# Sediment Quality Assessment Study at the B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek, San Diego

## Sampling and Analysis Plan

March 10, 2003

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# 1.0 INTRODUCTON

Sediments in San Diego Bay in the vicinity of the B Street/Broadway Piers, Downtown Anchorage, and near the mouth of Switzer Creek are contaminated with anthropogenic chemicals. In addition, these sites contain degraded benthic macroinvertebrate communities, and samples from these areas have been demonstrated to be toxic to various marine invertebrate species in laboratory toxicity tests. As a consequence, these sites have been identified as areas of impaired water quality. In response to this contamination, the San Diego Regional Water Quality Control Board (SDRWQCB) has initiated efforts to develop TMDLs for the sites in order to reduce ongoing loadings of contaminants of concern. In addition, the SDRWQCB has initiated planning to determine the extent and potential source reduction and clean up requirements for the impaired environment. Both of these efforts require similar information in order to initiate action: a description of the spatial extent and magnitude of impairment. Such information is needed by the SDRWQCB in order to prioritize TMDL actions, determine contaminants of concern, and identify sources. Similar information is needed for remediation planning, so that the affected area can be defined, and effective clean-up standards established. The primary objective of these actions is elimination of the impairment of benthic animal communities. In addition, the SDRWQCB has determined that these efforts should also minimize human health and wildlife impacts resulting from the accumulation and possible biomagnification of contaminants in the food web.

This Sampling and Analysis Plan (SAP) provides the overall guidelines for conducting a spatial assessment of marine sediments adjacent to the B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek areas in San Diego Bay. The purpose of this study is to examine the spatial extent and severity of sediment quality impairment in the study areas, in order to provide some of the information needed to plan TMDL and cleanup activities. This study has been developed jointly by the University of California, Davis, the Southern California Coastal Water Research Project Authority (SCCWRP), the City of San Diego, the San Diego Unified Port District, and the SDRWQCB in an effort to minimize duplication of effort and to provide comparable data throughout San Diego Bay. This study is similar in scope and design to ongoing sediment assessment studies being conducted throughout San Diego Bay, and this document is based largely on the Sediment Assessment Plan prepared for the Chollas and Paleta Creek hotspots (Bay and Chadwick, 2001).

The relationship of the proposed study TMDL and cleanup activities is shown in Figure 1-1. Spatial assessment information is an integral component of both cleanup and TMDL activities at the study sites, consequently this information should be obtained during the initial portions of the program (Phase I in Figure 1-1). The Phase I data will be used to identify areas of greatest concern for detailed investigations to support the development of TMDLs (Phase II). These activities are not described in detail in this document, but they will include laboratory research to identify causes of sediment toxicity (toxicity identification evaluations), assessment of temporal patterns in the data, and evaluation of sources of the contaminants of concern.

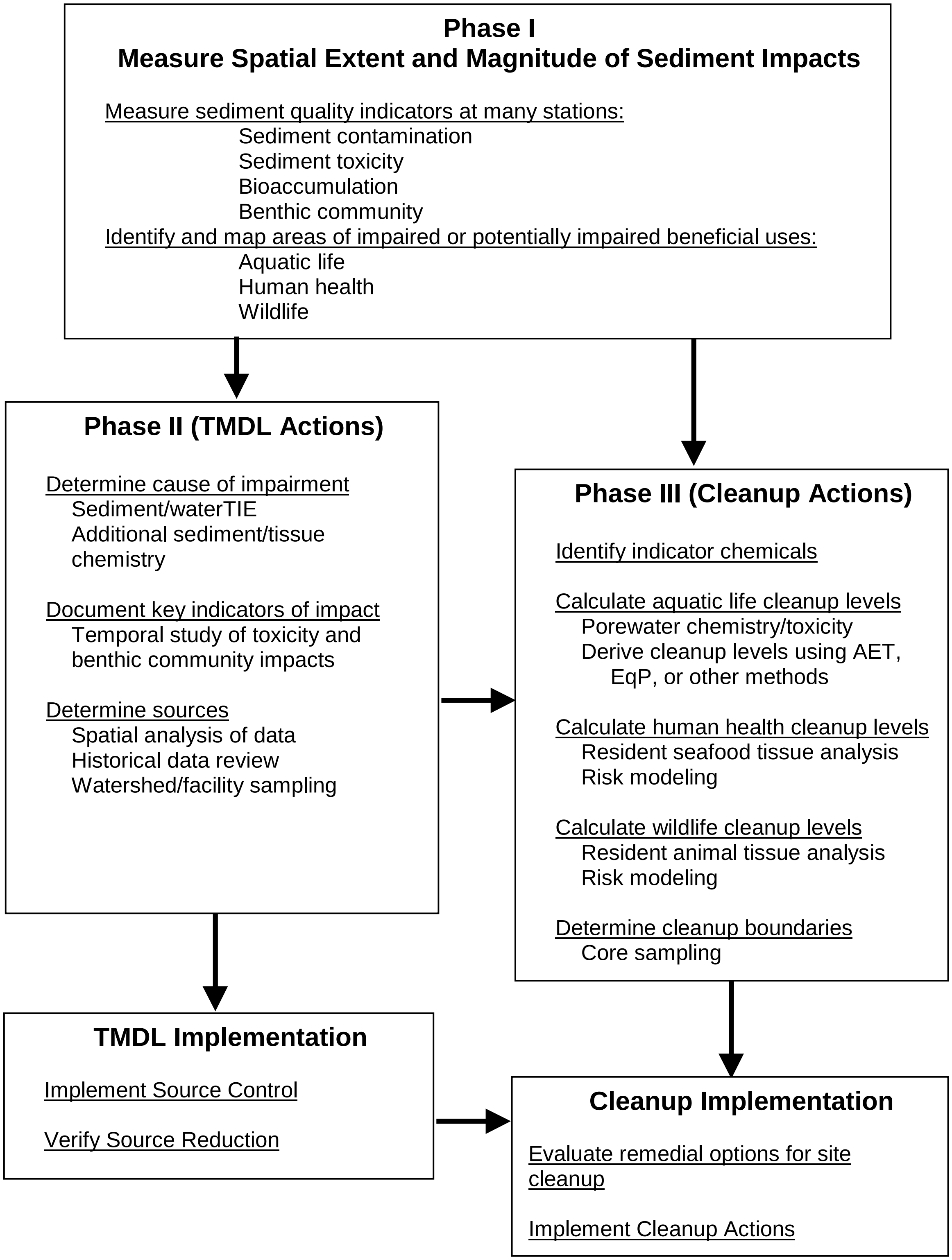


Figure 1-1. Relationship of study plan to potential subsequent TMDL and cleanup activities at the study sites.

Products from the Phase II studies and TMDL implementation will also influence potential cleanup activities at the sites, through the identification of contaminants of concern and control of ongoing contaminant sources. Studies that are being planned to support cleanup actions in other portions of San Diego Bay are expected to include the same components included in Phase I, plus additional studies necessary to derive numerical cleanup levels and determine the vertical extent of contamination (shown in Phase III). These Phase III studies may be conducted at a later date and at a reduced number of stations, depending upon the results of Phase I, in order to provide a more efficient and cost effective study design. Information is included that describes the statistical analysis of the data for the purposes of determining the presence and extent of contamination or effects. However, procedures for the determination of numerical load reductions or clean up levels are not included; determination of these parameters requires the consideration of additional factors (e.g., costs and degree of protection desired) and is outside the scope of this study.

Detailed descriptions of the Phase I study design, field sampling effort, laboratory analysis, and data analysis procedures are included in this document. This SAP follows the general approach of the California Bay Protection and Toxic Cleanup Program (BPTCP) and the Bight'98 regional survey in measuring multiple indicators of sediment quality and using a weight of evidence approach to identify areas of impaired sediment quality. Included in this effort are determinations of the spatial distribution of:

- Sediment contamination
- Sediment physical/chemical characteristics (e.g., grain size)
- Sediment and interstitial water toxicity
- Bioaccumulation of contaminants by a marine invertebrate
- Altered benthic community composition

## 1.1 BACKGROUND

The SDRWQB has established a cleanup plan for designated "known toxic hot spots" in San Diego Bay based on findings from the BPTCP. The cleanup plan provides definitions, rankings, and a preliminary assessment of actions for a number of sites around the bay. Under this definition, five specific areas were designated as toxic hot spots (THS), four with a ranking of moderate and one with a ranking of high. Many of the areas lie at the inlet of creeks or storm drains, indicating that stormwater may be a significant contributing factor. The three areas that are the focus of this study, one at the B Street/Broadway Piers, one in the vicinity of Downtown Anchorage, and one at the discharge of Switzer Creek, are shown in Figure 1-2.

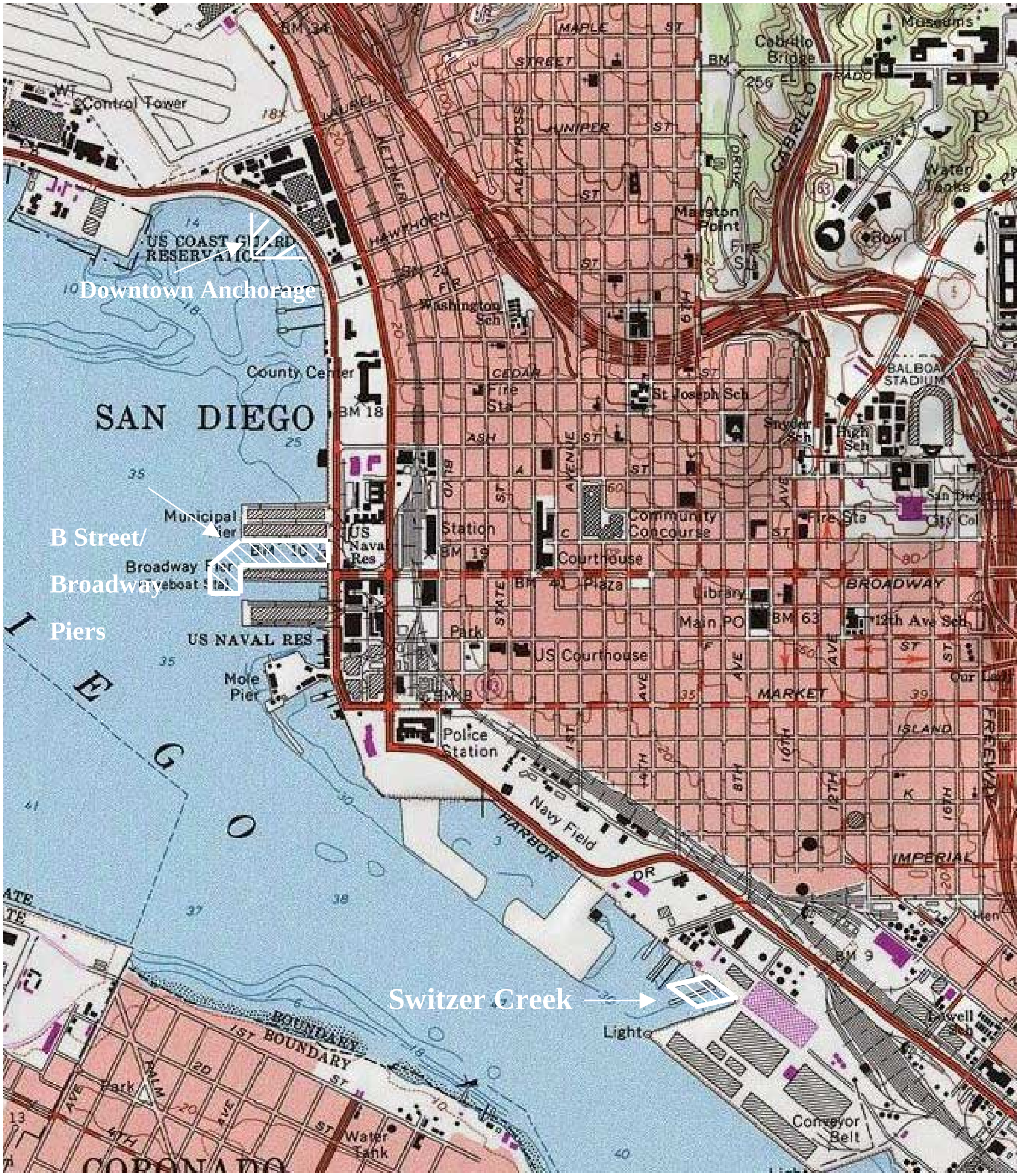


Figure 1-2. B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek designated sediment toxic hotspots (in crosshatch).

The B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek THS sites were designated as moderate priority sites. The B Street/Broadway Piers site was designated on the basis of benthic community degradation, and elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), copper, chlordane, and total chemistry. The Downtown Anchorage site was designated on the basis of metal and organochlorine pesticide contamination, sediment toxicity, and benthic community degradation. The Switzer Creek site was designated on the basis of toxicity, benthic community degradation, and elevated concentrations of copper, PAHs, chlordane and total chemistry (Fairey et al., 1996; Fairey et al., 1998).

## 1.2 SUMMARY OF HISTORICAL DATA REVIEW

Historical data for the B Street/Broadway Piers, Downtown Anchorage area, and Switzer Creek sites were compiled from BPTCP reports (Fairey et al., 1996; Fairey et al. 1998).

### 1.2.1 Switzer Creek

The Switzer Creek area was sampled as part of BPTCP activities in 1992 and 1993 for sediment chemistry and toxicity analyses, then again in 1996 for sediment quality triad studies (toxicity, chemistry, and benthic community structure). Based on the latter study, Fairey et al. (1998) recommended this area be classified as a high priority site for future study. Relative to ERM guideline values, sediment samples from this area are contaminated with elevated concentrations of copper, low and high molecular weight PAHs, chlordane, and mixtures of chemicals as represented by elevated sediment quality guideline quotient values (Effects Range Median -ERMQ). In addition, sediments from this area were acutely toxic to amphipods (*Eohaustorius estuarius* and/or *Rhepoxynius abronius*), and porewater from these sediments were toxic to sea urchin embryos. Possible sources of contaminants suggested by Fairey *et al.* (1998) include shipyard facilities, shipping activities associated with the 10$^{th}$ Avenue Marine Terminal, and the Switzer Creek storm drain system. In addition, Fairey *et al.* (1998) noted that this area once served as a PAH waste dump site for a San Diego Gas and Electric coal gasification plant, and once served as one of the original garbage dumps in this region.

### 1.2.2 B Street/Broadway Piers

Stations from this area were sampled in 1992 and 1993, and at these times, the two stations within the boundaries of the Broadway and B Street Piers exhibited degraded benthic communities. Sediments from these stations were contaminated with elevated concentrations of low and high molecular weight PAHs and the organochlorine pesticide chlordane. In addition, chemical mixtures, as represented by ERM quotient values, were elevated at this site. Sediment samples from these stations were not acutely toxic to the amphipod *Rhepoxynius abronius,* but porewater extracted from sediments from this area exhibited toxicity to sea urchin embryos. Fairey *et al.* (1996) suggested a number of possible sources of contaminants at this site, including stormwater runoff, redistribution of polluted sediments from adjacent areas (e.g., the downtown anchorage area), and commercial shipping activities in the Broadway and B Street Pier area.

### 1.2.3 Downtown Anchorage Area

Stations from this area were sampled in 1993, and at this time, one station in the vicinity of the downtown anchorage exhibited a degraded benthic community. Stations from this area were contaminated with high concentrations of metals and the organochlorine pesticide chlordane. Chemical mixtures were elevated in the vicinity of the downtown anchorage; the ERMQ was 1.82 at this station. In addition, sediment from this station was acutely toxic to amphipods, and porewater from the Downtown Anchorage area sediments were toxic to sea urchin embryos. Fairey et al. (1996) suggested a number of possible sources of contaminants in this area, including storm drains near the downtown anchorage area, and runoff from the San Diego International Airport. Other sources include metals from antifouling paints and redeposition of contaminated sediments from adjacent areas. Fairey et al. (1996) recommended this area be classified as a high priority site for future study.

# 2.0 STUDY DESIGN AND METHODS

## 2.1 OBJECTIVES AND APPROACH

The primary goals of this study are to determine the current spatial extent and relative magnitude of impacts on the benthic environment in the vicinity of the B Street/Broadway Piers, Downtown Anchorage, and the area adjacent to the mouth of Switzer Creek. This study has been designed to answer the following questions: what are the spatial extents of contamination and adverse biological impacts in the sediments at each site; which areas have the greatest degree of impairment; are the sediment contaminants likely to enter the food chain; and does the impairment show a spatial relationship to potential sources of contamination?

The conceptual approach of the study is based on three key assumptions. First, that the determination of biological impairment is best assessed through the measurement of biological effects associated with the study site (e.g. toxicity, bioaccumulation, and benthic community degradation). Second, multiple indicators of sediment quality must be measured in order to provide a confident assessment of impacts because no single test or parameter is a consistently reliable, accurate, and predictive indicator of impairment. The final assumption is that there may be unknown site-specific factors in the study areas that will significantly affect causal relationships between contamination and effects, thus site-specific information is needed to accurately assess impacts.

The basic study design entails the collection of sediment from multiple stations arranged in a grid pattern within each study area. Multiple measures of sediment quality will be conducted at each station so that maps of sediment impacts can be generated and hypotheses concerning relationships between contamination and effects can be developed for each location.

We will measure four indicators of sediment quality: sediment contamination, sediment toxicity, benthic community composition, and bioaccumulation. These four indicators are directly related to the reasons for including these sites on the 303(d) list of impaired water bodies. We will also measure other habitat factors that are necessary for the accurate interpretation of these indicator data. The use of multiple indicators will support a weight-of-evidence approach that increases the likelihood that the sediment quality at each sampling site will be accurately assessed.

Maps of the extent of sediment impairment will provide much of the information needed to address three of the primary questions of this study: extent, relative magnitude, and source of impairment. Determination of the numerical relationships between contamination and effects will supplement these efforts by investigating whether impacts are contaminant-related. These relationships will also be used in subsequent activities to develop clean up standards and TMDL goals. Results of the bioaccumulation tests will address the question of possible food chain transfer of contaminants and will provide some of the information needed to address human health impacts related to contamination at the sites.

The results of this spatial study will also be used to plan subsequent studies that are needed to support TMDL and cleanup activities at the sites. Maps of contamination and toxicity will be used to select stations for toxicity identification evaluation (TIE) in order to identify contaminants of concern for development of TMDL targets. Determination of the spatial extent of impairment will also facilitate identification of the area requiring remediation, and provide a baseline upon which to assess the effectiveness of load reductions and remediation actions.

## 2.2 SITE CONCEPTUAL MODEL

Based on existing data, site conceptual models were developed to help clarify the potential linkages between sources, exposure pathways, and receptors. All of the sites share similar characteristics including identified impairment of sediments, stormwater inputs from shoreline sources, and shoreline industrial activities. In addition, the Switzer Creek study area receives considerable upland inputs from the creek itself. Thus, the conceptual models for each study area reflect the generic processes that are expected to be dominant at the sites. The models are broken into two parts, the first illustrating the potential for ongoing sources to impact the site, and the second illustrating the potential exposure pathways for contaminated sediments to reach receptors.

The primary categories of potential ongoing sources are illustrated in Figures 2-1 and 2-2. These include stormwater from the upland watershed that enters the Switzer Creek site via creek drainage, stormwater from the neighboring shipping facilities and shipyards that enters the site primarily via small storm drains, and in-water sources primarily from ships via release from antifouling coatings and zinc cathodic protection systems. A significant fraction of this source material is likely to enter the site in association with particulate matter, or adsorb onto particulate matter at the site. Because of the relatively weak currents in the Switzer Creek study area, it is anticipated that much of the source material that enters the site will deposit to the sediment bed within the site, rather than be transported to the bay. This is the process that is conceptualized in Figure 2-1. In the B Street/Broadway Piers and Downtown Anchorage areas (Figure 2-2), there is greater potential for transport of contaminated sediment from adjoining areas because of tidal eddys in this part of the bay (Fairey et al. 1996). There are also a number of storm drains in the in the vicinity of the Downtown Anchorage. Additional insight into the links between these sources and the sediment will be gained from supporting and follow-on studies for source quantification and TIE characterization. A final potential pathway for contaminant inputs in this system is via air deposition. This has been shown to be significant for certain persistent organic pollutants such as dioxins and other chlorinated organic compounds. The site conceptual models include this potential pathway.

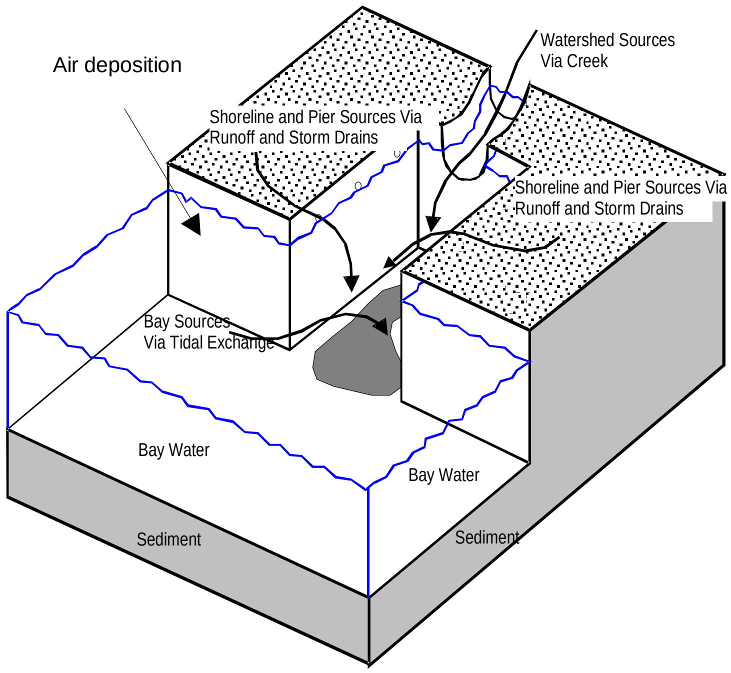


Figure 2-1. Generic site conceptual model for the Switzer Creek study area showing potential sources and pathways to the sediment.

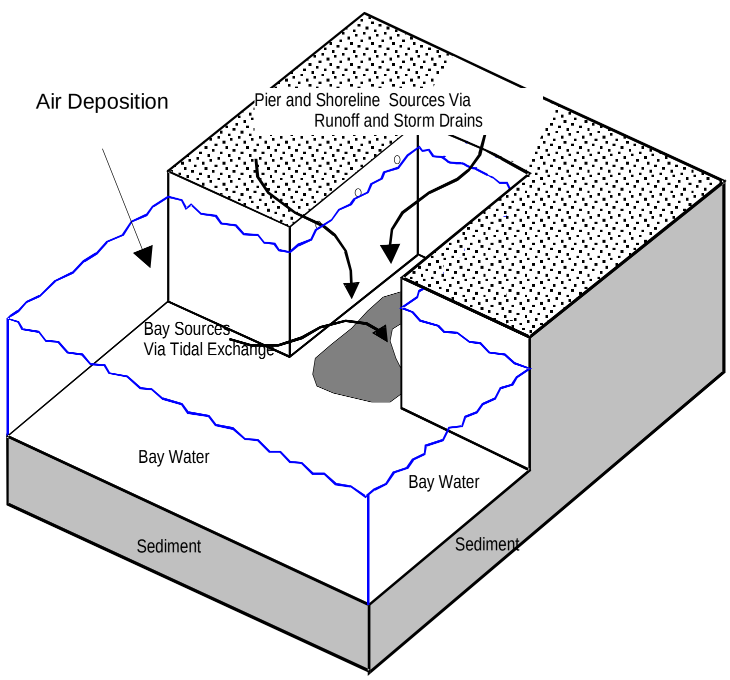


Figure 2-2. Generic site conceptual model for the B Street/Broadway Piers and Downtown Anchorage study areas showing potential sources and pathways to the sediment.

Potential pathways of exposure and receptors are illustrated in Figure 2-3. All of the sites under investigation are intermediate water depth environments. This has important implications for the potential exposure pathways that may exist. For the contaminants in the sediment, one potential ecological exposure pathway is for direct contact or ingestion by benthic infauna, primarily invertebrates such as crustaceans, polychaetes and mollusks (Fairy et al., 1996). In association with this pathway, a second level of ecological exposure may occur for bottom feeding fish that prey on these benthic invertebrates. Existing survey data suggests that in these areas exposure would be primarily to species such as the California Halibut, Round Stingray, and Barred Sand Bass (U.S. Navy/SDUPD, 2000). Because of the depth of the sites, it is unlikely that transfer to fish-eating bird species would occur. Diving birds and surface feeding birds generally limit their activities to shallow water areas, and there are few upper level receptors that feed directly on the bottom fish species mentioned above. It is possible that surf scoters (*Melanitta perspicillata*) or lesser scaup (*Aythya affinis*) feeding on shellfish may be exposed to bioaccumulatable contaminants at these sites, particularly at the Switzer Creek and Downtown Anchorage sites. Potential exposure to humans may occur through fishing activities that involve direct take of those bottom fish. Although fishing activity is generally not common within the direct confines of the sites, the mobility of the fish could provide a complete pathway for fishing activities that occur outside the site at nearby public fishing piers or in the open areas of the bay to the east of the site.

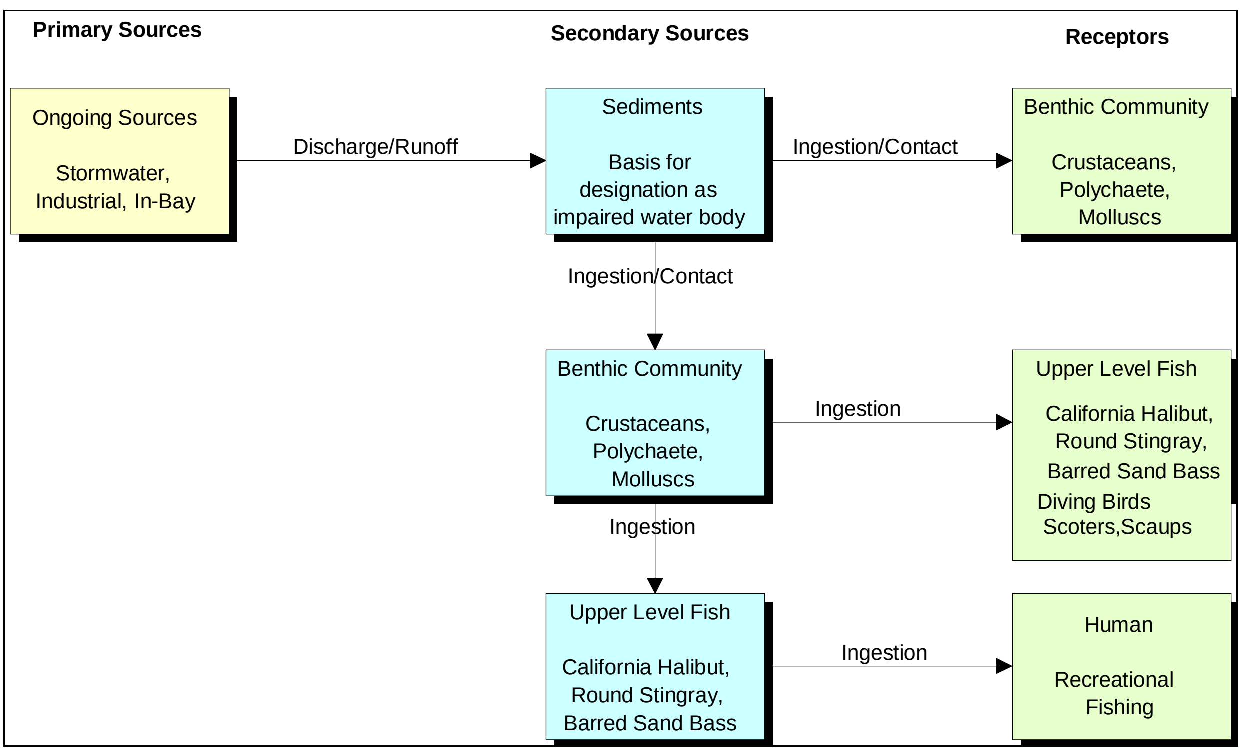


Figure 2-3. Generic site conceptual model for B Street/Broadway Piers, Downtown Anchorage and Switzer Creek showing the relationship between potential sources, pathways of exposure and receptors.

The measurements described in the following sections are designed to evaluate the exposure pathways conceptualized above. The sediment quality indicators were selected to provide quantifiable measurement endpoints to determine if these pathways of exposure are sufficient to drive significant ecological or human health risk.

## 2.3 SEDIMENT QUALITY INDICATORS

Up to four types of sediment quality indicators, as well as sediment characteristics necessary for indicator data interpretation will be measured at each station. Multiple indicators are necessary to increase the likelihood of an accurate determination of the presence or absence of sediment degradation at each site by supporting a weight of evidence approach to the data analysis. Each indicator is complementary to the others with regard to assessing the presence of an impact and determining whether impacts are related to chemical contamination.

Methods equivalent to those used in the BPTCP and Bight'98 regional surveys, and the Chollas and Paleta Creek studies will be used wherever there is a choice. This will permit directly comparing results of the present study with region-wide values when evaluating impacts and temporal trends.

### 2.3.1 Sediment Contamination

Sediment chemical measurements will be used to document the extent, spatial pattern, and relative magnitude of sediment contamination at each study site, assess temporal trends through comparisons to prior measurements, and indicate the potential biological availability of sediment-associated trace metals.

The concentrations in surface sediments of the trace metals and organic contaminants measured in the Bight'98 survey (Appendix 1) will be measured at all sampling sites. The chemical analyses will use methods that are comparable to those used in the Bight'98 survey. One difference is that instead of the top 2 cm sampled in previous surveys, surface sediments for the current study are defined as those within 5 cm of the sediment-water interface. The rationale for using a deeper sample is in response to concerns that the surficial flocculent layer in the study areas are subject short-term disturbance via tidal action and that a 2 cm deep sample would not represent consistent conditions. It was concluded that a 5 cm sample would better represent longer-term conditions in the study areas.

### 2.3.2 Sediment Toxicity

Sediment toxicity tests will be used to document the extent, spatial pattern, and relative magnitude of acute toxicity and sublethal effects in the sediments at each study site. More detailed descriptions of the toxicity test methods and their quality assurance guidelines are provided in the Quality Assurance Project Plan (Marine Pollution Studies Laboratory, 2003).

Acute toxicity will measure survival of the amphipod crustacean, *Eohaustorius estuarius,* after 10 days of exposure to whole sediment (EPA 1994). Porewater and overlying water in the test chambers will be measured for ammonia; water changes will be performed as needed to reduce ammonia effects.

Sublethal sediment toxicity will be assessed by measuring the effects of porewater on sea urchin fertilization (EPA 1995). Porewater will be extracted from samples of surface sediment by centrifugation and diluted with laboratory seawater to obtain concentrations of 100, 50, and 25%. Sea urchin sperm will be exposed to each sample for 20 minutes and then the toxic effects are evaluated by measuring the ability of the sperm to fertilize eggs.

The presence of sublethal effects and potential impacts of contaminated sediments on the water column will be assessed through the use of a sediment-water interface toxicity test (Anderson et al. 2001). Clean laboratory seawater (filtered natural seawater) will be added to sediment core samples that have been collected with a minimum of disturbance (in order to preserve gradients of oxidation and interstitial water composition in the surface sediments). Following an equilibration period of one day (with aeration) to allow desorption and diffusion of constituents from the sediment, mussel embryos (*Mytilus galloprovincialis*) will be added to the test chambers. The embryos will be removed after a 48-hour exposure period and examined to determine the incidence of adverse effects. The dissolved oxygen, pH, ammonia, and salinity of the water samples will be measured to determine whether any toxicity is due to these factors.

Toxicity possibly due to unionized ammonia will be assessed by comparing concentrations in the toxicity test containers to existing threshold effect and $LC_{50}$ concentrations established for each species. In addition, concurrent unionized ammonia reference toxicant tests will be conducted with each test species in water-only exposures to assess their relative sensitivity to this compound. Ammonia test results will be compared to previously published values, and to ammonia concentrations measured in the tests, to determine possible impacts due to this constituent.

### 2.3.3 Benthic Community Composition

The numbers and kinds of benthic invertebrates in sediment samples will be used to characterize benthic communities at each study site.

Sediment collected using a $0.1 m^2$ Van Veen grab at each sampling site will be sieved through a 1.0 mm-mesh screen onto a 0.5 mm screen. Animals retained on both screens analyzed separately will be identified to the lowest possible taxon, and enumerated. Most taxa will be identified to species. A number of metrics will be calculated to describe key components of benthic community structure. These are described in the data analysis section.

### 2.3.4 Sediment Characteristics

Sediment characteristics that influence the bioavailability of contaminants, the response of toxicity test organisms, and the structure of benthic communities will be measured to distinguish biological impacts (i.e., toxicity or benthic community alteration) due to contaminants from those due to physical or non-anthropogenic factors.

The sediment grain size distribution and total organic carbon content of surface sediments will be measured at each station using methods comparable to those used in the Bight'98 regional survey.

### 2.3.5 Bioaccumulation

Bioaccumulation tests will be used to evaluate the potential for contaminant uptake and subsequent food chain transfer of organic chemicals and metals from the sediment. Samples from the B Street/Broadway Piers, Downtown Anchorage area, and Switzer Creek stations will be compared to samples from appropriate reference stations to determine whether they pose a significantly greater potential for bioaccumulation. Bioaccumulation tests will be conducted at reference stations and a subset of B Street/Broadway Piers, Downtown Anchorage area, and Switzer Creek stations (5 stations in B Street/Broadway Piers and Downtown Anchorage areas, 3 in Switzer Creek area) that span the expected gradient of contamination at the site. Clams (*Macoma nasuta*) will be tested using the standard laboratory 28-day exposure protocol (USEPA/USACOE 1991), with sufficient number of organisms to provide ~50-100 g of tissue (wet weight) for chemical analysis. Sediments will be obtained from composite grabs from the top 5 cm at each station. Triplicate analysis will be performed at one station for each site and at one of the reference stations.

All trace metal and organic constituents to be measured in sediment samples will be measured in clam tissues after exposure to study-area sediments for 28-days. The data will be lipid normalized (where appropriate) and also compared to concentrations in tissue samples collected at the start of the experiment (t0). The test species is native to and widely distributed in San Diego Bay and actively ingests surface sediments. It is commonly used in dredged sediment studies (USEPA/USACOE 1991) because it provides enough tissue for trace level chemical analysis.

## 2.4 SEDIMENT SAMPLING

Sediment will be collected soon after the 2002-2003 wet season at 12 B Street/Broadway Piers, 9 Downtown Anchorage, 6 Switzer Creek, and 6 reference stations. Sampling methods will be consistent with procedures used in the BPTCP (Fairey et al. 1996) and the Bight'98 surveys; a 0.1 $m^2$ Van Veen Grab will be used for all sediment sampling except the sediment-water interface samples. Sediment for chemical, toxicity, or bioaccumulation analyses will be obtained from the upper 5 cm of the sediment surface. During each deployment of the grab sampler, sediment for toxicity, chemistry and bioaccumulation will collected from one side of the grab sample, and sediment cores for the sediment-water interface tests will be collected from the other side. The entire contents of a separate grab sample from the station will be processed for benthic community analysis.

Approximately 4-7 replicate grab samples will be taken at each station in order to provide sufficient sediment for all of the analyses, except at the bioaccumulation replicate stations where an additional 6-8 grabs will be required. Surface sediment from multiple grabs will be composited together on board ship, mixed to obtain homogeneity. Samples will be transported on ice to the clean facility at the Marine Pollution Studies Laboratory (Moss Landing), where they will be re-homogenized and then distributed into separate containers for chemistry, toxicity and bioaccumulation testing.

A sufficient number of grab samples will be collected in each study area to provide information on the spatial extent of contamination and any associated bioeffects. At Switzer Creek, 6 stations will be sampled. Based on the possible contaminant inputs and the shape of the hotspot area defined by previous sampling data, the six stations will be arrayed in a grid pattern with one corner at the creek input. This will allow determination of contaminant, and bioeffects gradients in three directions within the study area. Stations for bioaccumulation testing will be located as indicated in Figure 2-4. At the B Street/Broadway Piers, 12 stations will be sampled. Stations will be arrayed in a grid-like pattern within the rectangle between the two piers, with additional stations along the bayward perimeter. The sample pattern will allow determination of gradients in both east-west and north- south directions; and help determine whether the contamination extends beyond the delimited area. Stations for bioaccumulation testing will be located along a south-north gradient extending from the shore to the center of the bay. At the Downtown Anchorage area, 9 stations will be sampled. Stations will be arrayed in a triangle extending north from shore and will allow determination of gradients in north-south and east-west directions.

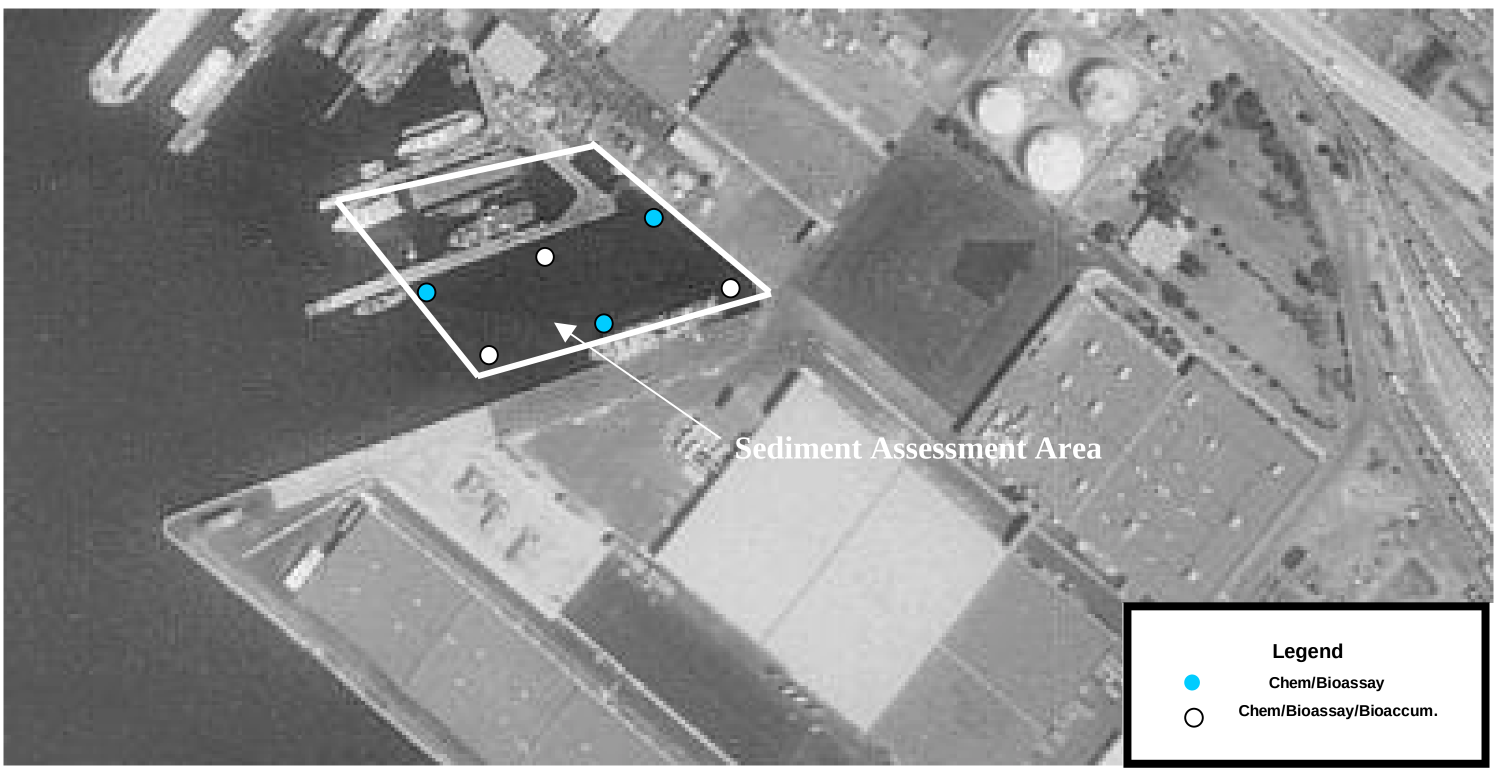


Figure 2-4. Switzer Creek study area with proposed sample locations.

### 2.4.1 Switzer Creek

The Switzer Creek study area (Figure 2-4) is located between the north side of the 10th Avenue Marine Terminal and the Cambell Shipyard Piers at the mouth of Switzer Creek. The total sediment surface area of the original hotspot designated by the SDRWQCB is approximately 28,000 $m^2$. Because a portion of this area is intended for development, a subsection of the original hotspot located between the 10th Ave Marine Terminal and the southern-most Cambell Shipyard Pier will be sampled for the current study. The stations will be arranged in a diamond-shaped grid representing 6 subregions within the designated area (Fig. 2-4). The locations of Switzer Creek stations are listed in Appendix 2.

### 2.4.2 B Street/Broadway Piers

The B Street/Broadway Piers study area is located between the Broadway and B Street Piers and extends southwest approximately 100 m from the end of the Broadway Pier (Figure 2-5). Total sediment surface area is approximately 48,000 $m^2$. The 12 sampling stations will be arranged in a rectangular grid within the designated area. This design allows discrimination of spatial gradients of contamination, and biological effects measurements away from shore-based sources. It also allows discrimination of gradients from both downtown piers. Specific locations of B Street/Broadway Piers stations are summarized in Appendix 2.

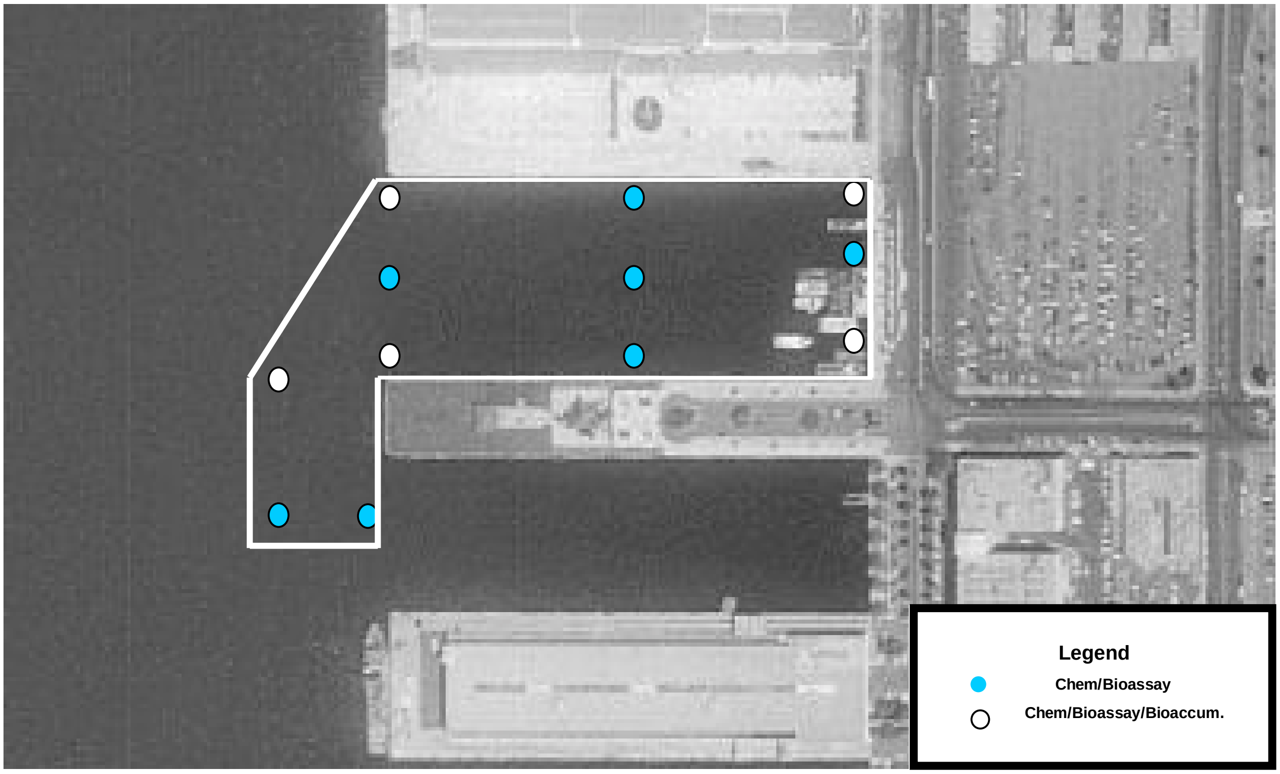


Figure 2-5. B Street/Downtown Piers study area with proposed sample locations.

### 2.4.3 Downtown Anchorage Area

The Downtown Anchorage study area is located between Grape Street and the downtown anchorage in the vicinity of the U.S. Coast Guard Reservation (Figure 2-6). Total sediment surface area is approximately 32,000 m$^2$. The 9 sampling stations will be arranged in a triangular grid within the designate area, allowing for discrimination of spatial gradients of contamination and toxicity away from shore-based sources. Specific locations of Downtown Anchorage area stations are summarized in Appendix 2.

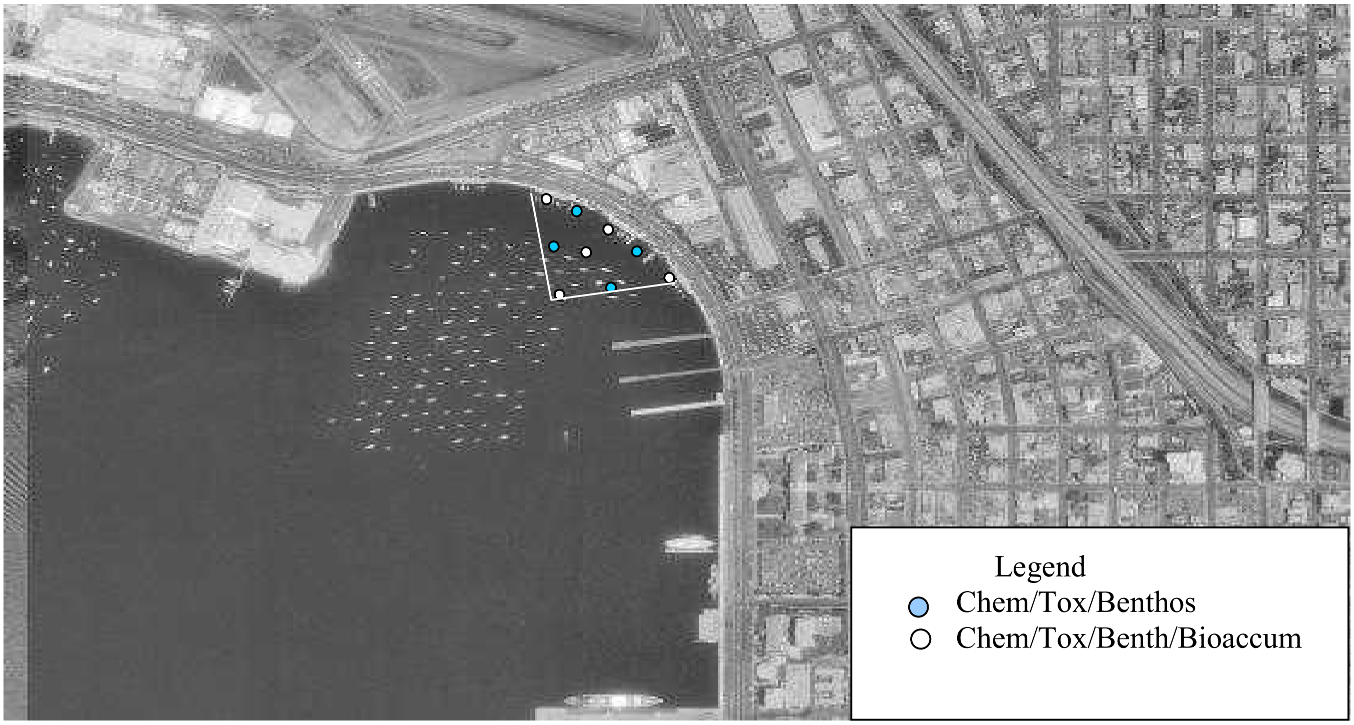


Figure 2-6. Downtown Anchorage study area with proposed sample locations.

### 2.4.4 Reference Stations

For consistency, three of the same reference stations used in the Chollas Creek, Paleta Creek, and NASSCO/Southwest Marine sediment assessment studies will be used in the current study. Two additional reference stations selected either from the BPTCP studies reported by Fairey et al. (1996, and 1998), or from the Bight '98 study may also be used. The six reference sites will be sampled from San Diego Bay to represent background conditions within the bay. The three stations used in the Chollas Creek, Paleta Creek studies were selected from analysis of Bight'98 sediment chemistry, toxicity, and benthic community data using a stepwise screening procedure. The screening procedure was conducted in three phases in order to obtain a pool of candidate sites representing a range of habitat characteristics and locations. In phase I, all 46 Bight'98 stations from San Diego Bay were evaluated on the basis of desired habitat characteristics, lack of acute toxicity, low overall contamination (mean ERM quotient), and diverse benthos (high number of species present). The sequence of steps is shown in Figure 2-7. The phase I selection process identified five of the cleanest stations (level 1) among the Bight'98 dataset, but the grain size and TOC characteristics of these stations were relatively restricted. Grain size of the phase I stations was 31-50% fines and these stations contained 0.5-0.9% TOC (Table 2-1).

The phase II selection procedure was applied in an effort to identify potential reference stations containing higher concentrations of TOC and finer grain size characteristics. This process differed from phase I in that only stations containing relatively high % fines were included and the criteria for contamination level and species diversity were modified in order to retain a sufficient number of stations (5) for further evaluation.

None of the stations selected in phases I or II were located in the central portion of San Diego Bay, near the study sites. A third selection round was then conducted in order to identify candidate reference sites closer to the study sites. The phase III selection procedure was conducted using only those 16 stations located in the central region of San Diego Bay, near the Downtown Pier, Grape Street, and Switzer Creek study sites. Two stations (level 3) were identified in phase III (Table 2-1).

The locations and selected characteristics of the 12 candidate reference sites are shown in Figure 2-8 and Table 2-1, respectively. Data on the three reference sites currently used for NPDES monitoring are also shown. In addition, data for 2 reference stations selected from the BPTCP 1996 and 1998 studies are also included.

A subset of six reference stations is recommended for use in sediment quality studies at the B Street/Broadway Piers, Downtown Anchorage area, and Switzer Creek sites. The recommended stations were selected in order to represent a wide range of grain size and TOC, while maintaining relatively low contaminant concentrations. In addition the selected reference stations had undisturbed benthic community structures based on either SCCWRP or BPTCP criteria. The recommended sites encompass a similar range of sediment grain size and have similar or lower contaminant concentrations than the NPDES reference sites. The recommended stations and some of the characteristics meriting their use are given below (Note that two of the reference station numbers are the same as those used by Bay et al. for the Chollas/Paleta Creek surveys: R03 and R06).

R03 (Bight '98 station #2433): Relatively high TOC and % fines, located in northern part of bay.

R06 (Bight '98 station #2238): Relatively low TOC and % fines, located in south part of bay.

Bight '98 station #2243: Relatively low TOC and % fines, located in the central part of the bay.

Bight '98 station #2240: Relatively low TOC and % fines, located in the central part of the bay.

The two additional reference stations selected from the BPTCP 1996 and 1998 studies are:

BPTCP station # 90053: > 90% fines, TOC > 1%; located in the south part of the bay

BPTCP station # 93195: ~50% fines; TOC $\geq$ 1%; located in the central part of the bay

Some of the candidate stations that are not recommended for use contained characteristics that were considered inappropriate. For example, station 2225 was located in a marina (potential impacts from boating activities), station 2442 had relatively high PAH concentrations, and station

2227 was located too close to another recommended site. After studies conducted in summer 2001 as part of the Chollas and Paleta Creek studies, Station 2231 was found to have a benthic community not considered to be representative of reference conditions in San Diego Bay. Station number 2440 was found to have elevated tissue concentrations of PCBs and PAHs in 28-d *Macoma* bioaccumulation tests (personal communication A. Monji; San Diego Regional Water Quality Control Board). While Station #2441 was considered to be an appropriate reference station in previous Shipyard and Navy sediment assessment studies, this station is unavailable for the current study because of U.S. Navy security concerns associated with the war in Iraq.

The remaining stations were not selected because they contained characteristics that were similar to those already recommended for use. The selection of the six recommended stations reflects the use of professional judgment to best satisfy the objectives of varied characteristics, multiple locations within the bay, low contamination, low toxicity, undisturbed benthos, and minimal bioaccumulation (note that bioaccumulation data are not available for the two BPTCP reference stations).

To further refine criteria for the original reference stations used in the Chollas/Paleta Creek studies conducted in 2001, additional criteria will be used to evaluate the six reference stations for the current study. Low contamination at reference sites will be defined as no individual contaminants exceeding ERM values (Long et al. 1995), excluding ERMs for which Long et al. (1995) had less confidence (e.g., mercury, nickel, ΣDDT). ΣDDT will be compared to the organic carbon normalized value reported by Swartz et al. 1994. Bulk-phase concentrations of individual and ΣPAHs will be compared to the consensus-based guideline values reported by Swartz et al. (1999). Bulk-phase concentrations of ΣPCBs will be compared to the consensus-based guideline values reported by MacDonald et al. (2000). Low contamination is further defined for chemical mixtures in bulk-sediment as a Sediment Quality Guideline Quotient value (SQGQ1 value) of 0.85, based on the relationship between this guideline quotient and amphipod mortality reported by Fairey et al. (2001). Acceptable toxicity at the reference stations will be assessed using amphipod toxicity test results and will be defined as survival greater than the Minimum Significant Difference value reported by Phillips et al. 2001. For the amphipod *Eohaustorius estuarius*, this is defined as survival greater than or equal to 75% of mean home sediment control survival. Results of the amphipod tests is prioritized for assessing reference stations toxicity response based on the suggestions of Ingersoll et al. (1995). These authors concluded that solid-phase tests with amphipods provide the least uncertainty for assessing risk to biota due to sediment toxicity. For the purpose of assessing acceptable benthic community structure at reference stations, a relative benthic index value (RBI) using methods described by Fairey et al. (1998) will be calculated. Acceptable (undisturbed) benthic community structure at reference stations will be defined as RBI values greater than or equal to 0.61. For the purpose of assessing acceptable bioaccumulation concentrations at reference stations, concentrations of selected chemicals in *Macoma nasuta* after 28-d laboratory exposures will be used to calculate doses to a representative clam-eating avian receptor, the lesser scaup (*Aythya affinis*). Methods will follow those described in the Naval Air Station North Island Bravo Pier Study prepared by SPAWAR (2001). The dose numbers will then be compared to the BTAG Toxicity Reference Values (TRVs) to assess risk to birds (HERD 2000). Dose/TRV ratios will be calculated and values < 1 will be considered to be acceptable bioaccumulation at reference stations (note: the TRV for lead will not be considered for this evaluation because this TRV is currently under review by HERD; personal communication, Michael Anderson, DTSC).

Reference station performance will be evaluated based on the weight-of-evidence compiled from bulk-phase chemical analyses, toxicity tests, benthic community structure, and bioaccumulation studies. These analyses will be compared to the respective thresholds described above. In the event that specific measures at reference stations exceed these thresholds, best professional judgement will be used to determine the significance of deviations from the criteria. If some of the reference station criteria are not met for selected indicators, project scientists will consult with all stakeholders to determine appropriateness of using specific reference data for assessing impacts of indicators at the B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek stations. A preliminary reconnaissance study of the proposed 6 reference stations will be conducted in early spring 2003 to determine their suitability for use in the Phase I studies scheduled for summer. During this preliminary study, sediments will be collected from each reference station and bulk-phase chemical and physical analyses will be conducted (trace organics, trace elements, grain size and TOC). In addition, benthic community structure will be characterized at each station and toxicity will be measured with the 10-d amphipod test (*E. estuarius*) and the sediment-water interface test with sea urchin embryos (*S. purpuratus*). Results of these analyses will be compared to the criteria listed above to determine suitability of the reference sites.

It is possible that additional or alternative reference sites may be identified through later monitoring being conducted as part of the Chollas Creek, Paleta Creek, and NASSCO/Southwest Marine sediment assessment studies. If additional reference stations are identified that are considered appropriate for the B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek sediment assessment studies, these may be added to the current list of six stations, or may replace stations not considered to be appropriate after the reconnaissance survey.

Table 2-1. Characteristics of candidate reference sites for San Diego Bay. The characteristics of the B Street/Broadway Piers, Downtown Anchoragearea, and Switzer Creek study sites and NPDES reference sites are also shown. Shading indicates recommended reference stations.

| Station/ Area | Level | % Fines | TOC | Cu mg/kg | Zn mg/kg | PAH µg/kg | ERMq | # Species |
|---|---|---|---|---|---|---|---|---|
| **Switzer** | | 24-75 | 0.2-2.2 | | | | | |
| **DownTn Piers** | | 48-62 | 1.2-2.2 | | | | | |
| **Grape St. area** | | 36-86 | 0.9-1.9 | | | | | |
| **REF-01** | | 38 | | 16.6 | 49.4 | 902 | | |
| **REF-02** | | 42 | | 179 | 226 | 72 | | |
| **REF-03** | | 65 | | 99.1 | 159 | 5957 | | |
| **2227** | 1 | 50 | 0.9 | 53.9 | 112 | 324 | 0.12 | 52 |
| **2435** | 1 | 49 | 0.5 | 28.4 | 64.4 | 0 | 0.07 | 59 |
| **2229** | 1 | 43 | 0.9 | 58.9 | 99.3 | 970 | 0.12 | 62 |
| **2440** | 1 | 38 | 0.5 | 41.8 | 81.1 | 0 | 0.09 | 58 |
| **2231** | 1 | 31 | 0.6 | 58.1 | 92.5 | 258 | 0.10 | 70 |
| **2441** | 2 | 79 | 2.0 | 71.8 | 123 | 1061 | 0.13 | 84 |
| **2225** | 2 | 57 | 1.0 | 127 | 130 | 146 | 0.19 | 69 |
| **2433** | 2 | 71 | 1.2 | 71.6 | 126 | 240 | 0.14 | 58 |
| **2442** | 2 | 79 | 2.0 | 77.7 | 139 | 4950 | 0.14 | 52 |
| **2238** | 2 | 57 | 1.0 | 55.1 | 143 | 0 | 0.12 | 41 |
| **2243** | 3 | 35 | 0.5 | 38.8 | 81.2 | 0 | 0.09 | 47 |
| **2240** | 3 | 44 | 0.5 | 47.4 | 103 | 85 | 0.11 | 40 |
| **BPTCP 90053** | | 92 | 1.5 | 87 | 240 | 422 | 0.18 | 30 |
| **BPTCP 93195** | | 48 | 1.0 | 86 | 200 | 1202 | 0.25 | 28 |

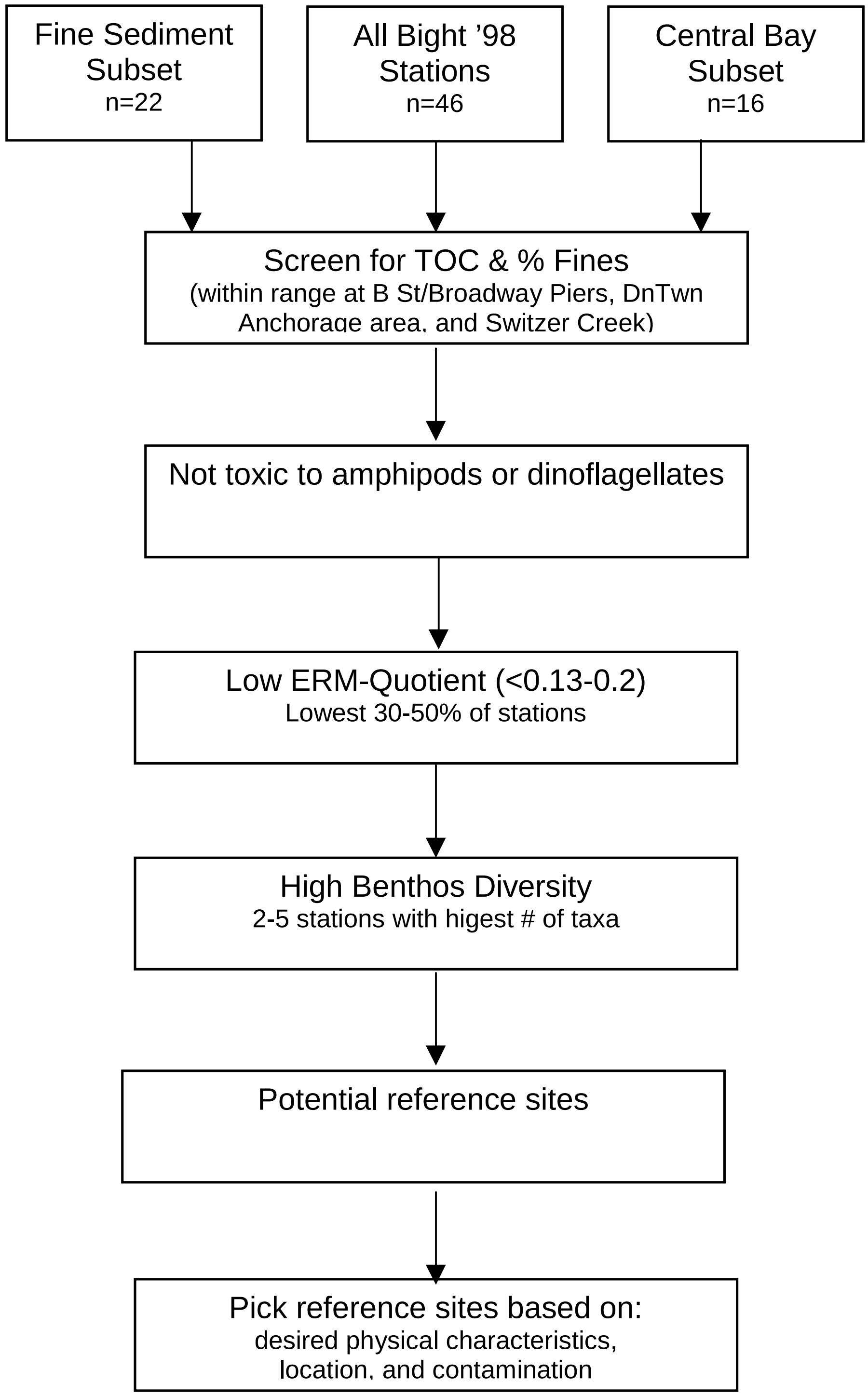


Figure 2-7. Overview of Chollas/Paleta Creek study reference site selection process. The selection process was applied to three groups of Bight'98 stations from San Diego Bay. Reference stations from BPTCP studies used selection process of Fairey et al. 1996; 1998.

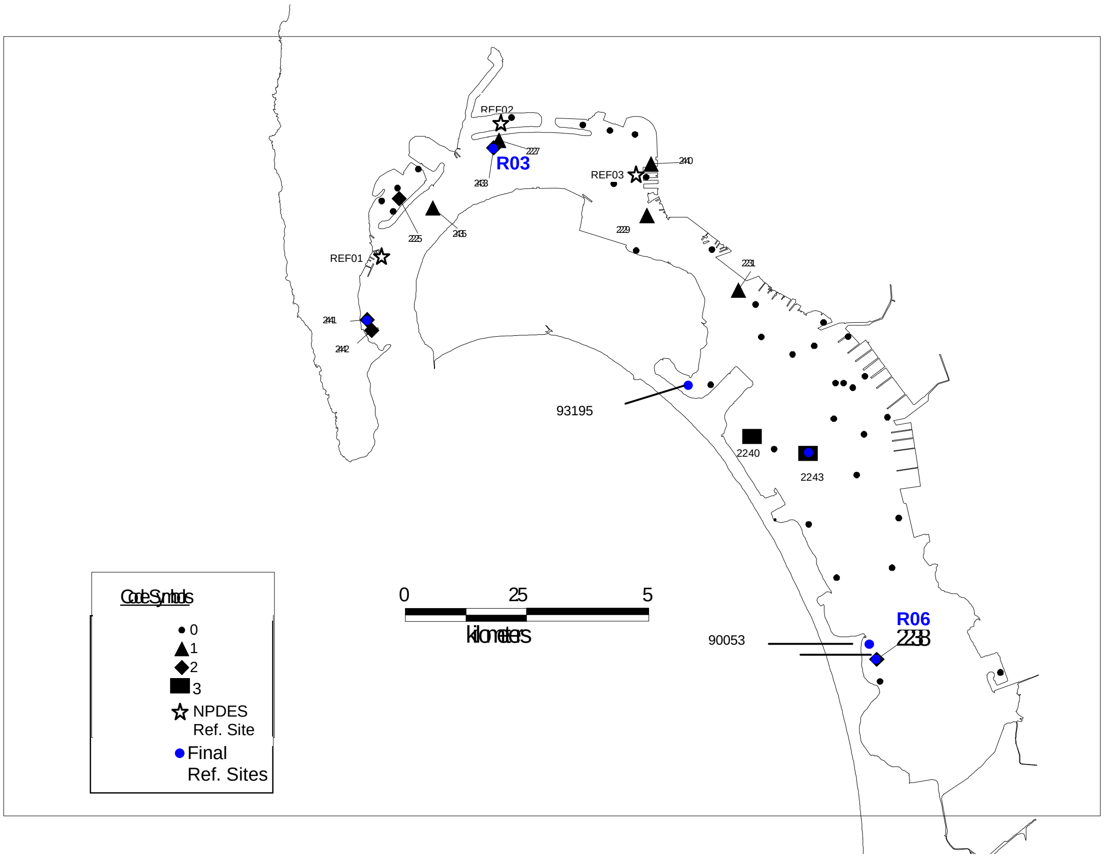


Figure 2-8. Location of candidate reference sites in San Diego Bay. Code numbers indicate whether the station was selected during phase I, II, or III of the selection process. Station #2238 = reference station 6 from Chollas/Paleta study. Station #'s 93195 and 90053 were selected from BPTCP data sets (Fairey et al. 1996 and 1998).

# 3.0 TOXICITY IDENTIFICATION EVALUATIONS (TIES)

Toxicity Identification Evaluations (TIEs) are laboratory experiments that incorporate various treatments designed to reduce toxicity of water and sediment samples. The treatments are designed to mitigate toxicity caused by specific classess of chemicals such as non-polar organic compounds, divalent cations, and ionizable contaminants. Results of these experiments provide information on chemical causes of toxicity. TIEs are designed to proceed in three phases: Phase I procedures characterize the chemicals responsible for toxicity; Phase II procedures identify the cause(s) of toxicity; Phase III confirm the cause(s) of toxicity. In the current study, TIEs will be conducted on samples from selected sites exhibiting significant toxicity. TIEs at sites toxic to sea urchin sperm or bivalve embryos will use aqueous samples (as described below). For sites exhibiting solid-phase toxicity to amphipods, follow-up 10-day porewater and solid-phase experiments will be conducted to determine the likely route of toxicant exposure. If effects are equivalent between both test matrices, TIEs will be conducted using porewater. If there is greater solid-phase toxicity, ingestion will be considered as a possible exposure route and solid-phase TIEs will be used. This approach is detailed as a TIE decision tree in schematic form in Appendix 7. In all cases, TIEs will be used in conjunction with physical and chemical analyses of different sediment matrices and tissues, and correlation analyses of relations between chemistry and toxicity, as part of a weight-of-evidence approach to determining causes of sediment toxicity. Emphasis will be placed on resolving toxicity due to potential factors which may confound toxicity test results. These include toxicity due to elevated unionized ammonia, hydrogen sulfide, and percent clay, and extreme deviations in porewater pH. In many cases, toxicity due to confounding factors will be addressed by measuring these characteristics and compairing these values to established toxicity thresholds (e.g., U.S. EPA application limits) or other published effect values.

## 3.1 BIVALVE AND SEA URCHIN TIES

Bivalve and sea urchin sperm cell TIEs will be conducted on selected samples exhibiting either sediment-water interface or porewater toxicity. Sediment-water interface TIEs will expose bivalve embryos to the overlying water from the intact core samples. Porewater TIEs will expose sea urchin embryos to different dilutions of porewater. The number and type of bivalve and sea urchin TIEs will depend on results of toxicity screening experiments experiments, and by necessity, may vary between the three study areas. Stations for TIE studies will be selected through consultation with Regional Water Board staff scientists. The general approach for bivalve and sea urchin TIEs will follow procedures outlined in Appendix 7. After the class of chemical(s) responsible for bivalve toxicity is characterized through Phase I TIEs, toxic chemicals will be identified as part of a Phase II TIE. An example of a Phase II manipulation would be selected separation of specific metal cations using cation column elution techniques to determine their relative role in toxicity. Confirmation of specific chemicals responsible for bivalve toxicity will then be performed as part of a Phase III TIE. Phase III TIEs include correlation analyses, species sensitivity determinations, matrix spiking, and mass balance techniques (EPA 1993). An example of a Phase III TIE technique would be testing of species having differences in toxicity to specific contaminants identified during Phase I and II procedures.

Because all TIEs are iterative studies that build on previous experimental results, division of resources between Phase I, II, and II TIEs among the three study areas will to be decided as the study proceed

### 3.2 AMPHIPOD TIES

It is anticipated that TIEs will also be conducted at selected stations exhibiting significant toxicity to amphipods at the Downtown Anchorage, B St/Broadway Piers, and Switzer Creek study areas. The number and type of amphipod TIEs may vary between study areas. Stations will be selected in consultation with Regional Board staff scientists. For amphipd tests, TIEs will be prioritized at stations exhibiting the highest magnitude and most consistent toxicity. The general approach for amphipod TIEs will follow Appendix 7. Once the class of chemicals responsible for toxicity is characterized. Phase II and III techniques may be used to characterize, identify, and confirm specific contaminants from solid-phase samples. A similar weight-of-evidence approach is proposed for other stations exhibiting toxicity to amphipods. As suggested above for the bivalve experiments, it is anticipated that the TIE process for determining causes of amphipod toxicity will be an iterative process involving decisions at key junctures as the study proceeds.

# 4.0 DATA ANALYSIS AND INTERPRETATION

Analysis and interpretation of the results will consist of 4 activities: evaluation of data quality, determination of impacts for each indicator, assessment of impairment at each station, and evaluation of spatial contamination patterns. The procedure used to accomplish each of these activities is described below.

## 4.1 DATA QUALITY EVALUATION

Upon completion of testing, the data from each indicator will be compared to predetermined objectives for data quality. These objectives include parameters such as control performance for toxicity tests, accuracy and precision for sediment and tissue chemical analyses, and sorting efficiency and identification accuracy for benthic analysis. The objectives used in this study will be those specified in the Bight'98 quality assurance plan (chemistry, toxicity, and benthos: http://www.sccwrp.org/regional/98bight/qaqc/qapln.html) or in the standard method used for the bioaccumulation tests. Measurements failing to meet data quality objectives will be repeated wherever possible. Reanalysis may not be possible in some cases due to limited sample or holding time constraints. In these cases, the data will be evaluated by a supervising analyst and their best professional judgment used to determine the validity of the data. Data failing to meet all quality objectives will be flagged in the database produced from this study.

## 4.2 DETERMINATION OF IMPACTS

The data for each indicator will be evaluated separately to determine the presence of significant impacts (i.e., toxicity, contamination, or altered benthic community structure) at each station. The same general two-step approach will be followed for each indicator in most cases. First, the data will be compared to a threshold or criterion that indicates whether a significant response was obtained. Then the results will be compared to the reference site values to determine whether impacts greater than the background condition in the bay were present. This approach is based on the framework for evaluating sediment quality developed by the EPA for application in the St. Louis River Area of Concern (US EPA 2000b). In most cases, comparisons will be made against the 95% confidence interval of all reference site data (e.g. chemical constituents, toxicity, and bioaccumulation).

### 4.2.1 Sediment Contamination

A conceptual framework for analysis of the sediment chemistry data is shown in Figure 4-1. The goal of this analysis is to determine whether overall sediment contamination levels are of potential biological concern for either benthic communities or human health. The determination of potential concern for benthic organisms will be made by calculating the mean sediment quality guideline quotient (SQGQs) using methods of Fairey et al. (2001). A mean SQGQ is defined as the mean of the concentration of an individual chemical divided by its guideline value, averaged for all chemicals for which guideline have been established. The mean SQGQ is calculated by summing all of the guideline quotients and dividing by the total number included in the summation. Calculation of the mean SQGQ value recommended by Fairey et al. (2001) includes ERMs (copper, zinc, total chlordane, dieldrin), PELs (cadmium, silver, lead) and Consensus Based Guideline Values (total PAHs – Swartz et al. 1999; total PCBs – MacDonald et al. 2000). The mean SQGQ will be compared to categories expected to cause toxicity (Fairey et al., 2001; Table 7). In addition to SQGQs, mean ERM quotients will be calculated and compared to benchmarks established by Long and MacDonald (1998) to classify the stations in one of four categories (related to the probability of sediment toxicity to amphipods): lowest priority, mean ERMq <0.1; medium-low priority, mean ERMq 0.11-0.5; medium-high priority, mean ERMq 0.51-1.5; and highest priority, mean ERMq >1.5. Stations with mean ERMq values of >0.1 have potentially significant contamination levels. The significantly contaminated sites will then be compared to reference sites to determine if the observed contamination is site-specific. In addition to SQGQs and ERMQs, the number of ERM guidelines exceeded at each station will also be calculated and compared to the number exceeded at the reference stations. Chemicals for which no sediment quality guideline values have been calculated will be compared to the range of chemical concentrations in the BPTCP statewide database. This database contains concentrations of approximately 120 analytes measured in sediments collected throughout the majority of California's bays, estuaries, near-coastal areas and lagoons. Non-guideline chemicals will be compared to the $90^{th}$- and $95^{th}$ percentile thresholds from this database to assess relative contamination.

### 4.2.2 Sediment Toxicity

Sediment, porewater and sediment-water interface toxicity results will be compared to the negative control (collection site sediment or laboratory seawater) to determine if a statistically significant response was present (Figure 4-2). Those samples with a statistically significant difference that are also below the respective minimum significant difference (MSD) values for the respective protocols will be considered toxic (Phillips et al., 2001). Samples with unacceptable levels of confounding factors (e.g., grain size and ammonia) will be normalized to adjust for the matrix effect or classified indeterminate. The data will then be compared to the reference site data to determine whether the responses are significantly greater than background (impacted).

### 4.2.3 Benthic Community Composition

A number of measures of community health including abundance, diversity, and numbers of species will be calculated from the species abundance data. In addition, abundances of indicator taxa and appropriate multi-metric and multivariate indices of benthic impact, including the indices used by BPTCP and being developed for Bight'98 (if available) will be used to measure benthic community condition and identify potential impacts (Figure 4-3). The significantly impacted sites will then be compared to reference sites to determine if the observed benthic community degradation is site-specific. The data will also be compared to measurements of sediment characteristics, physical disturbance (e.g., prop wash) or other noncontaminant factors, as available, to exclude impacts that are not due to anthropogenic inputs.

### 4.2.4 Bioaccumulation

Trace metal and chlorinated organic compound concentrations in clam tissue will be compared to measurements made on a subsample of clams at the start of the experiment to detect the presence of contaminant bioaccumulation (Figure 4-4). Tissue concentrations of clams exposed to study site sediments will then be compared with tissue concentrations of clams exposed to reference sediments to determine if the elevated concentrations are above those characteristic of background conditions in the bay. Stations producing tissue contaminants above reference levels will be classified as having elevated site-specific concentrations of bioavailable contaminants.

Concentrations of selected chemicals in *Macoma nasuta* after 28-d laboratory exposures will be used to calculate doses to a representative clam-eating avian receptor, the lesser scaup (*Aythya affinis*). Methods will follow those described in the Naval Air Station North Island Bravo Pier Study prepared by SPAWAR (2001). The dose numbers will be compared to the BTAG Toxicity Reference Values (TRVs) to assess risk to birds (HERD 2000). Dose/TRV ratios will be calculated and values < 1 will be considered to be acceptable bioaccumulation at reference stations (note: the TRV for lead will not be considered for this evaluation because this TRV is currently under review by HERD; personal communication, Michael Anderson, DTSC).

### 4.3 DETERMINATION OF IMPAIRMENT

A weight of evidence approach will be used to develop an integrated assessment of the magnitude of impairment at each station. This approach uses all of the available information (sediment chemistry, toxicity, benthic community, and bioaccumulation) to determine whether sediment quality for use by aquatic species is likely to be impaired (Table 4-1). Aquatic life impairment is highly likely when sediment contamination is present and more than one indicator of biological effects (toxicity and benthos) are impacted. Impairment is likely when contamination or bioaccumulation is present and one of the biological effects indicators is impacted. The potential for impairment is less likely when contamination or bioaccumulation is not present or no toxicity is detected. In situations where benthic community structure is degraded but no significant acute toxicity is observed, the potential for contaminants eliciting chronic effects should be considered.

Table 4-1 also shows that impairment related to human or wildlife health is possible whenever bioaccumulation above TRV levels is observed. However, measurement of prey/seafood contamination levels and exposure/risk modeling is needed before a more definitive assessment of potential human health impacts can be made.

### 4.4 SPATIAL CONTAMINATION AND IMPACT PATTERNS

Maps will be prepared showing the distribution of selected contaminants of concern (identified though comparison with sediment quality guidelines or statistical analyses of the biological effects data). In addition, the spatial distribution of impacts and impairment, calculated in the previous sections, will also be mapped. These maps will be used to propose hypotheses regarding the relative contribution of various sources on sediment quality in the study sites (e.g., shoreline stormwater, and runoff from the creeks vs inputs from within the bay). The maps will also be used to select a subset of stations for subsequent studies of the cause of toxicity (TIE), temporal changes, or vertical distribution of contamination (sediment cores).

Table 4-1. Decision matrix to assess sediment quality using the results of multiple indicators. See Figure 1-1 for description of Phase I and II studies.

| Sediment Contam. | Toxicity | Degraded Benthos | Bioaccu-mulation | Beneficial Use Impairment: Aquatic Life | Beneficial Use Impairment: Human/ Wildlife | Recommended Action |
|---|---|---|---|---|---|---|
| + | + | + | + | Highly Likely | Possible | Phase II studies<br>Phase III studies<br>Refine health assessment |
| + | + | + | - | Highly Likely | Unlikely | Phase II studies<br>Phase III studies |
| + | - | + | - | Likely | Unlikely | Possible Phase II studies |
| + | + | - | - | Likely | Unlikely | Possible Phase III studies |
| + | - | + | + | Likely | Possible | Possible Phase II studies |
| + | + | - | + | Likely | Possible | Possible Phase III studies<br>Refine health assessment |
| - | + | + | + | Possible | Possible | Possible Phase II studies |
| - | + | - | + | Possible | Possible | Evaluate confounding factors |
| - | - | + | + | Possible | Possible | Evaluate analyte list, consider chronic toxicity<br>Refine exposure pathways |
| + | - | - | + | Unlikely | Possible | Refine health assessment |
| - | - | - | + | Unlikely | Possible | Refine exposure pathways |
| - | + | + | - | Possible | Highly Unlikely | Possible Phase II studies<br>Evaluate Confounding Factors |
| - | + | - | - | Unlikely | Highly Unlikely | |
| - | - | + | - | Possible | Highly Unlikely | Evaluate analyte list, consider chronic toxicity |
| + | - | - | - | Unlikely | Unlikely | No Further Action |
| - | - | - | - | Highly Unlikely | Highly Unlikely | |

+ = impact (above reference condition or screening level) present.

- = no impact present.

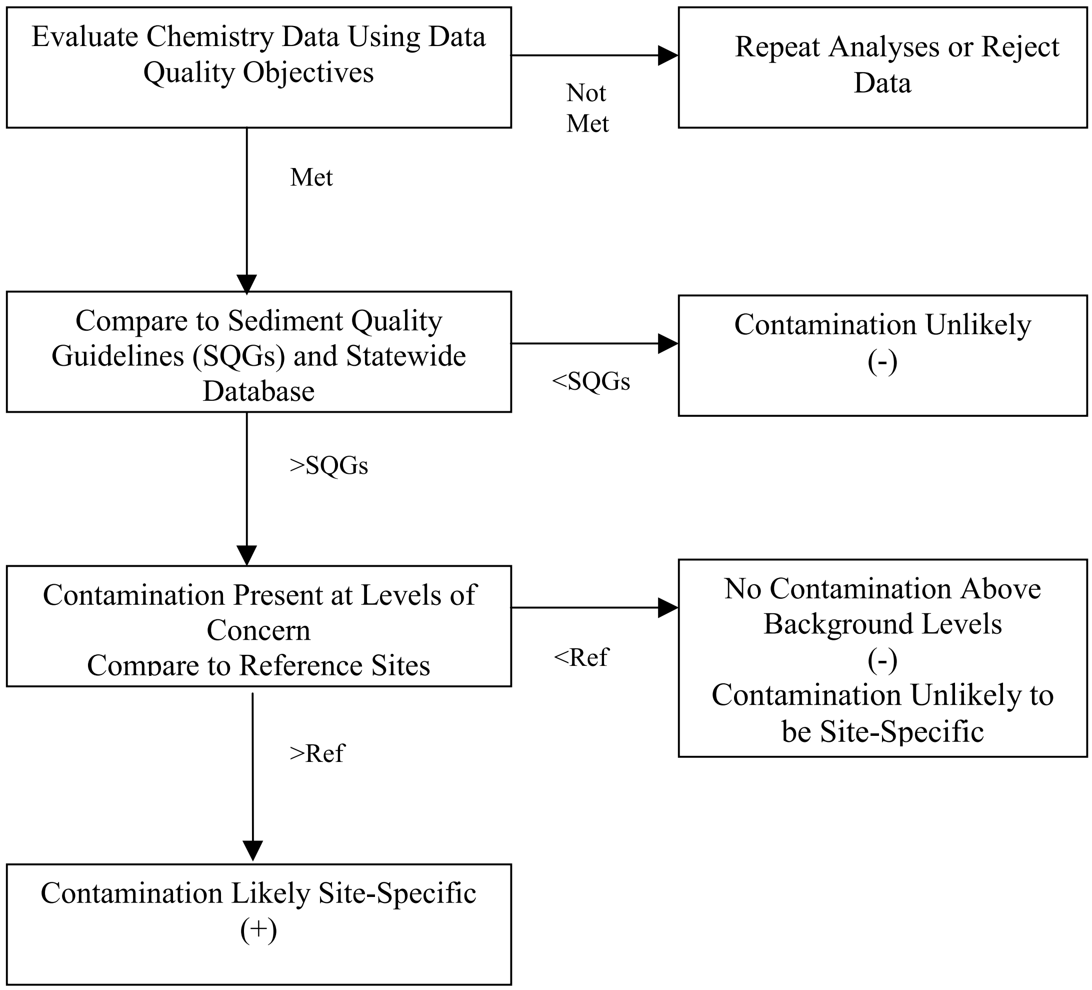


Figure 4-1. Procedure for assessing sediment chemistry data. Symbols in parentheses indicate the classification of the station as either contaminated (+) or uncontaminated (-) relative to the potential for impacts on aquatic organisms or humans.

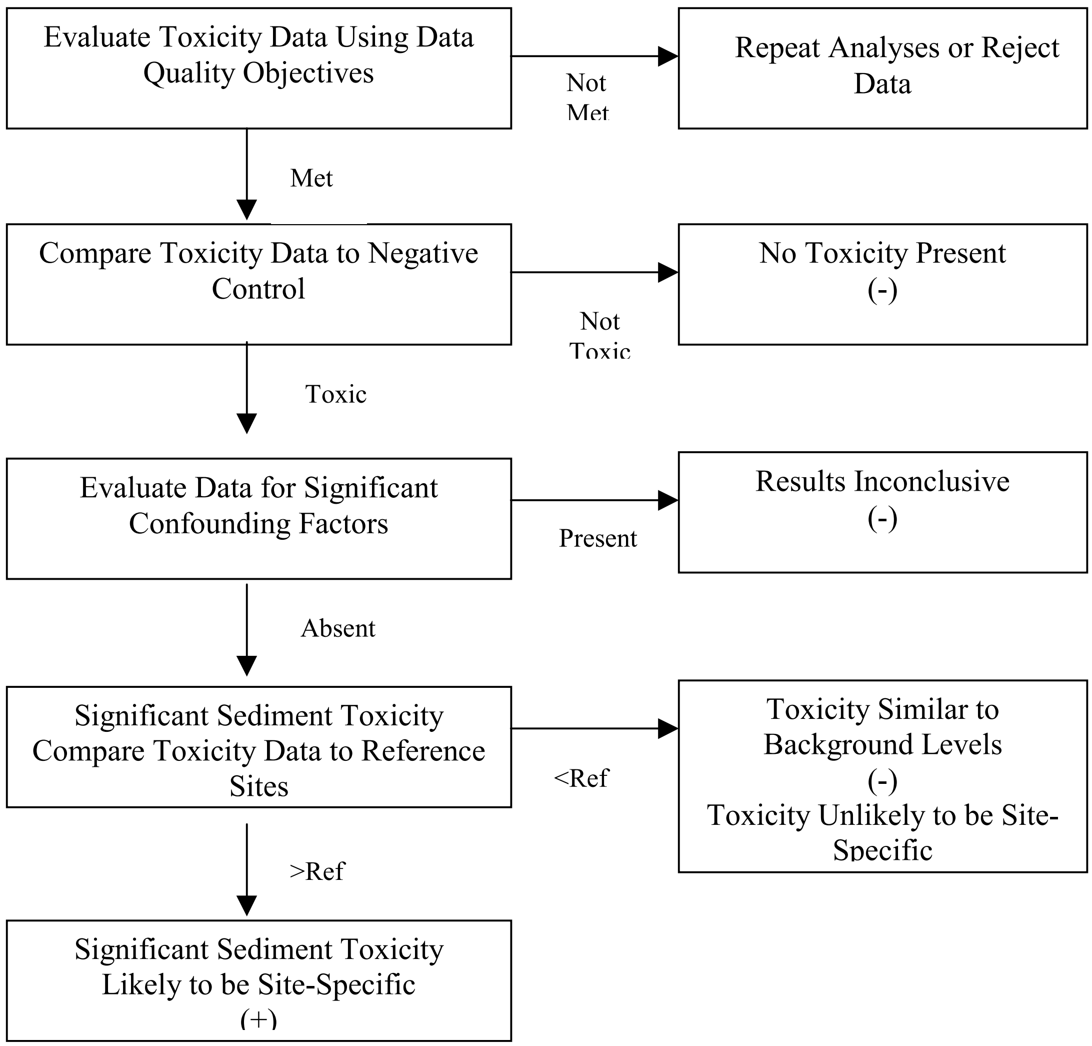


Figure 4-2. Procedure for assessing sediment toxicity data. Symbols in parentheses indicate the classification of the station as either impacted (+) or unimpacted (-) relative to the potential for effects on aquatic organisms.

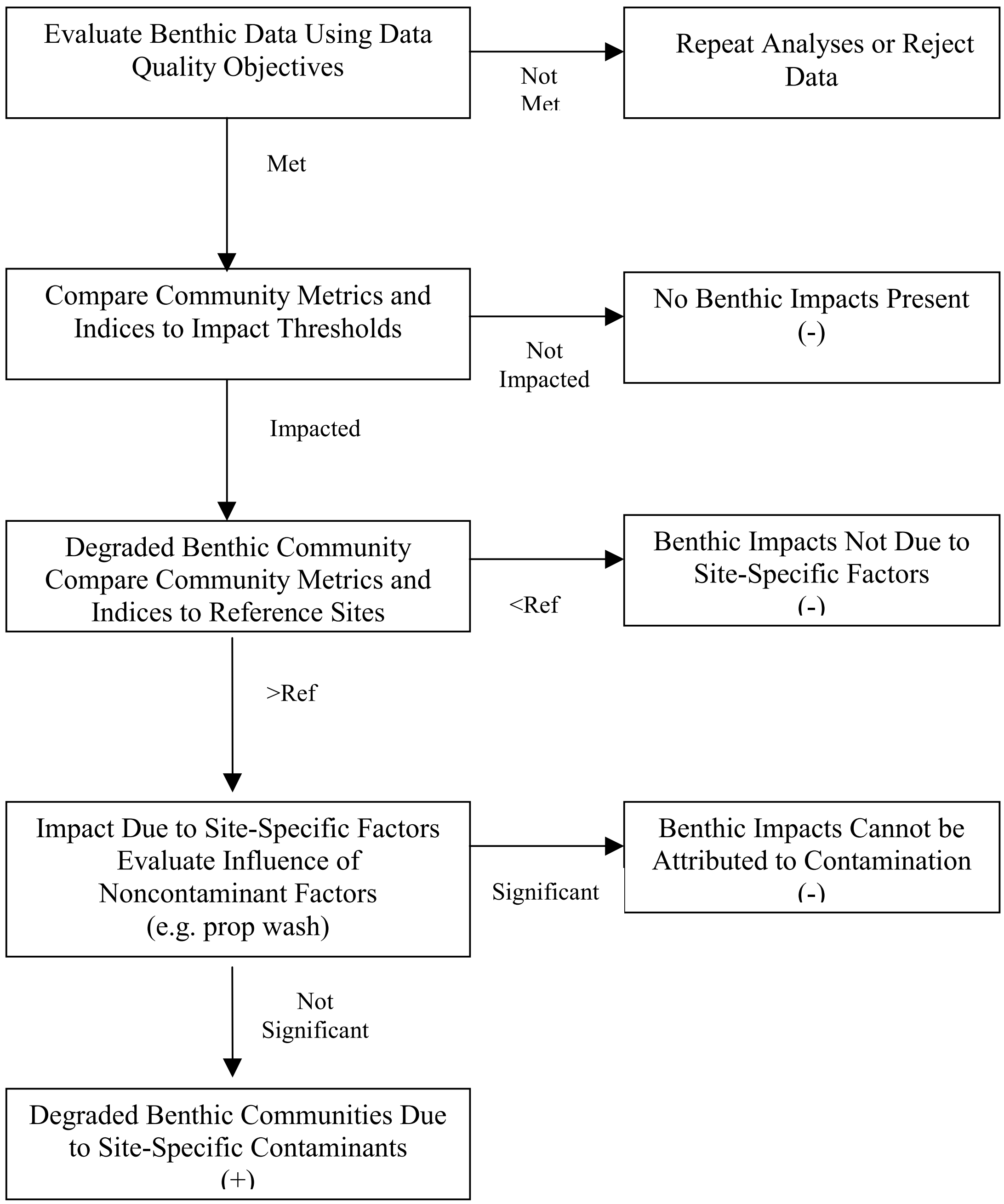


Figure 4-3. Procedure for assessing benthic community data. Symbols in parentheses indicate the classification of the station as either impacted (+) or unimpacted (-) relative to the presence of benthic degradation.

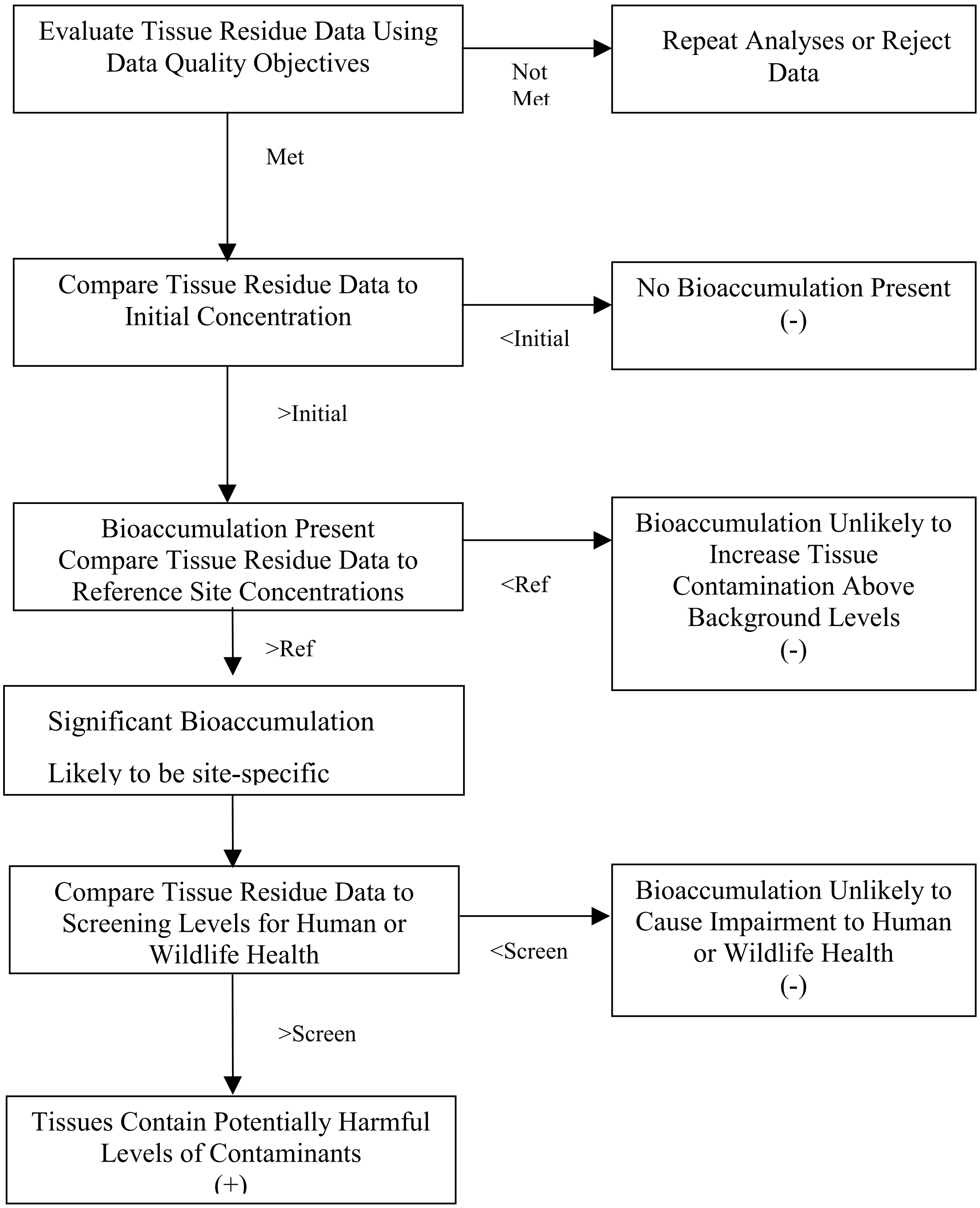


Figure 4-4. Procedure for assessing bioaccumulation data. Symbols in parentheses indicate the classification of the station as either impacted (+) or unimpacted (-) relative to the presence of bioaccumulation.

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# 6.0 APPENDICES

## 6.1 APPENDIX 1.

Constituents that will be measured in marine sediments for spatial assessment studies in San Diego Bay.

| GENERAL CONSTITUENTS | | PCB Congeners[a] |
|---|---|---|
| Sediment grain size | | *MDL = 0.01-1 (ng/g dry wt.)* |
| Total organic carbon | | |
| | | |
| **Metals** | | CHORINATED PESTICIDES |
| *MDL = 0.1 (ug/g dry wt.) except Cd, Ag, Hg = 0.02* | | *MDL = 0.1-2 (ng/g dry wt.)* |
| Aluminum | | 4,4'-DDT |
| Antimony | | 2,4'-DDT |
| Arsenic | | 4,4'-DDD |
| Barium | | 2,4'-DDD |
| Beryllium | | 4,4'-DDE |
| Cadmium | | 2,4'-DDE |
| Chromium | | Dieldrin |
| Copper | | Cis & trans-Chlordane; Oxychlordane |
| Iron | | Cis & trans Nonachlor |
| Lead | | **PAHs** |
| Mercury | | *MDL = 0.7-2.8 (ng/g dry wt.)* |
| Nickel | | Acenaphthene |
| Selenium | | Acenaphthylene |
| Silver | | Anthracene |
| Zinc | | Benz[a]anthracene |
| | | Benzo[a]pyrene |
| | | Benzo[b]fluoranthene |
| | | Benzo[e]pyrene |
| | | Benzo[g,h,i]perylene |
| | | Benzo[k]fluoranthene |
| | | Biphenyl |
| | | Chrysene |
| | | Dibenz[a,h]anthracene |
| | | Fluoranthene |
| | | Fluorene |
| | | Indeno(1,2,3-c,d)pyrene |
| | | Naphthalene |
| | | Perylene |
| | | Phenanthrene |
| | | Pyrene |
| | | 2,6-Dimethylnaphthalene |
| | | 1-Methylnapthalene |
| | | 2-Methylnapthalene |
| | | 1-Methylphenanthrene |
| | | 1,6,7-Trimethylnaphthalene |

[a]Congeners 18, 28, 37, 44, 49, 52, 66, 70, 74, 77, 81, 87, 99, 101, 105, 110, 114, 118, 119, 123, 126, 128, 138, 149, 151, 153, 156, 157, 158, 167, 168, 169, 170, 177, 180, 183, 187, 189, 194, 201, 206.

## 6.2 APPENDIX 2

List of station locations for B Street/Broadway Piers, Downtown Anchorage area, and Switzer Creek study areas and reference sites.

B Street/Broadway Piers

| Station | Longitude | Latitude |
|---|---|---|
| D01 | -117°10.409’ | 32°42.998’ |
| D02 | -117°10.416’ | 32°49.977’ |
| D03 | -117°10.409’ | 32°429.62’ |
| D04 | -117°10.492’ | 32°43.003’ |
| D05 | -117°10.488’ | 32°42.986’ |
| D06 | -117°10.488’ | 32°42.959’ |
| D07 | -117°10.597’ | 32°43.002’ |
| D08 | -117°10.597’ | 32°42.981’ |
| D09 | -117°10.597’ | 32°42.958’ |
| D10 | -117°10.672’ | 32°42.954’ |
| D11 | -117°10.675’ | 32°42.910’ |
| D12 | -117°10.603’ | 32°42.910’ |

**Downtown Anchorage**

| Station | Longitude | Latitude |
|---|---|---|
| G01 | | |
| G02 | | |
| G03 | | |
| G04 | | |
| G05 | | |
| G06 | | |
| G07 | | |
| G08 | | |
| G09 | | |

**Switzer Creek**

| Station | Longitude | Latitude |
|---|---|---|
| S01 | -117°09.479’ | 32°42.111’ |
| S02 | -117°09.528’ | 32°42.009’ |
| S03 | -117°09.569’ | 32°42.085’ |
| S04 | -117°09.493’ | 32°42.126’ |
| S05 | -117°09.535’ | 32°42.114’ |
| S06 | -117°09.583’ | 32°42.096’ |

**Reference**

| Station | Longitude | Latitude |
|---|---|---|
| 2433 | -117.20.92 | 32.72.24 |
| 2238 | -117.12.87 | 32.62.54 |
| 2243 | -117.14.27 | 32.66.45 |
| 2240 | -117.15.41 | 32.66.75 |
| BPTCP 90053 | -117.07.84 | 32.37.70 |
| BPTCP 93195 | -117.10.17 | 32.40.67 |

## 6.3 TOXICITY IENTIFICATION EVALUATION PROCEDURES

## 6.3 Toxicity Identification Evaluation Decision Tree

Initial toxicity test (amphipods, bivalves, sea urchins)

Sample is toxic?

No → Resample - Retest

Test for aqueous-phase toxicity and solid-phase toxicity

Toxicity equal in both phases?

Yes

No - Toxicity Greater Solid-phase

Solid-Phase TIE

(see next page)

Proceed to Aqueous Sample Phase I TIE

(after EPA 1996)

| TIE Treatment | Target Toxicants |
|---|---|
| Initial Test | Determines sample toxicity |
| Baseline Test | Confirms toxicity during TIE |
| Centrifugation | Removes particulates |
| Aeration | Reduces volatiles (e.g., $H_2S$, BTEX) |
| EDTA | Binds divalent cations |
| Sodium Thio. | Neutralizes oxidants, binds some metals |
| C18 Column | Removes non-polar compounds |
| C18 Eluate | Returns non-polar compounds to solution |
| Aerat./Column | Removes mixtures of non-polars and volatiles |
| Column/EDTA | Removes mixtures of non-polars and metals |
| Pip. Butox. | Blocks oraganophosphate pest. Metabolism, potentiates pyrethroids |
| pH 7 | Affects bioavailability of metals, organics, ammonia |
| pH 8 | Affects bioavailability of metals, organics, ammonia |
| pH 9 | Affects bioavailability of metals, organics, ammonia |
| Cation Ex. Col. | Binds divalent cations |
| Cation Eluate | Returns divalent cations to solution |

Toxicity Reduced?

Yes

Phase II TIE

based on Phase I

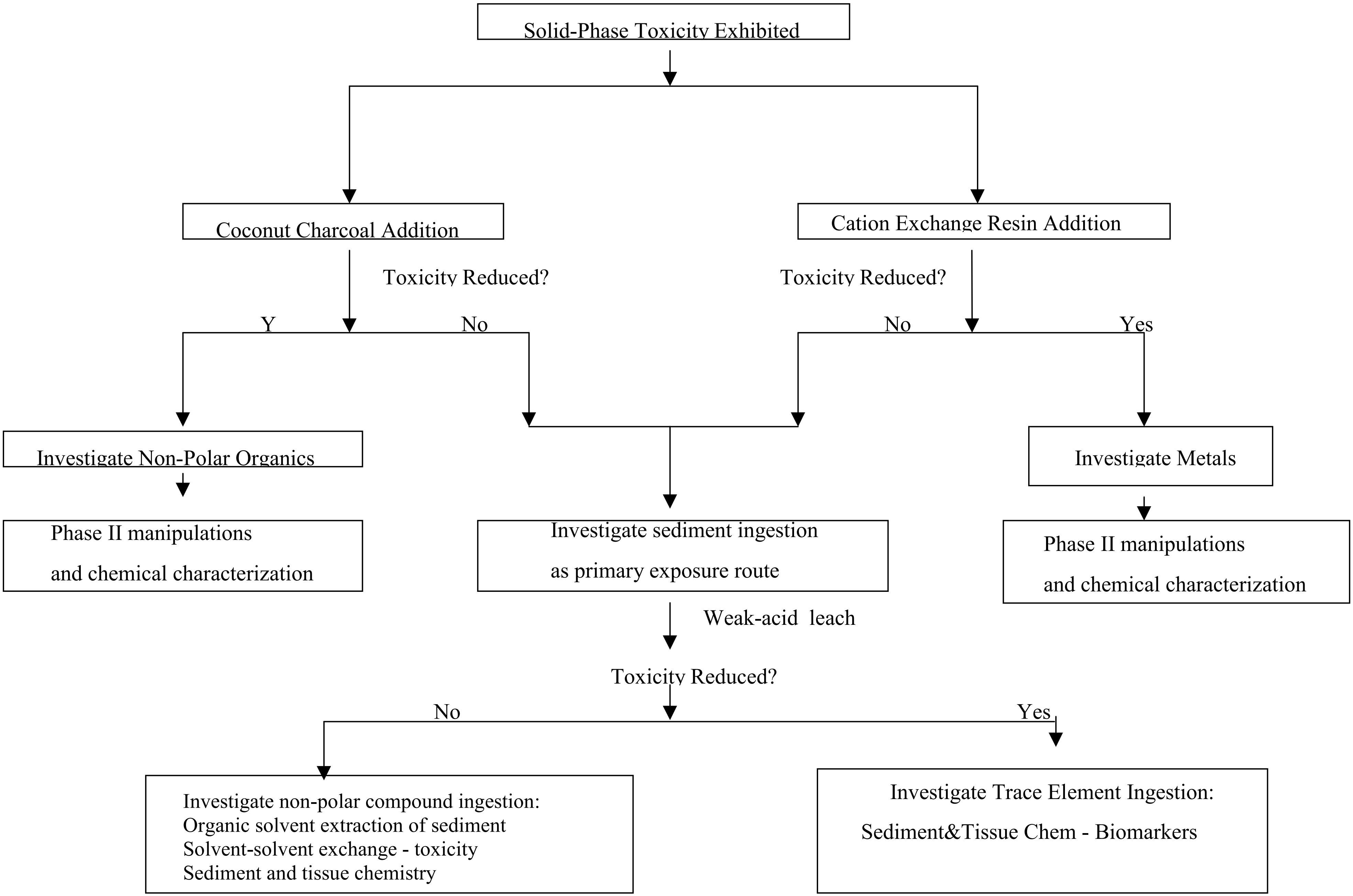
results

N

1. Try combination treatments to investigate multiple toxicants

## Toxicity Identification Evaluation Decision Tree - Solid Phase TIE

## (Conducted when sample exhibits greater solid-phase toxicity than aqueous-phase toxicity)



## 6.4 PROJECT TASKS AND DELIVERABLES TIMELINE

FY 2003 – 2004 (Spatial Extent and Magnitude of Contamination and Bioeffects)

| Task Completed | Sites | May03 | June03 | July03 | Nov 03 | Dec 03 | Jan 04 | Feb 03 | Mar 03 | April 04 | May 04 | June 04 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tox Tested | DwTn Piers<br>Grape St<br>Switzer | | X | | | | | | | | | |
| Chem Sampled | | | X | | | | | | | | | |
| Benthos Sampled | | | X | | | | | | | | | |
| Bioaccum Tested | | | X | | | | | | | | | |
| TIE | | | X | X | | | | | | | | |
| Data analysis | | | | | | | | | | | | |
| Progress Report | | | | X | | | X | | | X | | |
| | | | | | | | | | | | | |

FY 2003 – 2004 (Spatial Extent and Magnitude of Contamination and Bioeffects)

| Task Completed | Sites | July 04 | Aug 04 | Sept 04 | Oct 04 | Nov 04 | Dec 04 | Jan 05 | Feb 05 | Mar 05 | April 05 | May 05 | June 05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tox Analyzed | DwTn Piers Grape St Switzer | | X | | | | | | | | | | |
| Chem Analyzed | | | | | | X | | | | | | | |
| Benthos Analyzed | | | | | | X | | | | | | | |
| Bioaccum Analyzed | | | | | | X | | | | | | | |
| Data analysis | | | | | | X | X | X | | | | | |
| Progress Report | | X | | | | | | X | | | | | |
| Draft Final Report | | | | | | | | | | | | X | |
| Final Report | | | | | | | | | | | | | X |