# SECTION 7.0 REMEDIAL INVESTIGATION OF PORTLAND HARBOR SEDIMENTS

The remedial investigation of Portland Harbor sediments builds on information known to date, as described in Sections 4, 5, and 6, and requires the collection of additional information at sites, elsewhere within the Harbor, and at reference areas. Feasibility studies will be done where RI results indicate. Also critical is an integrated program for implementation providing the structure, resources, and coordination to carry out the investigation and required cleanup. This section describes the RI/FS activities that DEQ will undertake to characterize sediment contamination and associated risks in Portland Harbor and environs, and to evaluate potential remedial options in those parts of the Harbor where remediation is warranted, whether site-specific locations or between-site areas. Technical details of the proposed programmatic and remedial investigation activities are provided in Appendix G.

## 7.1 Portland Harbor Environmental Management Framework

Specific environmental management goals have been established for Portland Harbor. These goals implement the PHSMP mission statement provided in Section 1.4. In accordance with federal and state law, they ensure the protection, both now and in the future, of public health, safety, and welfare, and the environment, from a release or threat of release of hazardous substances in Portland Harbor. They also address issues related to beneficial uses, and are as follows:

*Reestablish and maintain sediment quality in Portland Harbor to: (1) protect the benthic community; (2) support commercial use of the Harbor; (3) allow human (recreational, subsistence, and occupational) use of the Harbor; (4) provide a safe pathway for migratory fish; (5) prevent harm to individual threatened, endangered, and other special status species; and (6) protect resident fish and water-dependent wildlife populations.*

Oregon's achievement of these goals, and thus of an environmentally acceptable Portland Harbor, will be assessed by means of five specific technical objectives. The sediment assessment methodology (de-tailed in Appendix G) will be used to determine, by means of several technical evaluation frameworks, whether these objectives are being met in Portland Harbor and, if not, what actions need to be taken to meet them. Attaining these objectives will ensure that:

• Benthic communities are not exposed to toxic levels of contamination in sediment. • Persons using the Harbor for recreational or occupational purposes (boating, swimming, fishing, diving, etc.) are not exposed to unacceptable risks from contact with, or incidental ingestion of, sediment or through consumption of fish or shellfish exposed to sediment.

• Migratory fish using the Harbor are not exposed to toxic levels of COIs in water, sediment, or food.

• Individuals of threatened, endangered, or other special status fish species, as well as resident fish populations, are not exposed to toxic levels of COIs in water, sediment, or food.

• Individuals of threatened, endangered, special status, or indicator (surrogate) water-dependent wildlife species, as well as resident water-dependent wildlife populations, are not exposed to toxic levels of COIs in water, sediment, or food.

A technical evaluation framework is associated with each of these five objectives. These frameworks, which are essentially the conceptual models for each objective, consist of assessment endpoints, testable problem statements, and measures of exposure and effect (See **Table 7-1**). The technical evaluation frameworks described in **Table 7-1** will be implemented within the context of the RI/FS process. Both effects- and risk-based assessment methodologies are utilized, and human health and ecological risk assessments are integrated. Several tools have been identified to collect the data necessary to evaluate each objective, and decision (i.e., risk characterization) guidelines are provided to help interpret the resulting data and determine whether or to what degree each objective has been attained.

**Table 7- 1. Summary of Technical Evaluation Framework**

Similar to the CERCLA RI process, the Portland Harbor remedial investigations will include a review of existing information and identification of data gaps (**Section 4**), development of a conceptual site model (Section 4), identification of likely response scenarios and remedial action objectives (**Section 7.5**), identification of potential federal/state ARARs **(Section 3.6**), identification of initial data quality objectives (**Appendix G**), and project plans (**Sections 7.2** and **7.3**) and site-specific RI/FSs (**Section 7.4**). The goal of the RI is to characterize the nature and extent of contamination, evaluate the need for remedial action (by assessing the risk to human health and ecological receptors), and provide the basis, if warranted, for the resulting feasibility studies. **Section 7.5** provides an overview of the CERCLA FS process, which evaluates the feasibility of potential remedial action alternatives to reduce risk. As described in EPA's *Contaminated Sediment Management Strategy*, the selection of the appropriate remedial option should be per-formed on a site-specific basis after careful consideration of the risks posed by the sediment contaminants to human health and the environment, the benefits of remediation, the short-and long-term effects of implementing the remedial option, and the implementability of the remedial action. In order to optimize RI/FS activities for a large and complex area such as Portland Harbor, a phased approach to site-specific and harbor-wide remedial investigations will be necessary, as described in the following sections. The phased approach is illustrated in **Figure 7-1**, showing the programmatic activities needed to develop and support the various scientific and technical tools used as part of the RI/FS investigations.

Principal programmatic activities will include:

1. developing sediment quality guidelines (SQGs), as well as establishing and maintaining the associated SEDQUAL database,
2. developing human and wildlife target tissue levels (TTLs),
3. developing fish tissue screening concentrations (TSCs),
4. program-matic activities supporting site-specific RI/FS and harbor-wide investigations to accomplish successful implementation of the PHSMP,
5. developing a harbor-wide biota-sediment bioaccumulation function (BSAF), and
6. selecting reference areas for Portland Harbor.

These approaches are described below, with details provided in Appendix G.

**Figure 7- 1. Integration of Program, Programmatic, and Remedial Investigation Elements**

## 7.2 Portland Harbor Programmatic Activities

Programmatic activities will begin with a scoping of RI/FS goals and objectives, followed by preparation and approval of scopes of work for technical ser-vices. DEQ will establish one or more technical work groups (see Section 9.2) to advise DEQ on these activities. These technical work groups will also be involved in reviewing work plans and final work products and will be available for consultation during implementation.

### 7.2.1 Guideline Development

The general term "guidelines" is used to refer to SQGs, TSCs for fish, and TTLs for human and wildlife (typically fish-eating birds and mammals) food items. Guidelines streamline sediment evaluations at specific sites where remedial investigations are conducted , and will also be used in the site discovery process.

#### 7.2.1.1 Sediment Quality Guidelines

SQGs are numeric sediment concentrations above which further biological testing and/or a feasibility study may be warranted and below which suspected sediment contaminants are unlikely to pose an unacceptable risk. Currently there are no SQGs established for freshwater environments in the Pacific Northwest. SQGs developed for Portland Harbor will address direct toxicity to benthic organisms; bioaccumulation endpoints

will be addressed through tissue guidelines. SQGs, once developed, will be used to determine, based on sediment chemistry alone, whether the benthic community at a given site is likely to be adversely affected by the presence of contaminants in sediment (Objective 1). A prediction of toxicity based on SQGs can be confirmed through optional biological testing.

Development of SQGs requires synoptic sediment chemistry and bioassay data from locations through-out the Harbor and in reference areas. Many of these data exist, but more data will be collected through harbor-wide sampling and from remedial investigations being conducted at specific sites. Consistent electronic data reporting templates will be used by all parties generating data to facilitate direct transfer to the database. Data quality will be verified prior to entering the data into DEQ's SEDQUAL database. Using the SEDQUAL database, preliminary guidelines will be calculated using all existing data (including studies in progress as they are completed). If the results from one or more bioassays are adequate for use (i.e., sufficient data are available to calculate stable SQGs), those SQGs will be finalized without further sampling.

Additional sediment chemistry and bioassay testing needed for completion of *Hyalella, Chironomus, and Microtox* SQGs will be identified once all existing data sets have been entered into the database and preliminary SQGs calculated. At that time it will be possible to identify target concentration ranges for specific bioassays that need to be filled, and focus further chemistry and bioassay testing on those contaminants and concentration ranges. It is likely that most of the sampling locations to complete these SQGs will need to be in areas with high contaminant concentrations. Thus, a majority of the sampling stations could be located within known sites and the synoptic data can also be used to fulfill RI requirements for those sites. Costs of any additional harbor-wide synoptic sampling will be minimized by use of a single contractor. The costs for individual stations will be apportioned and allocated back to responsible sites within the Harbor. Cooperating responsible parties will be given the option of collecting the required synoptic data as part of their site-specific remedial investigation, if the timing fits into the overall SQG development schedule.

The development of SQGs for a chronic freshwater bioassay will require a more comprehensive sampling effort, since there are no existing data for these tests. One or more chronic bioassays will be selected by a work group for testing on a harbor-wide basis. Regional laboratories will be provided an opportunity to participate in order to establish a regional capability to conduct these tests, and training on the new test will be provided to the participating laboratories prior to the harbor-wide study.

To assist with the development and peer review of SQGs, DEQ will form a SQG technical work group. This work group will be tasked with reviewing SQGs at key development stages, including selection of the final data set, identification of hit/no-hit criteria, testing of distributions for significant differences, quality assurance review of calculation algorithms, outlier and sensitivity analysis, and review of technical support documentation. This work group will also provide input into any harbor-wide sampling efforts to generate sufficient data for SQG development.

#### 7.2.1.2 Tissue Guidelines (TTLs and TSCs)

Tissue guidelines (TTLs and TSCs) will be developed to assess risk to human health, wildlife, and fish from sediment contamination in the Harbor. Because of the long exposure duration assumed for humans (typically 30 years) and the high mobility of wildlife receptors and their prey items, these risks are best assessed on a harbor-wide basis. The objective of the tissue guidelines will be to identify those bioaccumulative chemicals of concern (B-COCs) which must be assessed at sites where they are present at elevated levels. It is possible that for some B-COCs significant sources may be present outside the Harbor (i.e., tissue guidelines also exceeded in reference areas) and source control and remediation within the Harbor could be insufficient to reduce risk to acceptable levels. Technical details on proposed methods to develop tissue guidelines can be found in Appendix G.

A TTL is the tissue concentration in food items (e.g., fish or shellfish, clams, crayfish) above which unacceptable risk would be expected in birds, mammals, or humans that consume these food items. If the TTL is exceeded, or predicted to be exceeded, further bioaccumulation testing and/or a feasibility study

may be warranted at sites where that COI is found at elevated concentrations. Tissue guidelines protective of human health will be calculated based on several fish consumption scenarios (general population, recreational fisherman, subsistence, and tribal), EPA cancer slope factors (CSFs) and reference doses (RfDs), and acceptable cancer and non-cancer risk levels in accordance with state law (Oregon's risk levels are more stringent than CERCLA). Refine-ment of harbor-specific fish consumption rates will be the objective of a harbor-wide supporting investigation described in Section 7.3.3.

Fish tissue guidelines to protect wildlife that eat fish will be calculated based on Portland Harbor assessment endpoints (e.g., great blue heron, osprey, bald eagle, merganser, mink, river otter), their body weights and ingestion rates, toxicity reference values for these species, and acceptable risk levels in accordance with federal law (here, federal law is a more stringent ARAR than state law). Refinement of relevant wildlife exposure scenarios will be the objective of a harbor-wide supporting investigation (Section 7.3.2).

A TSC is the contaminant concentration in fish tissue below which adverse effects are not expected for most species. It is intended as a guideline protective of the fish themselves, as opposed to species that eat fish (for which TTLs are used). TSCs for fish will be calculated using tissue residue-effects data available in compiled databases (e.g., Environmental Residue-Effects Database (ERED)) and from peer-reviewed scientific literature. While TSCs are designed to be protective of a majority of the species and effects for which data are available (e.g., 90%), additional consideration will be given to inclusion of data for species and endpoints of special concern in Portland Harbor (e.g., juvenile salmonids and fish-eating birds). Similar to the SQG development effort, DEQ will form a technical work group to assist with the development and peer review of tissue guidelines. This work group will also provide input into any supporting investigations performed to generate refined harbor-specific exposure data for tissue guideline development.

### 7.2.2 Harbor-Wide Biota-Sediment Accumulation Function (BSAF)

The relationship between tissue concentrations and sediment concentrations is known as the biota-sediment accumulation function, or BSAF. BSAFs will be calculated using tissue and sediment chemistry data from both harbor-wide and site-specific investi-gations. Once available, BSAFs will be used along with tissue guidelines to calculate remedial action objectives (RAOs) for bioaccumulative chemicals on a harbor-wide or site-specific basis. RAOs are sediment concentrations that are expected to be met as a result of remedial actions selected for implemen-tation. As with other guidelines, the usefulness of BSAFs and RAOs lies in their ability to streamline sediment evaluations. The tissue guideline technical work group will peer-review the proposed BSAFs and RAOs.

### 7.2.3 Reference Area Selection

Reliable reference areas are needed for comparison with specific sites and harbor-wide investigations when bioassay testing is done as part of cleanup and dredging projects. DEQ will initially identify candidate reference areas through a review of existing sediment data, land uses, and other available information for areas in the lower Willamette River above and below Portland Harbor, and in the Columbia River. Sediment chemistry analyses, benthic community analyses, and bioassays will be conducted in candidate reference areas to ensure that they will meet performance standards during subsequent testing events. Once reference area studies have been completed in the lower Willamette River and Columbia River the chemistry, bioassay, and benthic data will be reviewed to confirm the selection of reference areas. Selected reference areas must (1) be located between Willamette Falls and the mouth of the Willamette River (or in the Columbia River), away from known sources of chemical contamination, (2) have contaminant concentrations as far below ambient levels as possible, (3) exhibit no significant toxicity in bioassay tests, (4) have a healthy benthic community relative to other areas within the River, and (5) include a range of sediment physical characteristics, to assist in matching reference sampling stations to site sampling stations.

### 7.2.4 Continuing Development Activities

As noted above, there will be ongoing and future activities related to the development and maintenance of SQGs, TTLs, TSCs, BSAFs, and RAOs. These include (1) using the results of the harbor-wide sup-porting investigations to revise human and wildlife TTLs based on consumption surveys and habitat use surveys, (2) implementing new freshwater chronic bioassay protocols and then using data from these chronic tests to update SQGs, (3) performing periodic updates of all guidelines, protocols, and test procedures, and (4) participating in annual review meetings. As noted earlier, remedial investigation activities begin with a scoping of project goals and objectives, followed by preparation and approval of a scope of work for technical services. The selected technical contractor or contractors will initially be tasked with preparing a detailed work plan to perform the activities generally described below and in greater detail in Appendix G. The resulting work plan will be subject to approval by DEQ, in addition to a review of its technical adequacy by a work group established for that purpose. It is expected that the work group will include EPA as well as trustee agencies, tribes and other interested parties.

## 7.3 Remedial Investigation of Portland Harbor

Remedial investigations will be used to fill data gaps in the understanding of human and ecological processes in Portland Harbor. These will include surveys of (1) the distribution and abundance of benthic communities at selected areas within the lower Willamette River, (2) type, size, and movement of fish populations, (3) presence of, and habitat utilization by, wildlife, specifically fish-eating birds and mammals, and (4) human uses of the Willamette River within Portland Harbor, including consumption patterns of fish caught in the Harbor. Following a more complete review of existing data and data gaps, sediment chemistry and bioassay data may also be collected on a harbor-wide basis (i.e., outside the boundaries of known cleanup sites*)* to determine whether or not harbor-wide effects exist and to what extent existing sites or other point sources are contributing to any such observed effects. The results of these surveys and analyses will be used to conduct human health and ecological risk assessments for Portland Harbor, with specific emphasis on risk associated with consumption of fish. The risk assessments will be performed by comparing mea-sured tissue concentrations of COIs in fish tissue to human and wildlife TTLs and to fish TSCs, and possible comparison of sediment chemistry, bioassay, and benthic data on a harbor-wide scale to SQGs and reference data.

### 7.3.1 Benthic Community Survey

Benthic surveys will be conducted to provide information on the status of benthic communities in the lower Willamette River and the usefulness of benthic community surveys for assessing risks at individual sites or harbor-wide. The first step will be to evaluate whether the natural variability of the community is low enough that benthic community analysis would be a cost-effective tool for harbor-wide or site-specific risk assessment. Data interpretation metrics have not been established for the freshwater systems on the west coast, and this will be an important data evaluation task. Once appropriate metrics have been established, and if variability is low enough, DEQ will use the data to evaluate whether benthic communities in Portland Harbor are experiencing adverse impacts relative to other areas of the River and possibly determine the sources (e.g., chemical, physical, or both) of those impacts. If possible, the results of the benthic surveys will also be used to validate the SQGs and reference areas

### 7.3.2 Ecological Characterization of Portland Harbor

There is currently a data gap regarding the types and abundance of fish and wildlife within Portland Harbor; information that would be useful for verifying or altering the choice of assessment endpoints to be carried through the ecological risk assessment. In addition, information regarding the behavior (migratory habits, eating habits, and preferred habitat) of fish and wildlife identified within Portland Harbor will also be collected; as will information regarding the nature and extent of various habitat types present in, along, and near the River. Such information will be used in the evaluation of how fish and wildlife may be exposed to chemicals present in sediment and potentially to refine harbor-wide exposure scenarios used in tissue guidelines and BSAFs. A map showing the location of functioning ecological habitats along the River will be generated from these studies.

### 7.3.3 Human Activity/Fish Consumption

Similar information is needed on human uses of the Harbor as inputs to the harbor-wide and site-specific human health risk assessments. Information regard-ing recreational and subsistence fishing, tribal fishing, in-water recreation, and working conditions within the Harbor, will be obtained. This information will be used to refine harbor-specific exposure scenarios if evaluation of fish tissue data indicates a risk from consuming fish and shellfish from the Harbor.

### 7.3.4 Sediment Chemistry and Bioassay Testing

Sediment chemistry analyses and bioassay testing will be performed within reference areas, within the Harbor at locations other than known sites, and at known sites. These analyses will be used to assess the nature and extent of contamination on a harbor-wide and site-specific basis, assess risks to the benthic community, and provide data to SEDQUAL for the ongoing development of SQGs. Supplemental chemistry and bioassay data may need to be obtained from specific locations, those with particular chemical

concentrations of COIs or physical sediment characteristics. The harbor-wide RI will focus on collection of data from reference areas, areas of the Harbor outside known sites, and on data needed to fill data gaps for calculation of SQGs for both acute and chronic freshwater bioassays. Site-specific RIs will focus on collection of sediment chemistry and bioas-say data at individual sites.

### 7.3.5 Fish Tissue Sampling

Fish are generally mobile and may be exposed to multiple sites within and outside the Harbor. As a result, the collection of site-specific fish tissue data for the risk assessment is unlikely to generate meaningful results. To accurately assess whether fish contain levels of COIs that represent a threat to the health of the fish or to birds, mammals, and humans that ingest them, DEQ will conduct a harbor-wide assessment of COI concentrations in fish. The sampling will assess a range of species, both resident and migratory, at locations within Portland Harbor and in other areas of the lower Willamette River and the lower Columbia River. Tissue chemistry results from those samples will be compared with TTLs and TSCs to determine whether receptors may be at risk . Once contaminants of concern (COCs) have been identified on the basis of their presence in fish tissue above unacceptable risk levels, site-specific bioaccumulation testing may be necessary at sites with elevated concentrations of these chemicals to verify whether they are sources of harbor-wide contamination. Alternatively, a harbor-wide approach may be taken to identify areas deserving of remedial response on the basis of the presence of bioaccumulative contaminants as described in Appendix G.

### 7.3.6 Risk Assessment

Results from the harbor-wide investigations described above will be used to prepare harbor-wide human health and ecological risk assessments. These will determine whether there are unacceptable risks (i.e., exceedance of TTLs) to humans or wildlife from consumption of fish or shellfish taken from the Harbor, or unacceptable risks (i.e., exceedance of TSCs) to fish from exposure to contaminated sediment. All of these are in addition to any risk assessments performed at specific sites. If unacceptable harbor-wide risks are predicted, a feasibility study for the entire Harbor may be warranted. Additional site discovery activities may have to be undertaken to identify previously unknown contaminant sources in the Harbor and elsewhere.

In addition, if the harbor-wide risk assessment determines that harbor-wide effects exist, additional investigations will be required at specific sites that contain elevated levels of COCs detected in fish or shellfish tissues. This effort will focus on known sources of contaminants identified in the risk assessment as likely producing adverse effects on human health and the environment, site discovery efforts to identify other sources of these contaminants, and data collection efforts to determine the extent to which wide-spread, ubiquitous chemicals are contributing to the observed effects. The result of this inquiry has significant implications for remedial action evaluation and selection.

## 7.4 Remedial Investigations at Sites

Sites identified prior to initiating the Portland Harbor project require continued investigation and, if necessary, remediation. Work is expected to continue on these projects under the agreements/orders currently established. Site-specific activities will generally include a full RI/FS to address the upland portion of the site, an assessment of the extent to which contaminants are migrating from upland areas to Portland Harbor, and a full evaluation of the nature and extent of sediment contamination adjacent to upland areas. In addition, the extent to which ongoing contaminant migration due to groundwater discharge, overland transport, or airborne transport are contributing to the observed concentrations will be determined, as appropriate.

Under Oregon cleanup law, DEQ may require individual sites to collect the data necessary to fully delineate the extent of hazardous substances released to Portland Harbor. In addition to the collection of sediment chemistry and toxicity data, this may also include tissue analyses of fish and other aquatic or benthic organisms, evaluation of contaminant transport processes within Portland Harbor, an evaluation of contaminant uptake processes, or any other data collection activities necessary to characterize a release of hazardous substances to Portland Harbor.

Site-specific activities begin with a scoping of project goals and objectives, followed by preparation and approval of contracts for technical services. All of these tasks are performed by the responsible party with DEQ oversight. In some cases when Orphan Site Account funds are used, DEQ will carry out the activities using a similar contractual approach. To address risk not attributable to specific sites, DEQ will perform a feasibility study and implement necessary remediation. The responsible party (or their selected technical contractor) is required to prepare a detailed site-specific work plan to perform the activities generally described below and in greater detail in Appendix G. The resulting work plan is subject to approval by DEQ. All site-specific data collection, analysis, and interpretation activities are expected to be conducted in a manner consistent with the protocols established in Appendix G of the PHSMP.

In order to ensure that data collection, analysis, and interpretation activities at individual sites are performed in a manner consistent with the PHSMP, adequate to meet its requirements, and conducted in the most efficient and cost-effective manner possible, regular meetings between all DEQ project managers working on sites in Portland Harbor and surrounding portions of the Willamette River have been initiated and will continue throughout implementation of the PHSMP. The DEQ Sediment Strategy Group will also provide oversight and input.

### 7.4.1 Phase I - Sediment Toxicity / Human Health

During this phase, individual sites will be required to collect information on the nature and extent of site-related sediment contamination in the locality of the facility. The resulting sediment chemistry data may be compared to SQGs, if available, on a contaminant-by-contaminant basis. If SQGs are not available, site-specific bioassay testing will be required. Sediment chemistry and toxicity testing will largely be conducted at individual sites within the Harbor, where concentrations are higher than ambient Harbor levels. Such sampling will be required at all sites that have not already completed this type of sampling. Until SQGs can be developed, both chemical and biological testing data will be needed.

Following completion of sampling and analysis, site-specific risk assessments will be performed to evaluate (using standard EPA Risk Assessment Guidance for Superfund (RAGS) protocols) dermal contact and incidental ingestion risks to human health, and toxicity to the benthic community (using either SQGs or effects-based bioassay tests). If unacceptable risks to the benthic community and/or to localized human health receptors are indicated, a site-specific feasibility study will be required. In addition, if there is reason to suspect risks from bioaccumulative contaminants (based on the physicochemical proper-ties of site-related contaminants in conjunction with results of the harbor-wide investigations), a Phase II investigation will be required at the site.

### 7.4.2 Phase II - Bioaccumulation

For individual sites at which risks from bioaccumulative contaminants are suspected, further investigative efforts will be designed to determine the extent to which the site is contributing to the harbor-wide contaminant loading. These efforts may include some combination (see Appendix G) of a comparison of site sediment concentration to reference sediment concentrations, comparison of site sediment concentrations to harbor-wide RAOs, performance of onsite bioaccumulation testing and calculation of site-specific BSAFs, and collection of additional sediment chemistry and/or tissue data. Results will determine whether there are risks (i.e., exceedance of TTLs) to humans or wildlife from consumption of fish or shellfish taken from the Harbor, or risks (i.e., exceedance of TSCs) to fish from exposure to contaminated sediment.

If it is determined that an individual site is contributing to a harbor-wide effect, remedial actions may be required. This may take the form of preventing ongoing discharges of these contaminants to the Willamette River, sediment removal and treatment or disposal, or capping. In some instances, interim remedial action measures under DEQ removal authority may be implemented at individual sites to more immediately curtail ongoing releases. Additional site discovery activities may have to be undertaken to identify previously unknown contaminant sources in the Harbor and elsewhere.

### 7.4.3 Strategy for New Site Discovery

#### 7.4.3.1 Developing Strategy Recommendations

In order to ensure that all sources of sediment contamination within Portland Harbor are identified, DEQ will prepare strategy recommendations for sites identified during the site discovery effort will be prepared. It is expected that this process will result in the collection of additional site-specific sediment chemistry, toxicity, and benthic community data within Portland Harbor. Data collection efforts at these sites will ensure that all sediments within Portland Harbor are adequately characterized.

Much of the site discovery effort for Portland Harbor has been completed, with the exception of investigating contributions from stormwater and combined sewer outfalls and natural drainages, and determining specific sources of elevated sediment concentrations in some areas of the Harbor. DEQ has identified potential point sources likely to be associated with observed elevated contaminant levels. Site assess-ment work, consisting of the preparation of strategy recommendations for each of the identified sources, will continue into the year 2000. Strategy recommendations will be prepared for the sites based on their priority, considering the number of contaminants associated with the site, elevation above baseline, and, (as available) concentration levels relative to SQGs and presence of B-COCs to the Harbor.

DEQ will establish a system for prioritizing assignment of these sites once the strategy recommendations have been prepared. It is expected that many of these sites will enter into voluntary cleanup agree-ments or consent orders. However, unilateral orders may be required to compel recalcitrant potentially responsible parties to perform the necessary investigative and cleanup activities. At sites for which no viable responsible party is available, Orphan Site Account funds will be utilized to ensure that the necessary data are collected.

#### 7.4.3.2 Outfalls and Natural Drainages

DEQ's site discovery effort resulted in a preliminary evaluation of all but a dozen or so of the properties located immediately adjacent to the Willamette River within the Portland Harbor area. Many of the sites identified have one or more private outfalls discharging storm water to the river and these will be evaluated as part of the follow-up work on specific sites. In addition, several City of Portland storm water outfalls also discharge to the Portland Harbor. Unlike the private outfalls, which generally have only one party

discharging through the line, the City outfalls have many connections and the resulting discharge reflects the combined discharges from several different source properties. Similarly, natural drain-ages (creeks, streams, ditches) also discharge to the river and may contain chemicals from upstream sources. Neither storm sewers nor natural drainages were specifically targeted in the harbor-wide investigation completed in 1997. Consequently, additional sediment data may need to be collected in the vicinity of these discharges.

During implementation of the PHSMP, DEQ will work with the City to establish an interagency agreement to assess the significance of City outfalls as they relate to elevated concentrations in sediment. This may require additional sampling in the vicinity of outfalls.

Natural drainages within the Harbor will be mapped and DEQ will assess the need for further sampling in the vicinity of these drainages. This information will be used to identify additional point sources of contamination or determine the extent to which non-point sources of contaminants are impacting Portland Harbor through these drainage pathways.

#### 7.4.3.3 Expanding Study Area Boundaries

The boundaries for the 1997 Portland Harbor investigation were established based on the known level of industrial activity and availability of resources. River-wide studies and studies completed as part of individual investigations have demonstrated that sediment contamination is present both up- and downstream of the Harbor area. Historical industrial activities have also not been limited to Portland Harbor and water quality studies suggest other portions of the River likely contain significant contamination. Consequently, site discovery efforts may be expanded to surrounding portions of the Willamette River. A subsequent phase of sampling similar to the original investigation is not currently planned. However, the techniques used to identify potential sources in Portland Harbor will be applied to other portions of the River as appropriate including reviewing available sediment data from active sites and other River studies, reviewing databases and historical land uses, site reconnaissance, and indicated follow-up.

## 7.5 Portland Harbor Feasibility Study

Determination of unacceptable risk or adverse effects during the remedial investigation leads to a need to consider remedial actions, which are the subject of a feasibility study. Such a study generally has three phases: development of remedial alternatives, screening of these alternatives, and a detailed analysis of the remaining alternatives. Consistent with EPA's *Contaminated Sediment Management Strateg*y, each risk manager will need to consider the risks posed by the contaminants to human health and the environment, the benefits of remediation, the short-and long-term effects of implementing the remedial action, the feasibility of implementing the remedial action, and the costs of remediation, when selecting the appropriate remedial action at a contaminated sediment site.

Remediation of contaminated sediment sites will be undertaken to limit (via source prevention and control) continuing discharges to the environment and to clean up (via natural recovery or active remediation) sites to a degree sufficient to support existing and designated beneficial uses of the water body, including potential uses of the sediment. Minimizing new sources and implementing source controls will: (1) ensure long-term success of any remedial activity for the site, (2) minimize long-term costs of navigational dredging, and (3) increase opportunities for beneficial reuse of dredged material. However, further source prevention and control does not address existing (i.e., historical) unacceptable risks to human health and the environment from contaminated sediments, particularly in areas where natural recovery is not likely. In these instances, some form of active remediation will be needed.

If the results of the harbor-wide and site-specific risk assessments determine that contaminants causing unacceptable risks are present throughout Portland Harbor, actions to address any one site may not be effective. Coordinated remedial action at multiple sites will be implemented to reduce harbor-wide risks to acceptable levels. DEQ will evaluate risk reduction on a site-by-site basis and/or contaminant-by-contaminant, through implementation of feasibility studies. In general, DEQ does not believe that remediation to levels below harbor-wide baseline levels is feasible due to the potential for recontamination by contaminated sediments from upstream.

Furthermore, if the contaminant source is unrelated to discrete sources, it may not be feasible to control ongoing releases to Portland Harbor through DEQ's cleanup program. In these cases, the need to control sources upstream will be identified and coordinated with DEQ's water quality program for action. This may also necessitate looking to other federal, state, and local programs for assistance in controlling sources. In other cases DEQ will use data indicating upstream sources to expand the boundaries of the current investigation and initiate site discovery activities in upstream areas.

### 7.5.1 Source Control Measures

Controlling the release of contaminants through best management practices (BMPs) will work to ensure remediated sediments or sites are not being recontaminated. As described previously, industrial practices at many facilities in Portland Harbor have changed over the years as awareness grew of the environmental impact some of these activities can have. BMPs have been established for controlling releases from dry docks of Port of Portland Swan Island Shipyard, and for controlling releases during off-loading activities at Terminal 4. DEQ plans to review the types of releases that have resulted in contamination in the Harbor and assess where BMPs may need to be developed or modified.

It is clear that industrial activities in the lower Willamette River need to be accommodated. However, through cross-program coordination, there may be ways to more effectively prevent new releases from occurring. It is expected that completion of the phased RI will result in a clearer understanding of contaminant sources and other factors that may be contributing to observed effects within Portland Harbor. Once this effort been completed, other federal, state, and local programs dealing with water quality, sediments, and fish and wildlife will be implemented to develop a cross-program approach to Portland Harbor. This effort will include remedial or removal actions completed under DEQ cleanup authority, habitat restoration, and efforts toward reducing non-point and other sources of contaminants.

In addition to controlling permitted sources, site-specific remedial action alternatives will be required to address any upland sources of contamination to Portland Harbor (e.g., groundwater extraction and treatment to prevent the migration of contaminants to the Willamette River) that may be associated with historic site activities. These potential sources will be identified and addressed through a combination of upland and sediment RI/FS processes, and formalized through site agreements and orders.

### 7.5.2 Available Remedial Alternatives

Remedial action alternatives for sediments include:

- removal and confined disposal (in-water, nearshore, or upland)
- capping
- natural recovery
- enhanced natural recovery

Capping and confined disposal alternatives have been demonstrated through long-term monitoring to be highly effective in isolating contaminated sediments and preventing ecological and human exposures. Capping and confined disposal projects can be cost-effectively integrated with a variety of other ongoing activities, such as navigational dredging (providing a source of clean cap and fill material), waterfront construction (e.g., bulkhead stabilization or filling of slips and finger piers), and habitat restoration projects

(e.g., creation of intertidal habitat combined with cleanup by placing clean sediments over contaminated subtidal sediments).

If upland disposal is selected and the sediment is determined to be a hazardous waste, it must be disposed of in a permitted hazardous waste landfill. If the material were classified as a "hot spot" under DEQ's cleanup rules, there would be a preference for treatment prior to disposal in a landfill. Alternatively, treatment to non-hazardous status (if it is a characteristic waste) and use as contaminated fill (as described in the previous section) may be possible if all applicable land disposal restrictions are met. However, treatment of sediment is less often feasible than treatment of soils, due to high water content, mixtures of contaminant classes, and poorly degradable contaminants that are often present.

Where short-term risks and effects can be tolerated, natural recovery processes such as biodegradation, chemical degradation, and the deposition of clean sediments to diminish risks associated with the site may be favorable. Note that natural recovery does not mean "no action" since some form of monitoring will be required and the site will remain in the Environmental Cleanup Site Information (ESCI) database.

The size of the contaminated area is a key parameter to be considered. Widespread, low levels of contamination favor natural recovery while geographically limited areas containing high levels of contamination favors active remediation, particularly if these areas constitute hot spots as defined by the cleanup rules. However, natural recovery may not be a realistic option for areas without significant sources of sedimentation.

Site hydrodynamics also affect the decision because sediments must be stable to prevent off-site transport and ensure burial over time. If contaminated sediments are continually being transported into more critical habitats or being spread over a wider area to an extent that remediation is no longer technically or economically feasible, active remediation will be performed to halt such migration. Finally, natural recovery may not be the method of choice for contaminants that slowly biodegrade or transform into more persistent, toxic compounds (e.g., DDT to DDE).

In areas where natural recovery processes are slow or minimal (e.g., sedimentation rates are low and the contaminant is not rapidly biodegradable), approaches are available for enhancing the rate of natural recovery through thin-layer capping and/or beneficial re-use of clean dredged material. The goal of this approach is to mimic natural recovery by providing a source of clean sediment to the system. The clean sediment is worked into the underlying sediments by natural processes, lowering the overall concentration over time. This can be done as a single application of clean material, or repeated thin-layer applications coordinated with dredging cycles.

### 7.5.3 Remedy Selection

The goal of all remediation activities will be to achieve cleanup levels that pose no unacceptable risks to aquatic life or to wildlife, to human consumers of aquatic species (shellfish, finfish), or through direct contact and incidental ingestion exposure routes. It should be noted, however, the PHSMP does not mandate specific cleanup standards for sediment remediation projects. The decision on an appropriate cleanup level for any project will have to incorporate a number of site-specific factors which may include, but are not be limited to: beneficial uses of the water body; ecology, geology, and hydrology of the site; technical feasibility; risks posed by various treatment or disposal options; benefits of remediation; and economic constraints. Identification of designated beneficial uses impaired by sediment contamination will allow short-term, active remediation to be evaluated against long-term natural recovery.

For both harbor-wide and site-specific contaminants, the evaluation of remedial action alternatives must be consistent with Oregon rule and statute, which require that all remedies be protective, and be based on a

balancing of the remedy selection factors, which include effectiveness, long-term reliability, implementability, short-term risk, and cost reasonableness.

Factors that will be critical to the evaluation of remedial action alternatives include:

- Specific contaminants present and their associated risks
- Designated beneficial uses impaired during recovery
- Size of the affected area
- Feasibility of remediation
- Site hydrodynamics
- Time required for natural recovery

Harbor-wide remedial action alternatives are not necessarily more complicated than site-specific alternatives, possibly just more extensive and more costly. Harbor-wide cleanup alternatives may, in fact, prove to be relatively simple, since they may be typically limited to source control, natural recovery, and enhanced natural recovery (e.g., beneficial use of dredged material). Harbor-wide alternatives will likely depend on the nature of the contaminant source. For contaminants with a limited number of known and well defined sources, remedies are expected to be similar to those selected for individual sites. For contaminants with unknown sources or that are widespread throughout Portland Harbor, remedial alternatives may be limited.

Selection of harbor-wide alternatives will be challenged by a number of issues, including, but not limited to the: (1) minimal sedimentation in Portland Harbor, except in certain very limited locations, which limits natural recovery as a realistic large-scale solution, (2) presence of upstream sources of certain key contaminants, making recontamination a much more likely outcome than recovery, and (3) existing land and water uses and habitat impacts. However, habitat restoration must be an important part of the design process for any remedial actions in Portland Harbor.