polychlorinated Biphenyls (PCBs): the sum of PCBs

- Copper (Cu), Lead (Pb), and Zinc (Zn): the sum of selected metals

- Arsenic (As): a toxic metal known to be present in emissions from the ASARCO smelter, in sandblasting material used by shipyards, and in natural seawater.

The rationale for choosing these selected indicator variables and supporting data for the study area and reference areas are provided in the Initial Data Summaries and Problem Identification report.

Because available data are limited, the prioritization of specific problem areas for this Work Plan was based mainly on sediment chemistry and toxicity bioassays using amphipods and oyster larvae. Elevation Above Reference (EAR) values for these indicators are provided for each priority area in Appendix B of this report. Given the uncertainty associated with the original sample analyses and pooling of data sets from different investigators, EAR values are presented as ranges, for example:

Chemical Concentrations

• Very high	>1,000X reference
• High	100-1,000X
• Moderate	10-100X
• Low	<10X
• Not significant	Below the maximum concentration observed in reference areas.

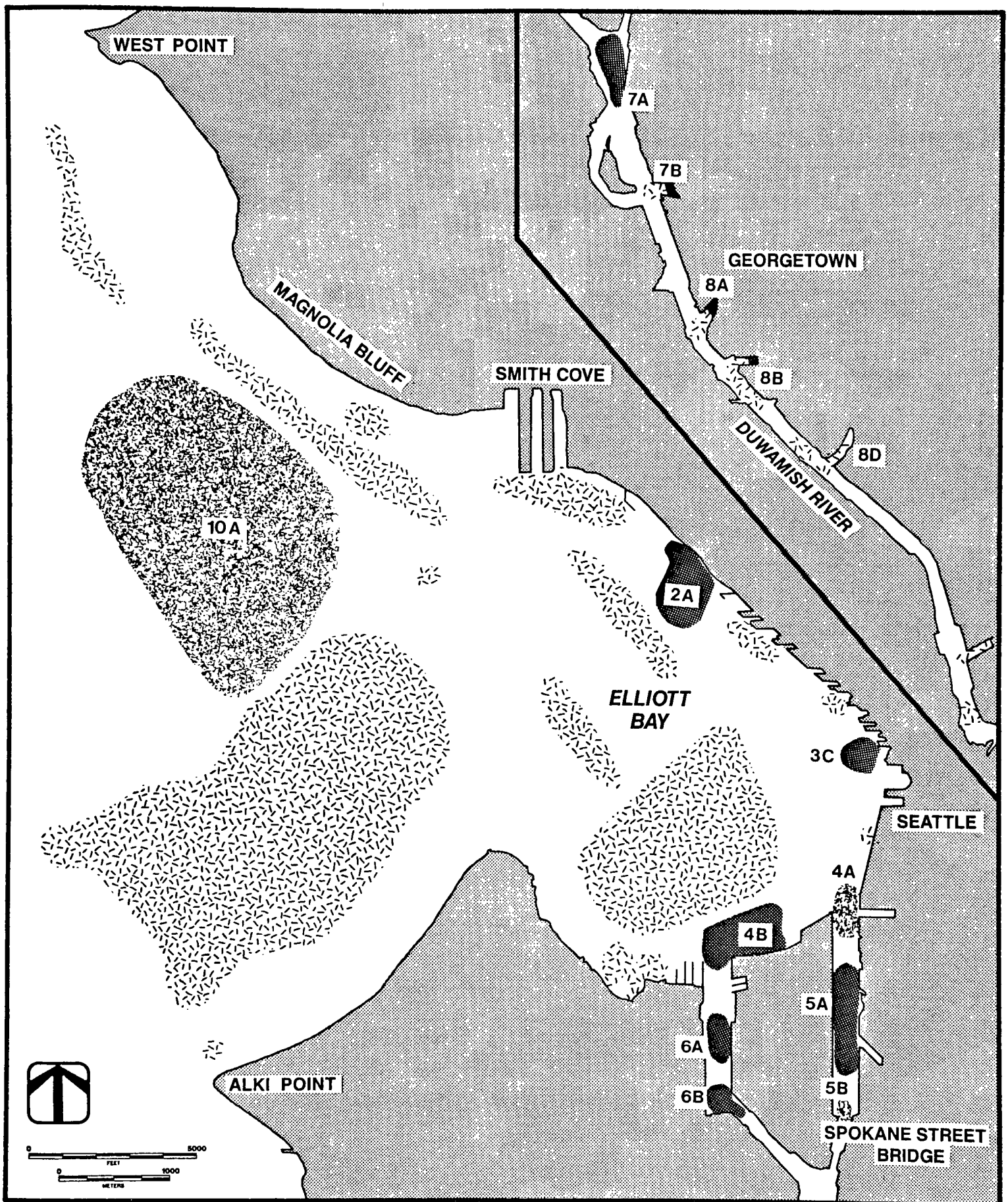


Figure 3. Classification of study area segments in terms of priority for interim action.

REPORT ORGANIZATION

The remainder of this document describes interim actions to be taken to control the input of contaminants to Elliott Bay and the lower Duwamish River. Two kinds of interim actions are addressed: area-wide actions and site-specific actions. Area-wide actions generally apply to large portions of the study area, whereas site-specific actions are unique measures taken (by a regulatory agency or other entity) within each study area segment. Because many area-wide actions are regulatory programs that affect specific sites (e.g., discharge permitting programs), area-wide actions are described first. For a more complete description of area-wide actions, refer to the Review of Existing Plans and Activities.

Site-specific actions are described in the Site-Specific Work Plan (Table 2). The introduction to the second section describes how interim actions are defined, and the steps for implementing them. The Work Plan contains an annotated list of actions and an agenda for implementation. The actions are organized according to study area segment (see Figure 3 above) and appear in approximate order of priority for interim action.

Following the Site-Specific Work Plan are several figures that outline the decision framework for controlling pollutant sources. The decision framework illustrates the regulatory and management decisions that occur throughout the source control process.

The appendices include additional information which the reader may find helpful:

- Appendix A contains two maps of the study area. The first map illustrates public access points and recreational areas, and the second map shows contaminant sources and selected industry locations.

- Appendix B describes each study area segment in terms of existing environmental conditions (based on recent data, 1979-present) and potential sources of toxic contamination.

INTERIM WORK PLAN FOR ELLIOTT BAY TOXICS ACTION PROGRAM

AREA-WIDE ACTIONS

The following programs and plans are described in terms of actions that can be taken to identify or control sources of toxic contamination. Regulatory measures in some areas would be greatly facilitated with better information about the extent of existing contamination, and/or information about sources of toxicants. For this reason, ongoing or planned studies (sampling and analysis) are considered interim actions.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

- Superfund: This program provides for the identification, study, and cleanup of dangerously contaminated sites. Western Processing in Kent and the Harbor Island Superfund site may be contributing toxic contaminants to the study area via surface runoff or groundwater. The Final Remedial Investigation Data Report was released for Western Processing in December, 1984. A draft report on the preliminary assessment of Harbor Island was released in June, 1985. Superfund also provides for on-site testing, which may lead to further source identification. Section 104(e) of Superfund legislation requires private industry within designated areas to release any pertinent information, such as data on groundwater testing or past spills. Under a joint U.S. EPA/Washington Department of Ecology program, preliminary assessments of potential hazardous waste sites are being performed. Several such sites are in the study area.

- Elliott Bay Sampling and Analysis Design: This plan has two purposes: 1) to fill in data gaps needed to better characterize existing problems, and 2) to obtain data needed to relate contaminant sources to environmental problems. The sampling and analysis was initiated in September, 1985 as part of the Elliott Bay Toxics Action Program. The final report on the results of the field investigation is scheduled for late 1986.

WASHINGTON DEPARTMENT OF ECOLOGY (Ecology)

- National Pollutant Discharge Elimination System (NPDES): Permits are generally issued on a site-by-site basis, and can include more than one discharge or source of pollutants. Permits for sewage treatment plants extend throughout the plant's service area and include combined sewer overflows (CSOs). Industrial permits can include a storm drain component (for surface runoff) as well as wastewater discharges. New NPDES regulations require land users in certain land use categories to submit data regarding surface water runoff

by December, 1987. Washington Department of Ecology will review this information to assess the need for issuing stormwater permits.

- Superfund: The Washington Department of Ecology is the lead agency for the Harbor Island site. A contractor has been retained to start evaluating the extent of the problem. Washington Department of Ecology reviewed the initial assessment of Harbor Island (mid-1985) and will make a decision about future action. Several action alternatives exist, including 1) de-listing the area, 2) recommending a sampling and analysis plan, or 3) proceeding with a remedial investigation.

- Resource Conservation and Recovery Act (RCRA): This is a joint U.S. EPA/Washington Department of Ecology program that governs the generation, handling, and disposal of hazardous wastes. Spill prevention and containment measures, material handling requirements, and groundwater monitoring can be required as part of a RCRA permit. There are six RCRA permits (pending) in the study area.

- Sampling and Analysis: Under various Washington Department of Ecology programs, sampling and analysis will provide additional information about existing conditions and possible sources of contamination in the study area. Specific study designs are not yet available.

MUNICIPALITY OF METROPOLITAN SEATTLE (METRO)

- Duwamish Industrial Non-Point Source Investigation: Several source-control actions are pending as a result of this program. Future investigations are not yet defined, but in general, the program includes 1) visits to 20 additional industrial and commercial sites, 2) follow-up monitoring and control measures at 10 previously identified sites, 3) sediment and water analyses for selected heavy metals and toxic organic compounds at 4 storm drains, and 4) follow-up sampling to determine the effectiveness of control measures.

- Industrial Pretreatment: METRO grants permits for industries discharging into its collection system. METRO and its component agencies are identifying new businesses and evaluating their need for pretreatment.

- CSO Planning: METRO has begun CSO planning as an integral part of facilities planning. New treatment plant permits will include revised conditions for CSOs (schedules of compliance, monitoring requirements). Short-term actions include the ongoing effort of improving CATAD to maximize in-line storage (thus reduce CSOs) and to prioritize the overflow sequence.

- Facilities Planning: Facilities planning includes upgrading the West Point plant to secondary treatment capacity and determining the fate of the Alki plant. A draft EIS was released in July, 1985.

- Renton Effluent Transfer System: METRO plans to divert Renton treatment plant effluent from its current discharge point in the Duwamish River to a site offshore from Duwamish Head in Elliott Bay. METRO recognized the need to divert the Renton effluent from the river in the Renton 201 Wastewater Plan. In March, 1982, Washington Department of Ecology issued an order and compliance schedule to relocate the discharge. METRO is now revising facility plans for the diversion pro-ject.

- Household Hazardous Waste Project: This is a public education program aimed at reducing the disposal of household toxic materials to the sewer system.

- Sampling and Analysis: Current knowledge about toxicant sources and existing contamination may be augmented by the sampling and analysis components of some of METRO's programs. Specifically, sampling and analysis of storm drains is planned as part of the continued Duwamish Industrial Non-Point Source Investigation (1985-1986). Sampling and analysis of selected CSOs will be required as part of METRO's new NPDES facilities permits. The baseline study for the Renton outfall relocation to Duwamish head will include subtidal, intertidal, and water column monitoring.

U.S. ARMY CORPS OF ENGINEERS (COE)

- Sampling and Analysis: The COE may contribute valuable source and contamination information as a result of various dredging projects. As part of the COE "widening and deepening" project, sediment in the East and West Waterways and the lower Duwamish River up to the 1st Avenue South Bridge will be sampled. If the project is authorized and proceeds, some contaminated sediment will be removed. The COE also has a major role in the "Puget Sound Dredged Disposal Analysis" (see below, Interagency Coordination). As a result of this project, the future of the Fourmile Rock Disposal Site will be determined. At this time, it is unclear whether or not the COE will be sampling the sediments in this area.

CITY OF SEATTLE

- CSO Planning: With direction from Washington Department of Ecology, the City of Seattle is continuing efforts to reduce the frequency and severity of CSOs. The city's CSO planning will depend in large part on METRO's planning efforts, as the two systems are closely related. The city, however, has taken several actions to increase storage and to separate or partially separate stormwater from sewer lines.

- Shoreline Master Program and Grading and Drainage Codes: Recent amendments to the Program and Codes include considerations for the storage and handling of hazardous or dangerous materials. It should be noted, however, that these regulations are not retroactive and only apply to future construction.

- Water Supply Corrosion Control Program: The City of Seattle treats its water with hardeners to reduce the leaching of zinc, copper, and iron from distribution pipes, thus reducing the input of these metals to receiving waters.

INTERAGENCY COORDINATION

- Elliott Bay Toxics Action Program: As part of the planning process, U.S. EPA has established an interagency workgroup composed of representatives from U.S. EPA, Washington Department of Ecology, Washington Department of Natural Resources (DNR), Municipality of Metropolitan Seattle (METRO), U.S. Army Corps of Engineers (COE), Port of Seattle, City of Seattle, King County, National Oceanic and Atmospheric Administration (NOAA), and the Washington Department of Social and Health Services (DSHS). This work group provides a communication network whereby involved agencies can reduce duplication of effort and bridge institutional and regulatory gaps. Work group representatives review the approach, progress, and results of the Elliott Bay Action Program project. Work group sessions were instrumental in developing the interim actions specified in this report. One obvious result from increased interagency coordination will be seen in the Elliott Bay Sampling and Analysis Design, which combines the resources of several agencies to meet a common goal.

- Puget Sound Dredged Disposal Analysis: A 3-yr cooperative project by DNR, COE, U.S. EPA, and Washington Department of Ecology. The objectives are to identify acceptable sites for open-water unconfined disposal of dredged material, to define chemical and biological evaluation procedures for assessing disposal alternatives, and to formulate management plans for disposal sites. The draft EIS for Phase I, which includes Elliott Bay and the Fourmile Rock Disposal Site, is scheduled to be available by December, 1986.

- CSO Planning: Strategies for reducing City of Seattle CSOs will be based upon METRO planning efforts for their CSOs. METRO intends to set priorities for reducing CSOs, partly in response to input from U.S. EPA and Washington Department of Ecology (based on the results of the Elliott Bay Toxics Action Program findings). A draft report on alternatives for reducing major CSOs in the project area will be released in November, 1985.

- Nonpoint Sources: Increased coordination between Washington Department of Ecology, U.S. EPA, METRO, King County, and the City of Seattle would facilitate control of toxicant loading from nonpoint surface runoff. For example, the Seattle Department of Construction and Land Use (Shoreline Management Program, Grading and Drainage Codes) will interact closely with Washington Department of Ecology's permit branch to coordinate on-site control (storage, handling, etc.) of toxic substances. A consistent strategy for control of stormwater runoff will be developed.

- Puget Sound Water Quality Management Plan: The Puget Sound Water Quality Authority (PSWQA) is directed by the Washington State Legislature to prepare a comprehensive, region-wide plan for managing water quality. At the time of this writing, a focus for this plan has not been developed, but it is expected to include toxic contamination. Current legislation calls for preparation of the plan by January, 1987.

- Toxic Spills: The Coast Guard, U.S. EPA, METRO, municipal fire departments, the Port of Seattle, the City of Seattle, King County, and Washington Department of Ecology will continue to develop procedures for systematic cooperation during emergency cleanup operations.

SITE-SPECIFIC WORK PLAN

The Elliott Bay Action Team was created by Washington Department of Ecology, U.S. EPA, and METRO to implement the Interim Work Plan. The multi-disciplinary team consists of professionals who will be responsible for on-site investigations, permit-writing, and permit inspections. The Action Team will also be responsible for helping personnel from other agencies with cleanup and sampling activities. Two Washington Department of Ecology positions are funded directly by Washington Department of Ecology and two are funded (for a period of at least 1 year) by METRO. Additional personnel from METRO and the City of Seattle will participate in source investigations and cleanup. The Action Team will coordinate the team's activities with U.S. EPA contractors and agencies responsible for ongoing investigations in Elliott Bay and the Duwamish River. The Action Team is expected to be fully operational in October, 1985, and its agenda through 1987 includes 27 site investigations.

The Action Team provides the regulatory link between problem identification and source control. The responsibility of the Action Team is to control or eliminate sources of toxic contaminants in a timely manner, through negotiations with responsible parties, permitting mechanisms, or compliance orders.

Table 2 presents the Work Plan for the Elliott Bay Action Team and associated agencies for late 1985, 1986, and 1987. The study area segments refer to priority areas defined in the Initial Data Summaries and Problem Identification report. Refer to Figure 3 above for a map of the study area and locations of these segments. The personnel column in Table 2 indicates the agency and program (where relevant) responsible for overseeing or carrying out the actions. The last column refers to the quarter, or month and year, in which implementation will begin. This Work Plan is the product of the coordinated, intensive efforts of many organizations and individuals (see Acknowledgements at front of this report). The actions noted in Table 2 were agreed upon after a great deal of discussion among, and planning by, members of the Interagency Work Group and Citizens Advisory Committee. Appendix A contains a summary of environmental conditions and lists potential sources of contaminants for each priority segment. The sources identified are probably not the only sources of contaminants, but they are subject to interim actions pending further source investigations.

TABLE 2. SITE SPECIFIC WORK PLAN FOR ELLIOTT BAY INTERIM ACTION PROGRAM

NORTH HARBOR ISLAND
SEGMENT 4B

Source	Action	Personnel	Implementation Dates
Waste disposal area	Perform search of ownership and business-license records to determine identities of former owners. Classify amounts and types of previous on-site wastes. Determine disposal practices of former occupants.	City of Seattle	10-12/85
Mobil Oil	Perform NPDES inspection.	Ecology	1-3/86
	Sample sediment directly under discharge of oil separator.	Ecology/USCG	1-3/86
	Review number, severity, and recovery methods of historic spills at site.	Ecology	1-3/86
	Review SPCC plans and implementation.	Ecology	7-9/86
	Perform groundwater investigation.	H.I. Superfund U.S. EPA/Ecology	To be scheduled
Todd Shipyards	Inspect Todd Shipyard. Interview Todd personnel. Document historic and present disposal practices of sandblast waste, paint and paint overspray, bilge water and stack cleaning wastes, waste oil, and solvents. Document previous occupants on site. Review SPCC plan and its implementation.	Ecology	To be scheduled
	Review present NPDES permit and modify if necessary based on FY 86 U.S. EPA samples.	Ecology	4-6/87
	Sample storm drains and perform regular maintenance if necessary - and probably corrective measures.	Todd	10-12/85
	Investigate groundwater contamination (waste paint and oil storage area was unpaved until 1984).	Todd/H.I. Superfund U.S. EPA/Ecology	To be scheduled
	Interview prior owner of part of site (i.e., Mobil Oil) and its employees for information on former waste handling and disposal practices.	METRO/Ecology Mobil Oil	1-3/86
CSO/SD 077	Characterize sediment contamination, toxicity, infauna, bioaccumulation, and liver pathology in immediate vicinity of CSO/SD. Analyze for priority pollutants in CSO/SD sediments and relate to environmental conditions.	U.S. EPA	9/85 - ongoing
Non-specified	Complete initial assessment of Harbor Island toxic contamination and sources by June, 1985. Issue sampling and analysis plan, including identification of groundwater sources. Also, Superfund legislation requires industries to disclose information on toxic spills, hazardous waste, and groundwater testing.	H.I. Superfund U.S. EPA/Ecology	Ongoing
	U.S. Status and Trends Program: Conduct annual long-term monitoring of sediment contamination, toxicity, and fish pathology at station north of Harbor Island.	NOAA	Ongoing

TABLE 2. (Continued)

EAST WATERWAY
SEGMENTS 4A/5A/5B

Source	Action	Personnel	Implementation Dates
Seattle Iron and Metal	Monitor and verify removal of copper wash effluent from Hanford St. storm drain to sanitary sewer with adequate pretreatment.	METRO/Ecology	7/85
	Sample Hanford St. storm drain for metals and organic toxicants, prioritize relative to other sources, and relate to waterway contamination and bioeffects.	U.S. EPA	9/85-ongoing
	Determine sources of PCB-laden transformers, chemical content of transformers from each owner, and treatment practices of transformer owners. Submit report to Washington Department of Ecology.	City Light	Begin 1/86
Oil tank farms (Texaco, Shell, GATX, Golden Penn, Chevron)	Investigate historic spills for on-site quantity and recovery. Include sites which have been redeveloped into Port container terminals, e.g., Shell. Check for on-site wells (7,000 gal at Chevron).	Ecology	1-3/86
	Perform NPDES inspections for disposal of oil separator wastewater.	Ecology	1-3/86
	Inspect Texaco truck wash discharge to check for detergent intruding into separator.	Ecology	1-3/86
	Review and implement SPCC plans.	U.S. EPA	1-3/86
	Sample river sediment below discharge of NPDES outfalls (except Chevron).	USCG/Ecology	1-3/86
	Review Chevron stormwater permit and require stricter controls if necessary.	Ecology	12/85
Major storm drains	Sample storm drain sediment at critical junctures of the major storm drains that discharge into the East Waterway(Hanford St., Hinds St., Spokane St., Florida St.). Relate sources to waterway contamination and bioeffects. Identify ultimate sources and develop control measures.	U.S. EPA, METRO, Ecology, City of Seattle	9/85-ongoing
	Continue mapping storm drains at Terminals 19, 102, 30, 37, and 25	Port of Seattle	Ongoing
Major CSOs	Implement CSO sampling concurrently with a key manhole sampling study to determine wastewater sources. Priority CSOs include Lander and Hanford.	METRO	9/85 to 1987
	Analyze priority pollutants in major CSO sediments and relate to waterway contamination and bioeffects.	U.S. EPA	9/85 - ongoing
	Divert upper Rainier Valley/Capitol Hill storm water from sanitary system by constructing Hanford St. tunnel.	METRO, City of Seattle	9/85 to 1989
Crowley Environmental Services	Issue RCRA permit, including consideration of groundwater monitoring.	U.S. EPA	To be scheduled
Terminal 30 contaminated sediments	Remove 50,000-90,000 cubic yards of contaminated sediments by dredging.	Port of Seattle	1985-1986

TABLE 2. (Continued)

EAST WATERWAY
SEGMENTS 4A/5A/5B

Source	Action	Personnel	Implementation Dates
Non-specified	Superfund: Complete initial assessment of Harbor Island toxic contamination and sources by June, 1985. Issue sampling and analysis plan, including identification of groundwater sources. Also, Superfund legislation requires industries to disclose information on toxic spills, hazardous waste, and groundwater testing.	Ecology	Ongoing
	Implement Elliott Bay Sampling and Analysis Design to characterize entire area in terms of sediment contamination, toxicity, and bioeffects.	U.S. EPA	9/85-ongoing
	Dredging: Develop plans for removal of contaminated sediments from portions of East Waterway as part of Widening and Deepening Project. Conduct sampling and analysis of deep sediment cores.	COE	1985

TABLE 2. (Continued)

WEST WATERWAY SEGMENTS 6A/6B

Source	Action	Personnel	Implementation Dates
SeaFab Metals	Investigate groundwater disposal practices.	Ecology/RCRA	4-6/86
	Proceed with RCRA closure plan for SeaFab Metals.	Ecology/RCRA	4-6/86
	Verify Lander St. cleanup, resample storm drain sediment.	U.S. EPA	9/85 - ongoing
Pioneer Sand and Gravel	Perform site inspection.	Ecology	4-6/87
Lockheed Shipyards 112	Inspect Lockheed Shipyards. Interview Lockheed personnel and document historic and present disposal practices of sandblast waste, paint and paint overspray, bilge water and stack cleaning wastes, waste oil, and solvents. Document previous occupants of site.	Ecology	10-12/85
	Review present NPDES permit and modify if necessary based on results of U.S. EPA Elliott Bay Sampling and Analysis.	Ecology	4-6/87
	Sample storm drains and perform regular maintenance and corrective measures if necessary.	Lockheed	10-12/85
	Investigate groundwater contamination.	Lockheed Superfund	To be scheduled
	Review SPCC plan and its implementation.	U.S. EPA	To be scheduled
Florida St. storm drain (Purdy Lot, Wyckoff)	Clean out sediments contaminated with PCB, PCP, PAH, copper, and arsenic.	Ecology, METRO, City, Wyckoff, Purdy	7/85 (completed)
	Control source of PCBs at head of storm drain.	U.S. EPA TOSCA	10/85
Tank farms (Texaco, Shell, Arco)	Investigate historic spills for on-site quantity recovery (e.g., check for on-site wells). Include sites that have been redeveloped into Port container terminals.	Ecology	1-3/86
	Perform NPDES inspections for disposal of oil separator wastewater.	Ecology	1-3/86
	Inspect Texaco truck wash discharge to determine if discharge is intruding into oil/water separator.	Ecology	1-3/86
	Review SPCC plans and implement them.	Ecology	1-3/86
	Sample river sediment below discharge of NPDES outfalls.	USCG/Ecology	1-3/86
Seattle Iron and Metal	Investigate groundwater disposal practices.	Ecology/RCRA	4-6/86
Waste Disposal Areas	Investigate groundwater contamination.	H.I. Superfund U.S. EPA/Ecology	4-6/87
West Seattle Landfill	Investigate groundwater contamination.	H.I. Superfund, Sea-King Co. Health Dept., Ecology, U.S. EPA Emergency Response	Ongoing

TABLE 2. (Continued)

WEST WATERWAY SEGMENTS 6A/6B

Source	Action	Personnel	Implementation Dates
Bethlehem Steel liquid and slag waste disposal area	Continue RCRA closure proceedings. Investigate drainage history of Longfellow Creek.	Ecology/RCRA	7-9/86
Small storm drains discharging into West Waterway	Sample small drains (Florida St./Harbor Island, Spokane St./Harbor Island) to determine if they are contributing contaminated sediment and water to the river.	METRO, City of Seattle, Ecology, U.S. EPA	9/85-ongoing
	Continue mapping of storm drains on Port properties (especially Terminal 5).	Port of Seattle	1985
Mono Roofing	Resolve issue of dumping solvents and roofing wastes into Spokane St. storm drain.	Ecology, METRO	7/85-6/86
Fischer Mills	Review cooling-water NPDES permit.	Ecology	1985
Shell	Review stormwater permit, apply stricter controls if necessary.	Ecology	1985
Chelan St. CSO	Review West Point treatment plant permit with monitoring requirements for discharge.	Ecology, METRO	1985
Other CSOs	CSO Planning: Construction was completed in 1984 to allow Longfellow Creek system to contain runoff from up to a 10-yr storm without CSO events. Begin planning to reduce or eliminate other CSOs.	City of Seattle	Ongoing
Non-specified	Superfund: Complete initial assessment of Harbor Island toxic contamination and sources by June, 1985. Issue sampling and analysis plan, including identification of groundwater sources. Also, Superfund legislation requires industries to disclose information on toxic spills, hazardous waste, and groundwater testing.	H.I. Superfund U.S. EPA/Ecology	Ongoing
	Implement Elliott Bay Sampling and Analysis Design to characterize area further, including source evaluation.	U.S. EPA	9/85-ongoing
	Dredging: Develop plans for removal of contaminated sediments as part of Widening and Deepening Project. Conduct sampling and analysis of deep sediment cores.	COE	1985

Source	Action	Personnel	Implementation Dates
Diagonal Way storm drain	Resample Diagonal Way storm drain sediments to prioritize relative to other sources and relate to Waterway contamination and bioeffects.	U.S. EPA	9/85-ongoing
	Implement cleanup of pole treatment yard (stabilize site).	Seattle City Light, Ecology	10/85
	Monitor storm drain discharge.	METRO	1985
Ash Grove Cement	Determine if unlined surge pond on riverbank is a pollutant source.	Ecology	1-3/86
	Perform Washington Department of Ecology state discharge permit inspection.	Ecology	1-3/86
	Document historical storage methods and use of ASARCO slag, flyash, and coal.	Ecology	1-3/86
Diagonal Way CSO	Implement CSO sampling concurrently with a key manhole sampling study to determine wastewater sources.	METRO	9/85 to 1987
	Divert upper Rainier Valley/Capitol Hill storm water from sanitary system by constructing Hanford St. tunnel.	METRO, City of Seattle	9/85 to 1989
Ideal Cement	Conduct a permit inspection.	Ecology	1-3/86
Port of Seattle T-105	Conduct groundwater study, investigate upland disposal of contaminated sediments.	Port of Seattle	Ongoing (groundwater study complete)
Janco-United, Inc.	Proceed with criminal investigation.	U.S. EPA	To be scheduled
Port of Seattle storm drains	Continue mapping storm drains on Port properties (especially Terminal 102 and shorelines south to Diagonal Way).	Port of Seattle	1985
Hanford 1 CSO	Review West Point Treatment Plant NPDES permit with monitoring requirements for discharge and receiving environment.	Ecology	1985
	CSO Planning: Evaluate alternatives for reducing CSOs. Monitor Hanford 1 CSO discharges.	METRO	To be scheduled
Non-Specified	Superfund: Complete initial assessment of Harbor Island toxic contamination and sources by June, 1985. Issue sampling and analysis plan, including identification of groundwater sources. Also, Superfund legislation requires industries to disclose information on toxic spills, hazardous waste, and groundwater testing.	H.I. Superfund U.S. EPA/Ecology	Ongoing
	Implement Elliott Bay Sampling and Analysis Design to further characterize this area.	U.S. EPA	9/85-ongoing
	Dredging: Develop plans for removal of contaminated sediments as part of Widening and Deepening Project. Conduct sampling and analysis of deep sediment cores.	COE	1985
	National Cancer Institute Study: Conduct sampling in June, 1985, to characterize sediment contamination, chemistry of English sole muscle and bile, and English sole histopathology.	NOAA	Ongoing

TABLE 2. (Continued)

DENNY WAY CSO
SEGMENT 2A

Source	Action	Personnel	Implementation Dates
Denny Way CSO	NPDES: Renew METRO West Point Treatment Plant permit and require monitoring of Denny Way CSO discharges.	Ecology	To be scheduled
	CSO Planning: Evaluate alternatives for reducing CSOs. Assess benefits and impacts of onsite storage or treatment and transfer of Denny Way CSO load to subtidal diffuser.	METRO	Ongoing (Report 11/85)
	Implement 1985 Elliott Bay Sampling and Analysis Design to test for contamination and toxicity of intertidal sediments. Analyze priority pollutants in CSO sediments to prioritize Denny Way CSO relative to other sources.	U.S. EPA	9/85-Ongoing
	National Cancer Institute Study: Conduct sampling in June, 1985, to characterize sediment contamination, chemistry of English sole muscle and bile, and English sole histopathology.	NOAA	Ongoing

TABLE 2. (Continued)

SEATTLE WATERFRONT
SEGMENT 3C

Source	Action	Personnel	Implementation Dates
CSOs	CSO planning: Begin planning to reduce or eliminate Number 071 CSO and Number 164 CSO.	City of Seattle	Ongoing
CSOs and historical sewage dishcarge	Characterize sediment contamination, toxicity, benthic infauna, bioaccumulation, and English sole liver pathology off Piers 53/54.	U.S. EPA	9/85-Ongoing

TABLE 2. (Continued)

SLIP 1
SEGMENT 7B

Source	Action	Personnel	Implementation Dates
Ideal Basic Industries	NPDES: Issue permit and require stricter controls if necessary.	Ecology	7/85-6/86
Non-specified	Characterize sediment contamination, toxicity, and benthic infauna at head of Slip 1 to prioritize area relative to other potential problem areas.	U.S. EPA	9/85-Ongoing
	Require local industries to supply data on storm drainage.	Ecology	To be scheduled

TABLE 2. (Continued)

SLIP 2
SEGMENT 8A

Source	Action	Personnel	Implementation Dates
Michigan St. CSO	Implement CSO sampling concurrently with a key manhole sampling study to determine wastewater sources. Evaluate alternatives to reduce or eliminate Michigan CSO.	METRO	9/85 to 1987
Chempro	Determine if groundwater is contributing to contaminated sediment in Slip 2.	METRO/Ecology	1-3/86
	Perform inspection and issue status report.	RCRA	To be scheduled
Historic dumps/waste disposal areas	Identify potential contaminated areas. Research ownership and business license records to obtain names of previous owners and site-use information.	City of Seattle	To be scheduled
Non-specified	Characterize sediment contamination and toxicity at head of Slip 2 to prioritize area relative to other potential problem areas.	U.S. EPA	9/85-Ongoing

TABLE 2. (Continued)

SLIP 3
SEGMENT 8B

Source	Action	Personnel	Implementation Dates
Marine Power and Equipment	Inspect MP&E. Interview personnel. Document historic and present disposal practices of sandblast waste, paint and paint overspray, bilge water and stack cleaning wastes, waste oil and solvents. Determine previous occupant of site.	Ecology	10-12/85
	Review NPDES permit.	Ecology	Draft 1/86 Final 6/86
	Proceed with issuance of Ecology fine and U.S. EPA criminal investigation.	U.S. EPA	To be scheduled
Fox Street storm drain	Map and identify storm drains.	City of Seattle	9/85
	Identify sources, resample storm drain sediment.	U.S. EPA, METRO/Ecology City of Seattle	9/85-ongoing
	Remove sediment from storm drain.	METRO/Ecology City of Seattle	To be scheduled
Possible groundwater contamination from Chempro and historic site	Determine if groundwater is contributing to contaminated sediment in Slip 3.	U.S. EPA/CID WDOE	To be scheduled
Michigan St. CSO	Implement CSO sampling concurrently with a key manhole sampling study to determine wastewater sources.	METRO	9/85 to 1987
	CSO Planning: Evaluate alternatives to reduce or eliminate Michigan CSO.	METRO	Ongoing
	NPDES: Renew permit for West Point treatment plant and require METRO to monitor CSO to determine degree of influence on conditions in Slip 3.	Ecology	To be scheduled
Non-specified	Characterize sediment contamination and toxicity at head of Slip 3.	U.S. EPA	9/85-Ongoing

TABLE 2. (Continued)

SLIP 4
SEGMENT 8D

Source	Action	Personnel	Implementation Dates
Georgetown Flume	Remove flume sediments and clean up upland site.	Seattle City Light, Ecology	10/85
Storm drains, CSOs	Characterize priority pollutant concentrations in drain and CSO sediments and relate to sediment contamination and toxicity at head of Slip.	U.S. EPA	9/85-Ongoing

TABLE 2. (Continued)

FOURMILE ROCK DISPOSAL SITE
SEGMENT 10A

Source	Action	Personnel	Implementation Dates
Fourmile Rock Disposal Site	Puget Sound Dredged Disposal Analysis: Investigate suitability of Fourmile Rock Disposal Site for future dredged material disposal. If site is selected for further use, develop final criteria for disposal and a management plan.	COE/DNR, EPA/Ecology	1985
	Disposal Criteria: Issue interim criteria for material to be disposed at this site before Puget Sound Dredged Disposal Analysis is completed. Proposed interim criteria were issued April 7, 1985.	U.S. EPA	4/85
	Implement Elliott Bay Sampling and Analysis Design to characterize contamination and effects at 30 ft depths inshore of the designated disposal site.	U.S. EPA/COE, DSHS	10/85 to 3/86
	Analyze toxic contaminant levels in samples of clams and sediments from an intertidal site on Magnolia Beach.	METRO	8-10/85

TABLE 2. (Continued)

| ADDITIONAL ACTIONS IN STUDY AREA |

Source	Action	Personnel	Implementation Dates
Sunset Demolition	Perform site inspections.	Lang Co., BALD, WDOE, Sea-King County Health	7-9/85
Malarky Asphalt	Inspect for PCBs and zinc.	Ecology	7-9/85
Duwamish Shipyard	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86
Monsanto	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86
Whitney Fidalgo	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86
Lone Star	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86
Northwest Glass	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86
Time D.C.	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86
Seattle Rendering	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86
Shell Oil	Perform inspections and draft NPDES permits.	Ecology	7/85-6/86

DECISION FRAMEWORK FOR CONTROLLING POLLUTANT SOURCES

Pollutant sources are controlled via several regulatory and management processes. The avenue for control depends on many factors, one of which is the nature of the source. Direct discharges and illegal dumping, for example, are controlled differently. This section outlines the principal strategies for source control and the decision-making steps inherent in each.

There are three principal stages in the process of contaminant source control:

- Characterization of direct discharges
- Characterization of ultimate sources
- Source control and cleanup.

Figures 4-7 illustrate the major steps taken by regulatory agencies to characterize and control sources of toxicants from drainage systems to the Elliott Bay/lower Duwamish River area. For a single drainage system (e.g., storm drain and its upstream sources), the entire process of problem identification and source control is anticipated to take 1-5 yr. The actual time spent depends on many variables, including 1) the complexity of the drainage system, 2) the nature and extent of contamination, 3) the feasibility of controlling the identified sources, and 4) the nature of enforcement and regulatory action.

The first stage - characterization of direct sources, such as drains discharging directly to waterways - involves the identification of problem storm drains and problem contaminants. This is accomplished primarily by analyzing storm drain sediments collected from drainage conduits close to the point of discharge into the waterway.

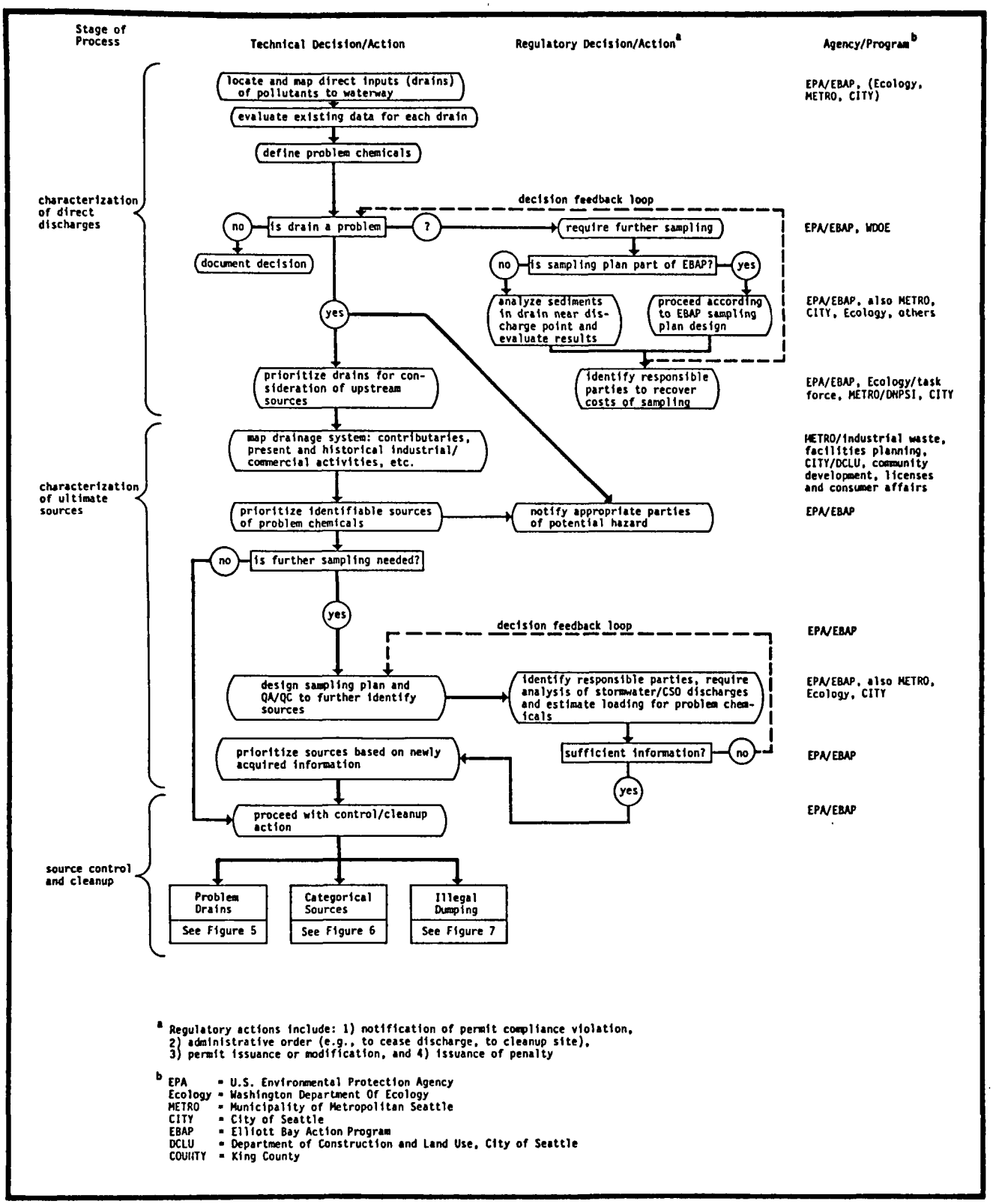
In the second stage, the highest priority drains are further investigated to determine the ultimate sources of the contaminants. Drainage system mapping and additional sampling may be required to identify and rank the ultimate sources of contaminants. Additional sampling may be required in several instances, for example when data about existing conditions are not adequate to identify ultimate sources or when legally defensible information is needed for a criminal investigation. Once ultimate sources are identified, responsible parties may be required to perform effluent analyses and estimate loading.

The third stage of regulatory activity involves actual cleanup and control of sources. Cleanup and control strategies vary widely depending on the nature of the source. Figure 5 presents procedures related to identified or point sources. If a discharge permit is required, the source can be controlled by 1) pretreatment, 2) discharge to a sanitary sewer, or 3) installation of a best management practice (BMP). If a discharge permit is not required, the responsible party may be called on to halt its discharge.

In either case, the discharger may have to assume costs related to sampling and site or sediment cleanup.

Nonpoint or categorical sources (Figure 6), such as direct runoff from urban areas, are predominantly controlled by designing and implementing BMPs. BMPs are usually designed for categories of sources (e.g., site runoff from oil tank farms or city streets).

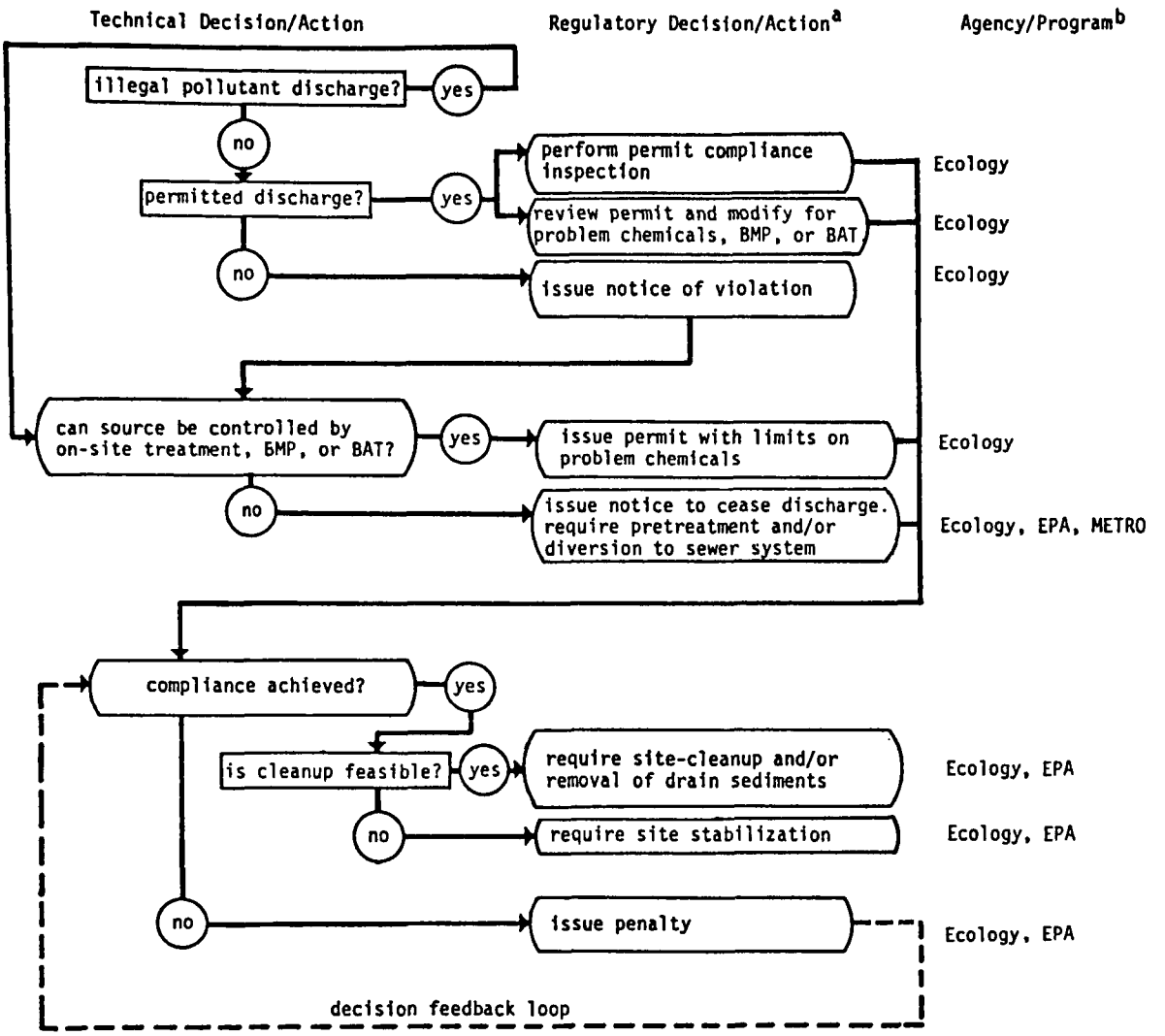
For illegal dumping (Figure 7), criminal investigation and enforcement depend heavily on apprehending the violator in the act. Until a violator is identified, regulatory activity involves primarily monitoring or "staking out" an area where illegal dumping is suspected.



[a] Regulatory actions include: 1) notification of permit compliance violation, 2) administrative order (e.g., to cease discharge, to cleanup site), 3) permit issuance or modification, and 4) issuance of penalty

[b] EPA = U.S. Environmental Protection Agency
Ecology = Washington Department Of Ecology
METRO = Municipality of Metropolitan Seattle
CITY = City of Seattle
EBAP = Elliott Bay Action Program
DCLU = Department of Construction and Land Use, City of Seattle
COUNTY = King County

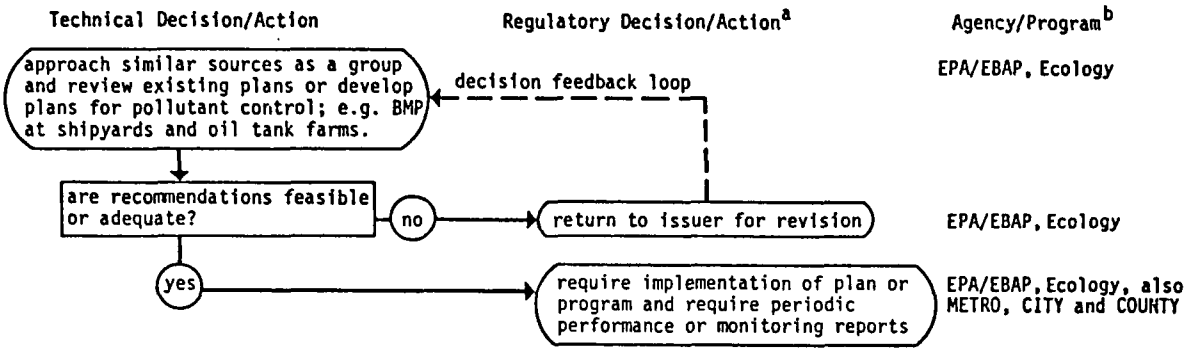
Figure 4. Approach to characterization of direct discharges and ultimate pollutant sources.



[a] Regulatory actions include: 1) notification of permit violation, 2) administrative order (e.g., to cease discharge, to cleanup site), 3) permit issuance or modification, and 4) issuance of penalty

[b]
EPA = U.S. Environmental Protection Agency
Ecology = Washington Department of Ecology
METRO = Municipality of Metropolitan Seattle
CITY = City of Seattle
EBAP = Elliott Bay Action Program
DCLU = Department of Construction and Land Use, City of Seattle
COUNTY = King County
BMP = Best Management Practices
BAT = Best Available Treatment

Figure 5. Control of problem drains and CSOs.



[a] Regulatory actions include: 1) notification of permit violation, 2) administrative order (e.g., to cease discharge, to cleanup site), 3) permit issuance or modification, and 4) issuance of penalty

[b]
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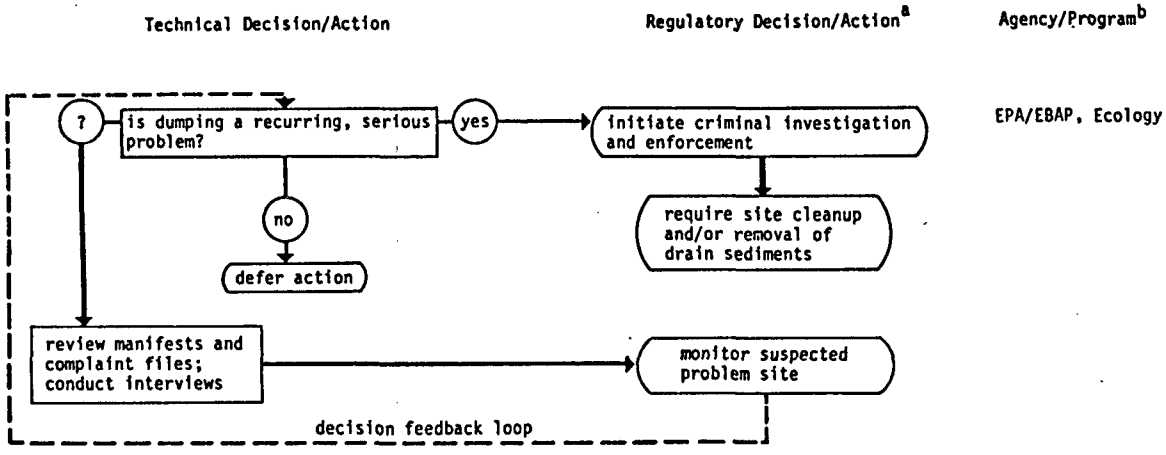
Figure 6. Control of categorical sources.



[a] Regulatory actions include: 1) notification of permit violation, 2) administrative order (e.g., to cease discharge, to cleanup site), 3) permit issuance or modification, and 4) issuance of penalty

[b]
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METRO = Municipality of Metropolitan Seattle
CITY = City of Seattle
EBAP = Elliott Bay Action Program
DCLU = Department of Construction and Land Use, City of Seattle
COUNTY = King County

Figure 7. Control of illegal dumping.

APPENDICES

APPENDIX A

MAPS

COMBINED SEWER OVERFLOW (MAJOR)
COMBINED SEWER OVERFLOW (MINOR)
COMBINED SEWER OVERFLOW/STORM DRAIN
STORM DRAIN (8" to 24")
STORM DRAIN (25" to 48")
STORM DRAIN (> 48")
TREATMENT PLANT OUTFALL
OTHER POTENTIAL SOURCES

WEST POINT
DISCOVERY PARK
DRAVUS ST.
FOURMILE ROCK
MAGNOLIA BLUFF
SMITH COVE PARK
SMITH COVE
PIER 91
PIER 90
DISPOSAL AREA
T-89 PUBLIC FISHING PIER
MYRTLE EDWARDS PARK
PIER 66
PIER 71
PIER 70
DENNY WAY
ELLIOTT BAY
WATERFRONT PARK
PIER 59/60
PIER 56
WASHINGTON STATE PARK
PIER 48 VIEWPOINT
SEATTLE
TERMINAL 46
TERMINAL 37
CONNECTICUT ST.
TERMINAL 18
PIER 13
SW FLORIDA ST.
ALASKAN WAY
WATERWAY
TERMINAL 30
LANDER ST.
TERMINAL 5
WEST WATERWAY
EAST WATERWAY
TERMINAL 25
HANFORD ST.
SPOKANE ST. BRIDGE
WEST SEATTLE FREEWAY PARKS
TERMINAL 102
TERMINAL 105
FISHING PIER
T-5
PIER 2
DON ARMENI PARK AND BOAT RAMP
DUWAMISH HEAD
ALKI BEACH PARK
ALKI PT.
55TH AVE. SW
FAIRMOUNT AVE. SW
TERMINAL 128
GEORGETOWN
DIAGONAL WAY
S. DIAGONAL ST.
KELLOGG ISLAND
KELLOGG ISLAND VIEWING AREA
SLIP 1
DUWAMISH
SLIP 2
1ST AVE. S. BRIDGE
MICHIGAN ST.
INDIAN NET FISHERY UPSTREAM LIMIT
BOAT RAMP
SLIP 3
TERMINAL 115
T-105
RIVER
GEORGETOWN PUMPING STATION
SLIP 4
DUWAMISH RIVER PARK
14TH ST. BRIDGE

122°20'
19'
47°33'
32'
39'
38'
37'
36'
47°35'
26'
122°25'
24'
22'
20'
600
300
100
50

DEPTH CONTOURS IN FEET BELOW MLLW
0 5000 FEET
0 1000 METERS

Public access points and recreational areas

MAP 1

EXISTING PUBLIC ACCESS
FISHING
PROPOSED PUBLIC ACCESS
FUTURE PUBLIC ACCESS
CITY PARKS
PROPOSED WILDLIFE REFUGE
RECREATIONAL SHELLFISH HARVEST AREA
GEODUCKS
KELP
EELGRASS

COMBINED SEWER OVERFLOW (MAJOR)
COMBINED SEWER OVERFLOW (MINOR)
COMBINED SEWER OVERFLOW/STORM DRAIN
STORM DRAIN (8" to 24")
STORM DRAIN (25" to 48")
STORM DRAIN (> 48")
TREATMENT PLANT OUTFALL
OTHER POTENTIAL SOURCES

WEST POINT
DRAVUS ST.
061
062
063
FOURMILE ROCK
MAGNOLIA BLUFF
064
W006
DISPOSAL AREA
CHEM PRO
SMITH COVE
INTERBAY
PIER 91
PIER 90
PIER 86
INTERBAY LANDFILL
DENNY WAY
PIER 71
069
ELLIOTT BAY
PIER 59/60
070
071
164
172
SEATTLE STEAM
072
PIER 48
KING
SEATTLE
TERMINAL 46
TERMINAL 37
CONNECTICUT
CONNECTICUT ST.
077
TERMINAL 18
QATX
CHEVRON
PACIFIC CHEM.
PIER 13
TODD
SW FLORIDA ST.
OLYMPIC
LANDER
TERMINAL 30
LANDER ST.
HANFORD
TERMINAL 25
HANFORD ST.
162
SEATTLE IRON & METAL
107
CROWLEY
SPOKANE ST. BRIDGE
6TH AVE. S LANDFILL
CITY LIGHT
ASH GROVE
TERMINAL 105
TERMINAL 102
SEATTLE
MONO
163
104
S.W. HIND ST.
CHELAN
ARCO
SHELL
TEXACO
SEAFAB
LOCKHEED
105
106
098
WYCKOFF
PIER 2
LONGFELLOW CR
WEST WATERWAY
EAST WATERWAY
PURDY
WEST SEATTLE LANDFILL
TERMINAL 5
082
083
A003
080
DUWAMISH HEAD
078
FAIRMOUNT AVE. SW
56TH AVE. SW
085
ALKI PT.
ALKI POINT
W035
DIAGONAL WAY
W034
KELLOGG ISLAND
SLIP 1
W041
DUWAMISH
DUWAMISH SHIPYARD
SLIP 2
1ST AVE. S. BRIDGE
MICHIGAN ST.
TERMINAL 115
MICHIGAN
SLIP 3
MARINE POWER
116
W042
RIVER
SEATTLE CITY LIGHT
SLIP 4
117
W043
W040
14TH ST. BRIDGE
SOUTH PARK LANDFILL
BOEING PL. 2
JORGENSON
156
MONSANTO
TERMINAL 124
BOEING DEV. CENTER
GEORGETOWN
SOUTH PARK
122°20'
19'
47°33'
32'
39'
38'
37'
36'
47°35'
26'
122°25'
24'
22'
20'
50
100
300
600

DEPTH CONTOURS IN FEET BELOW MLLW
0 5000 FEET
0 1000 METERS
HARBOR

Contaminant sources and selected industry locations in Elliott Bay and the lower Duwamish River

MAP 2

APPENDIX B

ENVIRONMENTAL CONDITIONS AND POTENTIAL SOURCES OF CONTAMINANTS FOR STUDY AREA SEGMENTS OF ELLIOTT BAY AND THE LOWER DUWAMISH RIVER

NORTH HARBOR ISLAND (4B)

ENVIRONMENTAL CONDITIONS

At Site 4B (North Harbor Island), sediments at the highest ranked stations exhibited the following environmental characteristics:

Variable	Elevation Above Reference	
LPAH	Very high	>1,000X
HPAH	Very high	>1,000X
PCB	High	100-1,000X
Cu+Pb+Zn	High	100-1,000X
As	High	100-1,000X
Amphipod mortality	Moderate	3.6-7.1X

This site ranked highest among all areas based on "worst-case" stations. Nearshore stations exhibited extremely high levels of PAH, PCBs, and metals in sediments from the mouth of the West Waterway east along the shore of North Harbor Island to Pier 16. Although the outflow of the Duwamish River contributes to high levels of pollution in this area, gradients in sediment concentrations of toxic chemicals suggest that local sources are important. Moreover, this is one of the few known locations in the study area where concentrations of LPAH in sediments exceeded 1,000 times the reference value of 41 ppb. The high levels of LPAH in sediments suggest an ongoing source of petroleum pollution. Much of the high arsenic content in sediments may be accounted for by historical releases of sandblast material containing 50 ppm or more of arsenic. However, some arsenic contamination may be related to historical treatment of shipyard dry docks with sodium arsenite. In sediment toxicity bioassays, amphipod mortality was 25-50 percent at the mouth of the West Waterway (Reference = 7 percent mortality), but was not significantly elevated at about the 50-ft depth off Pier 14. Finally, the prevalence of liver tumors in English sole collected from North Harbor Island and adjacent areas was 5.5 percent (Reference = 0 percent prevalence).

Although sediment chemical concentrations showed some variation among stations, the entire area displayed moderate to high elevations of all chemical indicators. Based on average conditions, this area ranked as one of the top four priority problem areas.

POTENTIAL SOURCES

- Todd Shipyards
- NPDES discharge of sandblast material and cooling water (24 M gal/yr) until 1975,
  Dry docks treated with Na_3AsO_3 (1,940 lb/yr arsenic),
  Storm drains

- Mobil Oil Company
- Pier 15
- NPDES stormwater discharge
- Oil Transfer Pier, possible oil spills.

EAST WATERWAY (4A/5A/5B)

Segments 4A, 5A, and 5B are considered together as part of the East Waterway system for two reasons. First, each of these sites may be influenced by sources throughout the waterway. Therefore, source control actions are similar for all of the sites. Second, when data become available for areas between these sites, extensive toxic contamination may be found throughout the waterway.

ENVIRONMENTAL CONDITIONS

Within the East Waterway, the highest ranked stations exhibited the following conditions for sediment chemistry and sediment toxicity:

Variable	Elevation Above Reference	
LPAH	Moderate	10-100X
HPAH	High	100-1,000X
PCB	High	100-1,000X
Cu+Pb+Zn	Moderate	10-100X
As	Moderate	10-100X
Amphipod mortality	High	>7.1X
Oyster abnormality	High	>8.2X

Segment 5A, which ranked third among all high priority areas based on "worst-case" conditions, accounted for the high ranking for the East Waterway overall. Contamination was heterogeneous within the waterway. For example, the head of the waterway (Segment 5B) ranked 17th, and the mouth of the waterway (Segment 4A) tied for the 12th position among priority problem areas. Based on the most contaminated sediment samples, PCBs, with an elevation of 770 times reference (6 ppb), and HPAH, with an elevation of 240 times reference (79 ppb), were the main problem chemicals. Also, the sum of copper, lead, and zinc exceeded an elevation above reference of 25 at two stations. Average EAR values were about 23 for LPAH, 120 for HPAH, 150 for PCBs, 3 for arsenic, and 16 for the other selected metals.

Both the amphipod bioassay and the oyster larvae bioassay exhibited above 50 percent response for samples from several locations within the waterway. The only bioassay response above 90 percent for the entire Elliott Bay system was found in an amphipod bioassay (98 percent mortality) near the Lander Street CSO. Based on the available pooled data for West and East Waterways and the North Harbor Island area, the prevalence of liver tumors in English sole was 5.5 percent, which was significantly elevated relative to reference conditions of 0 percent prevalence.

POTENTIAL SOURCES

• Connecticut CSO	• 30-100 M gal/yr
• Hanford CSO	• 100-700 M gal/yr
• Lander CSO	• 20-330 M gal/yr
• Hanford CSO/SD (162)	• SD = 60 M gal/yr, emergency CSO only
Seattle Iron and Metal	• Cu wash > settling pit overflows to Hanford SD
• S. Hinds CSO/SD (107)	• SD = 40 M gal/yr, emergency CSO only
• S.W. Spokane CSO/SD (163)	• SD = 3 M gal/yr, emergency CSO only
• S.W. Florida SD	• 20 M gal/yr
• S. Spokane SD	• Unknown flows
• GATX	• NPDES - storm water
• Chevron Oil Company	• NPDES - storm water
• Groundwater sources	
- Shell/Chevron	- "Product recovery" wells
- Golden Penn	- Waste solvent recycler, sludge lagoon possible (historical)
- SEAFAB	- Old seepage pond (battery acid, spent chemicals, yard drainage) closed 1982, Monitoring well installed
• Value Plating	• 1970-1978 wastewater discharged on grounds.

WEST WATERWAY (6A/6B)

ENVIRONMENTAL CONDITIONS

The most contaminated stations within the West Waterway exhibited the following conditions for sediment chemistry and sediment toxicity:

Variable	Elevation Above Reference	
LPAH	High	100-1,000X
HPAH	High	100-1,000X
PCB	High	100-1,000X
Cu+Pb+Zn	Moderate	10-100X
As	Low	<10X
Amphipod mortality	High	>7.1X
Oyster abnormality	High	>8.2X

The West Waterway ranked among the top seven priority areas based on "worst-case" stations and among the top three priority areas based on average conditions. Sediment chemistry was relatively homogenous throughout the West Waterway, although for some contaminants, sediment concentrations near the shore were slightly higher (e.g., 2-3 times) than those near mid-channel. Sediment toxicity bioassays and fish pathological indices indicate biological problems within this area (see section on East Waterway above for fish pathology data). Several stations exhibited bioassay responses above 40 percent response (47 and 63 percent mortality of amphipods and 78 percent abnormality of oyster larvae).

POTENTIAL SOURCES

- Chelan CSO — 1-50 M gal/yr
- S.W. Hinds CSO/SD (099) — SD = 280 M gal/yr, CSO = 60-90 M gal/yr
- S.W. Florida CSO/SD (098) — SD = 20 M gal/yr, emergency CSO only (PCBs, PAH, metals)
- S.W. Lander CSO/SD (105) — 50 M gal/yr (Pb), Cleaned 1984
- S.W. Florida CSO/SD (106) — SD = 30 M gal/yr, emergency CSO only
- S.W. 16th CSO/SD (104) — SD = 10 M gal/yr, emergency CSO only
- S.W. Lander SD — 8 M gal/yr (Pb, oil and grease)
- Fischer Flour — NPDES cooling water (23.4 M gal/yr), Storm drain

• Lockheed Shipyards	• NPDES cooling water (43.8 M gal/yr), Storm drains, Dry dock - Na_3AsO_3 treatment (1,490-2,980 lbs As/yr) until 1982
• Arco	• NPDES - storm water
• Shell	• NPDES - storm water
• Texaco	• NPDES - storm water (historical source of truck wash water)
• SEAFAB/RSR	• NPDES - cooling water (Pb) Groundwater - old seepage pond
• Golden Penn	• Groundwater source
• Harbor Island Machine	• Oil-contaminated surface runoff (source removed 1984)
• Old W. Seattle landfill	• Possible groundwater source.

SOUTH HARBOR ISLAND (7A)

ENVIRONMENTAL CONDITIONS

The highest elevations of sediment chemistry and toxicity bioassay variables observed in the South Harbor Island area were the following:

Variable	Elevation Above Reference	
LPAH	Moderate	10-100X
HPAH	High	100-1,000X
PCB	High	100-1,000X
Cu+Pb+Zn	Moderate	10-100X
As	Low	<10X
Amphipod mortality	High	>7.1X
Oyster abnormality	Moderate	4.1-8.2X

Based on the worst-case stations, this area tied with Segment 6B (West Waterway) for the 7th priority position. PCBs were the main problem chemical in sediments at this site, with elevations ranging from 170 to 805 times the reference value of 6 ppb. Although HPAH were elevated in the same order of magnitude range as PCBs, elevations of HPAH at all stations were below 150 times reference. In general, metals in sediments were not excessively high (i.e., metals indicators were less than 20 times reference at all but one station).

Average chemical conditions in the sediments indicated low to moderate contamination for all indicators. Based on average conditions, this area tied with Segment 5B for the 10th priority position.

Sediment toxicity bioassays at the worst station and fish pathology reflected the high levels of contamination in this area. The prevalence of liver tumors in English sole collected from this area and adjacent areas of the Duwamish River was 13-16 percent, among the highest values observed throughout Puget Sound. Average oyster larvae abnormality was very high (78 percent). However, average amphipod mortality for all stations was relatively low (22 percent), indicating heterogeneous conditions in this area.

POTENTIAL SOURCES

- Diagonal Way CSO/SD (111)
  - CSO = 80-550 M gal/yr, SD = 430 M gal/yr (I-5 - metals, PAH)
- S.W. Dakota SD
  - 20 M gal/yr
- S.W. Idaho SD
  - 60 M gal/yr

• Ash Grove Cement	• NPDES cooling water (78 M gal/yr) • Storm water/wastewater discharged to unlined surge pond (metals)
• Seaboard Lumber	• NPDES cooling water (4 M gal/yr).

DENNY WAY CSO (2A)

ENVIRONMENTAL CONDITIONS

Based on the highest ranked stations, environmental conditions for this site are as follows:

Variable	Elevation Above Reference	
LPAH	High	100-1,000X
HPAH	Very high	>1,000X
PCB	High	100-1,000X
Cu+Pb+Zn	High	100-1,000X
As	Moderate	10-100X
Amphipod mortality	Moderate	3.6-7.1X
Oyster abnormality	Moderate	4.1-8.2X

Among the high priority areas, this area ranked as the second most important site. Although lack of adequate reference data precluded calculation of Elevation Above Reference values for the site, available data show that benthic infaunal communities are degraded (i.e., low species richness, high abundance of pollution-tolerant species). Amphipod and oyster larvae bioassays of sediment also suggest that biological problems may be caused by the existing contamination of sediment at this site. Based on average conditions represented by sediment chemistry variables and bioassays, this site ranked only as a moderate priority, indicating heterogeneous conditions at the site. Nevertheless, HPAH were on average more than 300 times the reference level of 79 ppb, and PCBs were about 190 times the reference level of 6 ppb. Average concentrations of metals were of relatively minor concern.

POTENTIAL SOURCES

The ongoing source of toxic contamination in this area is the Denny Way CSO, the largest CSO in the Elliott Bay system (flow = 80-620 M gal/yr). No other potential sources have been identified.

SEATTLE WATERFRONT (3C)

ENVIRONMENTAL CONDITIONS

Based on the two highest ranked stations sampled in this area, sediment conditions for this site are as follows:

Variable	Elevation Above Reference	
LPAH	High	100-1,000X
HPAH	High	100-1,000X
PCB	High	100-1,000X
Cu+Pb+Zn	Moderate	10-100X
As	High	100-1,000X
Amphipod mortality	High	>7.1X
Oyster abnormality	Not significant	

This area tied with two other areas for the 5th rank among 14 high priority sites. Conditions at the two stations in this area were similar. Based on average sediment chemistry and bioassay data, the area ranked 5th in terms of environmental problems. On average, LPAH and total PCBs in sediments were each 260 times reference, and HPAH was 570 times reference. The sum of copper, lead, and zinc was 190 times reference at one station, but only 8 times reference at the other station. Arsenic concentrations in sediments did not indicate a problem, but only one data point was available.

POTENTIAL SOURCES

Several CSOs under the jurisdiction of the City of Seattle may be a continuing source of pollution in this area. Raw sewage was discharged into this area from the late 1800s to the early 1970s. Historical spills along the waterfront may also account for some of the contamination in this area.

The ongoing sources are as follows:

- City CSOs (071, 164)
  - Total flow = 1.14 M gal/yr, approximately 12 events per year
- Seattle Steam
  - NPDES discharge of cooling water (23.5 M gal/yr).

SLIP 1 (7B)

ENVIRONMENTAL CONDITIONS

Only sediment chemistry data were available for Slip 1. Based on three stations, the highest levels of contamination were:

Variable	Elevation Above Reference	
LPAH	Very high	>1,000X
HPAH	High	100-1,000X
PCB	Moderate	10-100X
Cu+Pb+Zn	Moderate	10-100X
As	Moderate	10-100X

Slip 1 tied with Segment 6A (West Waterway) for the 4th highest priority position based on environmental contamination and effects. The very high concentrations of LPAH (up to 42,000 ppb in sediments at the head of the slip) indicated an ongoing source of petroleum pollution. For all chemical indicators, there was a gradient from high concentrations at the head of the slip to relatively lower concentrations at midchannel of the Duwamish River adjacent to the slip. Based on average contaminant concentrations relative to other areas, Slip 1 ranked as the highest priority area.

POTENTIAL SOURCES

- PCB spill (1974)
- Manson Construction
- Ideal Cement
- 255 gal AROCLOR 1242
- Storm drain
- NPDES cooling water (5.5 M gal/yr), Settling Pond - Kiln and truck wash water.

SLIP 2 (8A)

ENVIRONMENTAL CONDITIONS

The entire Slip 2 area ranked as a low priority area based on average conditions as well as on "worst-case" stations. However, the head of the slip is included in this Interim Work Plan because contamination gradients from the mouth to the head of the slip are indicated by the limited data available. Concentrations of HPAH, PCBs, and the sum of copper, lead, and zinc in sediments were each elevated 10-100X reference levels. Elevations of HPAH and PCBs were about 35 times reference levels. Data on LPAH were not adequate for analysis. Arsenic in sediments did not appear to be a problem. No bioassay, benthic infauna, or fish pathology data were available.

POTENTIAL SOURCES

- Michigan CSO
- 90-210 M gal/yr

SLIP 3 (8B)

ENVIRONMENTAL CONDITIONS

Slip 3 and the adjacent river channel ranked 9th (tied with Fourmile Rock Disposal Site) based on "worst-case" stations, and 14th based on average conditions. The most contaminated station within Segment 8B was at the head of Slip 3. Because of the limited data available and the relatively high contamination indicated by this one station, the head of Slip 3 is included in this action plan.

Both LPAH and HPAH in sediments from the head of Slip 3 were elevated about 120 times above the reference value (Reference = 41 ppb for LPAH; Reference = 79 ppb for HPAH). PCBs were elevated 38 times above the reference value of 6 ppb. Arsenic in sediments was 24 times the reference level of 3.4 ppm. Although the sum of copper, lead, and zinc was 17 times the reference value of 34 ppm, this elevation is not of particular concern with respect to biological effects. Data on sediment toxicity bioassays, benthic infauna, and fish pathology were not available for Slip 3.

POTENTIAL SOURCES

- Michigan CSO
- 90-210 M gal/yr
- S. Fox CSO/SD (116)
- SD = 30 M gal/yr, emergency CSO only

SLIP 4 (8D)

ENVIRONMENTAL CONDITIONS

Relative to other study sites, Slip 4 and the adjacent river channel area ranked only as a moderate priority based on average conditions and "worst-case" stations. Nevertheless, the head of Slip 4 is included in this plan because of extremely high concentrations of PCBs in sediments and the known importance of nearby sources.

The time-averaged concentrations of toxic chemicals in sediments from the U.S. EPA 1982-1983 surveys were used to characterize conditions at the head of Slip 4. The contaminant group of major concern in Slip 4 is PCBs. The concentrations of PCBs in sediments at the head of the slip were 1,600 ppb in the 1982 survey and 4,600 ppb in the 1983 survey, yielding an average of 3,100 ppb or 517 times the reference value of 6 ppb. HPAH was of less concern, with an Elevation Above Reference of about 90. Metals were of no immediate concern, since elevations were less than 20 times reference values. No adequate data were available for LPAH and biological indicators. However, the observed concentrations of PCBs in sediments of Slip 4 are expected to cause biological problems.

POTENTIAL SOURCES

• Georgetown Flume	• PCBs in sediments = 137 ppm (dry weight)
• Slip 4 CSO/SD (117)	• PCBs in sediments = 103 ppm (dry weight); SD = 150 M gal/yr, emergency CSO only
• Slip 4 SD	• 140 M gal/yr
• I-5 drain	• 10 M gal/yr
• East Marginal Pump Sta CSO	• Emergency CSO only.

FOURMILE ROCK DISPOSAL SITE (10A)

ENVIRONMENTAL CONDITIONS

Based on the highest ranked stations within Fourmile Rock Disposal Site, environmental conditions for this area are as follows:

Variable	Elevation Above Reference	
LPAH	Moderate	10-100X
HPAH	High	100-1,000X
PCBs	High	100-1,000X
Cu+Pb+Zn	Moderate	10-100X
As	Low	<10X
Amphipod mortality	High	≥7.1X

Among the high priority areas, this area was ranked lowest in terms of environmental problems. However, the disposal site is considered for interim action because 1) available data are limited, 2) the public is concerned about transport of disposal material to beaches along Magnolia, and 3) the disposal area will be evaluated as part of the Puget Sound Dredged Disposal Analysis.

Environmental conditions at the Fourmile Rock Disposal Site are relatively heterogeneous. Based on average conditions, this area ranked lower than some of the moderate priority areas in the Elliott Bay system. Nevertheless, average PCB and HPAH concentrations in sediments were about 100 times the respective reference concentrations. The average concentration of PCBs in sediments at Fourmile Rock Disposal Site was 584 ppb, which is high enough to be of potential environmental concern.

The Fourmile Rock Disposal Site was the only priority area with both adequate data on benthic infauna (bottom-dwelling invertebrate organisms) and adequate reference data that could be used to calculate Elevation Above Reference values. These values indicated that benthic infaunal communities were modified slightly relative to corresponding communities found in clean areas near Seahurst in the main basin of Puget Sound. At the disposal site, dominance was moderately elevated (1.12-4.90 times Reference), total abundance was not depressed (<1 times Reference), the total number of taxa was moderately depressed (1.12-4.90 times below reference), and amphipod abundance was moderately depressed (1.12-4.90 times below reference). Because the available data are limited, no definitive conclusions about biological conditions at the Fourmile Rock Disposal Site can be made at this time.

POTENTIAL SOURCES

Disposal of dredged material is the primary source of toxic contamination at the Fourmile Rock Disposal Site.