Executive Summary

This report, *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States*, describes the accumulation of chemical contaminants in river, lake, ocean, and estuary bottoms and includes a screening assessment of the potential for associated adverse effects on human and environmental health. The United States Environmental Protection Agency (EPA) prepared this report to Congress in response to requirements set forth in the Water Resources Development Act (WRDA) of 1992, which directed EPA, in consultation with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers (USACE), to conduct a comprehensive national survey of data regarding the quality of aquatic sediments in the United States. The Act required EPA to compile all existing information on the quantity, chemical and physical composition, and geographic location of pollutants in aquatic sediment, including the probable source of such pollutants and identification of those sediments which are contaminated. The Act further required EPA to report to the Congress the findings, conclusions, and recommendations of such survey, including recommendations for actions necessary to prevent contamination of aquatic sediments and to control sources of contamination. The Act also requires EPA to establish a comprehensive and continuing program to assess aquatic sediment quality. As part of this continuing program, EPA must submit a national sediment quality report to Congress every 2 years.

To comply with the WRDA mandate, EPA's Office of Science and Technology (OST) initiated the National Sediment Inventory (NSI). The NSI is a compilation of existing sediment quality data; protocols used to evaluate the data; and various reports and analyses produced to present the findings, conclusions, and recommendations for action. EPA produced this first report to Congress in four volumes:

- **Volume 1: *National Sediment Quality Survey*—**Screening analysis to qualitatively assess the probability of associated adverse human or ecological effects based on a weight-of-evidence evaluation

- **Volume 2: *Data Summaries for Areas of Probable Concern (APCs)***—Sampling station location maps and chemical and biological summary data for watersheds containing APCs

- **Volume 3: *National Sediment Contaminant Point Source Inventory*—**Screening analysis to identify probable point source contributors of sediment pollutants

- **Volume 4: *National Sediment Contaminant Nonpoint Source Inventory***—Screening analysis to identify probable nonpoint source contributors of sediment pollutants (in preparation for subsequent biennial reports)

EPA prepared Volume I, the *National Sediment Quality Survey*, to provide a national baseline screening-level assessment of contaminated sediment over a time period of the past 15 years. To accomplish this objective, EPA applied assessment protocols to existing available data in a uniform fashion. EPA intended to accurately depict and characterize the incidence and severity of sediment contamination based on the *probability* of adverse effects to human health and the environment. The process has demonstrated the use of "weight-of-evidence" measures (including measures of the bioavailability of toxic chemicals) in sediment quality assessment. Information contained in this volume may be used to further investigate sediment contamination on a national, regional, and site-specific scale. Further studies may involve toxicological investigations, risk assessment, analyses of temporal and spatial trends, feasibility of natural recovery, and source control.

The *National Sediment Quality Survey* is the first comprehensive EPA analysis of sediment chemistry and related biological data to assess what is known about the national incidence and severity of sediment contamination. This volume presents a screening-level identification of sampling stations in several areas across the country where sediment is contaminated at levels suggesting an increased probability of adverse effects on aquatic life and human health. Based on the number and percentage of sampling stations containing contaminated sediment within watershed boundaries, EPA identified a number of watersheds containing areas of probable concern where additional studies may be needed to draw conclusions regarding adverse effects and the need for actions to reduce risks.

In addition to this and future reports to Congress, EPA anticipates that products generated through the NSI will provide managers at the federal, state, and local levels with information. Many of the NSI data were obtained by local watershed managers from monitoring programs targeted toward areas of known or suspected contamination. NSI data and evaluation results can assist local watershed managers by providing additional data that they may not have, demonstrating the application of a weight-of-evidence approach for identifying and screening contaminated sediment locations, and allowing researchers to draw upon a large data set of information to conduct new analyses that ultimately will be relevant for local assessments.

Description of the NSI Database

The NSI is the largest set of sediment chemistry and related biological data ever compiled by EPA. It includes approximately two million records for more than 21,000 monitoring stations across the country. To efficiently collect usable information for inclusion in the NSI, EPA sought data that were available in electronic format, represented broad geographic coverage, and represented specific sampling locations identified by latitude and longitude coordinates. The minimum data requirements for inclusion of computerized data in the NSI were monitoring program, sampling date, latitude and longitude coordinates, and measured units. Additional data fields such as sampling method and other quality assurance/quality control information were retained in the NSI if available, but were not required for a data set to be included in the NSI.

The NSI includes data from the following data storage systems and monitoring programs:

- Selected data from EPA's Storage and Retrieval System (STORET)
- NOAA's Coastal Sediment Inventory (COSED)
- EPA's Ocean Data Evaluation System (ODES)
- EPA Region 4's Sediment Quality Inventory
- Gulf of Mexico Program's Contaminated Sediment Inventory
- EPA Region 10/USACE Seattle District's Sediment Inventory
- EPA Region 9's Dredged Material Tracking System (DMATS)
- EPA's Great Lakes Sediment Inventory
- EPA's Environmental Monitoring and Assessment Program (EMAP)
- United States Geological Survey (Massachusetts Bay) Data

In addition to sediment chemistry data, the NSI includes tissue residue, toxicity, benthic abundance, histopathology, and fish abundance data. The sediment chemistry, tissue residue, and toxicity data were evaluated for this report to Congress. Data from 1980 to 1993 were used in the NSI data evaluation, but older data also are maintained in the NSI.

Evaluation Approach

The WRDA defines contaminated sediment as aquatic sediment that contains chemical substances in excess of appropriate geochemical, toxicological, or sediment quality criteria or measures; or is otherwise considered to pose a threat to human health or the environment. The approach used to evaluate the NSI data focuses on the risk to benthic organisms exposed directly to contaminated sediments, and the risk to human consumers of organisms exposed to sediment contaminants. EPA evaluated sediment chemistry data, chemical residue levels in edible tissue of aquatic organisms, and sediment toxicity data taken at the same sampling station (where available) using a variety of assessment methods.

The following measurement parameters and techniques were used alone or in combination to evaluate the probability of adverse effects:

Aquatic Life

(1) Comparison of sediment chemistry measurements to sediment chemistry screening values

- Draft sediment quality criteria (SQCs)
- Sediment quality advisory levels (SQALs)
- Effects range-median (ERM) and effects range-low (ERL) values

- Probable effects levels (PELs) and threshold effects levels (TELs)
- Apparent effects thresholds (AETs)

(2) Comparison of the molar concentration of acid volatile sulfides ([AVS]) in sediment to the molar concentration of simultaneously extracted metals ([SEM]) in sediment (under equilibrium conditions, sediment with [EVS] greater than [SEM] will not demonstrate toxicity from metals)

(3) Lethality based on sediment toxicity data

Human Health

(4) Comparison of theoretical bioaccumulation potential (TBP) of measured sediment contaminants to:

- EPA cancer and noncancer risk levels
- Food and Drug Administration (FDA) tolerance, action, or guidance values

(5) Comparison of fish tissue contaminant levels to

- EPA cancer and noncancer risk levels
- FDA tolerance, action, or guidance values

The sediment chemistry screening values used in this report are not regulatory criteria, site-specific cleanup standards, or remediation goals. Sediment chemistry screening values are reference values above which a sediment ecotoxicological assessment might indicate a potential threat to aquatic life. For example, independent analyses of matching chemistry and bioassay data reveal that ERL/ERMs and TEL/PELs frequently classify samples correctly either as nontoxic when chemical concentrations are lower than all these values or as toxic when concentrations exceed these values. (See Appendix B.) The sediment chemistry screening values include both theoretically and empirically derived values. The theoretically derived screening values (e.g., SQC, SQAL, [SEM]-[AVS]) rely on the physical/chemical properties of sediment and chemicals to predict the level of contamination that would not cause an adverse effect on aquatic life under equilibrium conditions in sediment. The empirically derived, or correlative, screening values (e.g., ERM/ERL, PEL/TEL, AET) rely on paired field and laboratory data to relate incidence of observed biological effects to the dry-weight sediment concentration of a specific chemical. Correlative screening values can relate measured concentration to a probability of association with adverse effects, but do not establish cause and effect for a specific chemical. Toxicity data were used to classify sediment sampling stations based on their demonstrated lethality to aquatic life in laboratory bioassays.

Under an assumed exposure scenario, theoretical bioaccumulation potential (TBP) and tissue residue data can indicate potential adverse effects on humans from the consumption of fish that become contaminated through exposure to contaminated sediment. TBP is an estimate of the equilibrium concentration (concentration that does not change with time) of a contaminant in tissues of aquatic organisms if the sediment in question were the only source of contamination to the organism. At present, the TBP calculation can be performed only for nonpolar organic chemicals. The TBP is estimated from the concentration of contaminant in the sediment, the organic carbon content of the sediment, the lipid content of the organism, and the relative affinity of the chemical for sediment organic carbon and animal lipid content. This relative affinity is measured in the field and is called a biota-sediment accumulation factor (BSAF, as discussed in detail in Appendix C). In practice, field measured BSAFs can vary by an order of magnitude or greater for individual compounds depending on location and time of measurement. For this evaluation, EPA selected BSAFs that represents the central tendency, suggesting an approximate 50 percent chance that an associated tissue residue level would exceed a screening risk value.

Uncertainty is associated with site-specific measures, assessment techniques, exposure scenarios, and default parameter selections. Many mitigating biological, chemical, hydrological, and habitat factors may affect whether sediment poses a threat to aquatic life or human health. Because of the limitations of the available sediment quality measures and assessment methods, EPA characterizes this evaluation as a screening-level analysis. Similar to a potential human illness screen, a screening-level analysis should pick up potential problems and note them for further study. A screening-level analysis will typically identify many potential problems that prove not to be significant upon further analysis. Thus, classification of sampling stations in this analysis is not meant to be definitive, but is intended to be inclusive of potential problems arising from persistent metal and organic chemical contaminants. For this reason, EPA elected to evaluate data collected from 1980 to 1993 and to evaluate each chemical or biological measurement taken at a given sampling station individually. A single measurement of a chemical at a sampling station, taken at any point in time over the past 15 years, may have been sufficient to categorize the sampling station as having an increased probability of association with adverse effects on aquatic life or human health.

In this report, EPA associates sampling stations with their “probability of adverse effects.” Each sampling station falls into one of three categories, or tiers:

- Tier 1: associated adverse effects are probable
- Tier 2: associated adverse effects are possible, but expected infrequently
- Tier 3: no indication of associated adverse effects (any sampling station not classified as Tier 1 or Tier 2; includes sampling stations for which substantial data were available, as well as sampling stations for which limited data were available).

The potential risk of adverse effects on aquatic life and human health is greatest in areas with a multitude of contaminated locations. The assessment of individual sampling stations is useful for estimating the number and distribution of contaminated spots and overall magnitude of sediment contamination in monitored waterbodies of the United States. However, a single “hot spot” might not pose a great threat to either the benthic community at large or consumers of resident fish because the spatial extent of exposure could be small. On the other hand, if many contaminated spots are located in close proximity, the spatial extent and probability of exposure are much greater. EPA examined sampling station classifications within watersheds to identify areas of probable concern for sediment contamination (APCs), where the exposure of benthic organisms and resident fish to contaminated sediment might be more frequent. In this report, EPA defines watersheds by 8-digit United States Geological Survey (USGS) hydrologic unit codes, which are roughly the size of a county. Watersheds containing APCs are those in which 10 or more sampling stations were classified as Tier 1, and in which at least 75 percent of all sampling stations were categorized as either Tier 1 or Tier 2.

The definition of "area of probable concern" was developed for this report to identify watersheds for which further study of the effects and sources of sediment contamination, and possible risk reduction needs, would be warranted. Where data have been generated through intensive sampling in areas of known or suspected contamination within a watershed, the APC definition should identify watersheds which contain even relatively small areas that are considerably contaminated. However, this designation does not imply that sediment throughout the entire watershed, which is typically very large compared to the extent of available sampling data, is contaminated. On the other hand, where data have been generated through comprehensive sampling, or where sampling stations were selected randomly or evenly distributed throughout a sampling grid, the APC definition might not identify watersheds that contain small or sporadically contaminated areas. A comprehensively surveyed watershed of the size typically delineated by a USGS cataloging unit might contain small but significant areas that are considerably contaminated, but might be too large in total area for 75 percent of all sampling stations to be classified as Tier 1 or Tier 2. Limited random or evenly distributed sampling within such a watershed also might not yield 10 Tier 1 sampling stations. Thus, the process used to identify watersheds containing APCs may both include some watersheds with limited areas of contamination and omit some watersheds with significant contamination. However, given available data EPA believes it represents a reasonable screening analysis to identify watersheds where further study is warranted.

Strengths and Limitations

For this report to Congress, EPA has compiled the most extensive database of sediment quality information currently available in electronic format. To evaluate these data, EPA has applied sediment assessment techniques in a weight-of-evidence approach recommended by national experts. The process to produce this report to Congress has engaged a broad array of government, industry, academic, and professional experts and stakeholders in development and review stages. The evaluation approach uses sediment chemistry, tissue residue, and toxicity test results. The assessment tools employed in this analysis have been applied in North America, with results published in peer-reviewed literature. Toxicity test data were generated using established standard methods employed by multiple federal agencies. The evaluation approach addresses potential impacts on both aquatic life and human health. Some chemicals pose a greater risk to human health than to aquatic life; for others, the reverse is true. By evaluating both potential human health and aquatic life impacts, EPA has ensured that the most sensitive endpoint is used to assess environmental impacts.

Two general types of limitations are associated with this report to Congress—limitations of the compiled data and limitations of the evaluation approach. Limitations of the compiled data include the mixture of data sets derived from different sampling strategies, incomplete sampling coverage, the age and quality of data, and the lack of measurements of important assessment parameters. Limitations of the evaluation approach include uncertainties in the interpretive tools to assess sediment quality, lack of quantitative risk assessment that consideres exposure potentials as well as contamination (e.g., fish consumption rates within APCs for human health risk), and the subsequent difficulties in interpreting assessment results.

These limitations and uncertainties are discussed in detail in Chapter 5 of this volume under "Limitations of the NSI Data Evaluation."

Data compiled for this report were generated using a number of different sampling strategies. Component sources contain data derived from different spatial sampling plans, sampling methods, and analytical methods. Most of the NSI data were compiled from nonrandom monitoring programs. Such monitoring programs focus their sampling efforts on areas where contamination is known or suspected to occur. Reliance on these data is consistent with the stated objective of this survey: to identify those sediments which are contaminated. However, one cannot accurately make inferences regarding the overall condition of the Nation's sediment, or characterize the "percent contamination," using the data in the NSI because uncontaminated areas are most likely substantially underrepresented.

Because this analysis is based only on readily available electronically formatted data, contamination problems exist at some locations where data are lacking. Conversely, older data might not accurately represent current sediment contamination conditions. The reliance on readily available electronic data has undoubtedly excluded a vast amount of information available from sources such as local and state governments and published academic studies. In addition, some data in the NSI were not evaluated because of questions concerning data quality or because no locational information (latitude and longitude) was available. NSI data do not evenly represent all geographic regions in the United States, nor do the data represent a consistent set of monitored chemicals.

EPA recognizes that sediment is dynamic and that great temporal and spatial variability in sediment quality exists. Movement of sediment is highly temporal, and dependent upon the physical and biological processes at work in the watershed. Some deposits will redistribute while others will remain static unless disturbed by extreme events. Because the data analyzed in this report were collected over a relatively long period of time, conditions might have improved or worsened since the sediment was sampled. Consequently, this report does not definitively assess the current condition of sediments, but serves as a baseline for future assessments

The lack of data required to apply some important assessment parameters hampered EPA's efforts to determine the incidence and severity of sediment contamination. For example, the component databases contain a dearth of total organic carbon (TOC) and acid volatile sulfide (AVS) measurements relative to the abundance of contaminant concentration measurements in bulk sediment. TOC and AVS are essential pieces of information for interpreting the bioavailability, and subsequent toxicity, of nonpolar organic and metal contaminants, respectively. In addition, matched sediment chemistry with toxicity tests, and matched sediment chemistry with tissue residue data, were typically lacking.

It is important to understand both the strengths and limitations of this analysis to appropriately interpret and use the information contained in this report. The limitations do not prevent intended uses, and future reports to Congress on sediment quality will contain less uncertainty. To ensure that future reports to Congress accurately reflect current knowledge concerning the conditions of the Nation's sediment as our knowledge and application of science evolve, the NSI will develop into a periodically updated, centralized assemblage of sediment quality measurements and state-of-the-art assessment techniques.

Findings

EPA evaluated more than 21,000 sampling stations nationwide as part of the NSI data evaluation. Of the sampling stations evaluated, 5,521 stations (26 percent) were classified as Tier 1, 10,401 (49 percent) were classified as Tier 2, and 5,174 (25 percent) were classified as Tier 3. This distribution suggests that state monitoring programs (accounting for the majority of NSI data) have been efficient and successful in focusing their sampling efforts on areas where contamination is known or suspected to occur. The frequency of Tier 1 classification based on all NSI data is greater than the frequency of Tier 1 classification based on data sets derived from purely random sampling.

The percentage of all NSI sampling stations where associated effects are "probable" or "possible but expected infrequently" (i.e., 26 percent in Tier 1 and 49 percent in Tier 2) does not represent the overall condition of sediment across the country: the overall extent of contaminated sediment is much less, as is the percentage of sampling stations where contamination is expected to actually exert adverse effects. For example, a reasonable estimate of the national extent of contamination leading to adverse effects to aquatic life is between 6 and 12 percent of sediment underlying surface waters (see Chapter 5 for expanded discussion of "extent of contamination"). This is primarily because most of the NSI data were obtained from monitoring programs targeted toward areas of known or suspected contamination (i.e., sampling stations were not randomly selected).

The NSI sampling stations were located in 6,744 individual river reaches (or water body segments) across the contiguous United States, or approximately 11 percent of all river reaches in the country (based on EPA's River Reach File 1). A river reach can be part of a coastal shoreline, a lake, or a length of stream between two major tributaries ranging from approximately 1 to 10 miles long. As depicted in Figure 1, approximately 4 percent of all river reaches in the contiguous United States had at least one station categorized as Tier 1, approximately 5 percent of reaches had at least one station categorized as Tier 2 (but none as Tier 1), and all of the sampling stations were classified as Tier 3 in about 2 percent of reaches.

Watersheds containing areas of probable concern for sediment contamination (APCs) are those that include at least 10 Tier 1 sampling stations and in which at least 75 percent of all sampling stations were classified as either Tier 1 or Tier 2. The NSI data evaluation identified 96 watersheds throughout the United States as containing APCs (Figure 2 and Table 1). (The map numbers listed on Table 1 correspond to the numbered watersheds identified in Figure 2.) These watersheds represent about 5 percent of all watersheds in the United States (96 of 2,111). APC designation could result from extensive sampling throughout a watershed, or from intensive sampling at a single contaminated location or a few contaminated locations. In comparison to the overall results presented on Figure 1, sampling stations are located on an average of 46 percent of reaches within watersheds containing APCs. On the average, 30 percent of reaches in watersheds containing APCs have at least one Tier 1 sampling station, and 13 percent have no Tier 1 sampling station but at least one Tier 2 sampling station. In many of these watersheds, the risk might be concentrated on certain water bodies or river reaches. Within the 96 watersheds containing APCs, 57 river reaches include 10 or more Tier 1 sampling stations. For more detailed information concerning individual watersheds containing APCs, please consult Volume 2 of this report.

The evaluation results indicate that sediment contamination associated with probable or possible but infrequent adverse effects exists for both aquatic life and human health. More sampling stations were categorized as either Tier 1 or Tier 2 for aquatic life concerns than for human health concerns. About 41 percent more sampling stations were classified as Tier 1 for aquatic life (3,287 stations) than for human health (2,327 stations). About 60 percent more sampling stations were categorized as Tier 2 for aquatic life (9,921 stations) than for human health (6,196 stations).

Recognizing the imprecise nature of some assessment parameters used in this report, Tier 1 sampling stations are distinguished from Tier 2 sampling stations based on the magnitude of a contaminant concentration in sediment, or the degree of corroboration among the different types of sediment quality measures. In response to uncertainty in both biological and chemical measures of sediment contamination, environmental managers must balance Type I errors (false positives: sediment classified as posing a threat that does not) with Type II errors (false negatives: sediment that poses a threat but was not classified as such). In screening analyses, the environmentally pro-tective approach is to minimize Type II errors, which leave toxic sediment unidentified. To achieve a balance and to direct attention to areas most likely to be associated with adverse effects, Tier 1 sampling stations are intended to have a high rate of "correct" classification (e.g., sediment definitely posing or definitely not posing a threat) and a balance between Type I and Type II errors. On the other hand, to retain a sufficient degree of environmental conservatism in screening, Tier 2 sampling stations are intended to have a very low number of false negatives in exchange for a large number of false positives.

To help judge the effectiveness of the evaluation approach described previously, EPA examined the agreement between matched sediment chemistry and toxicity test re-

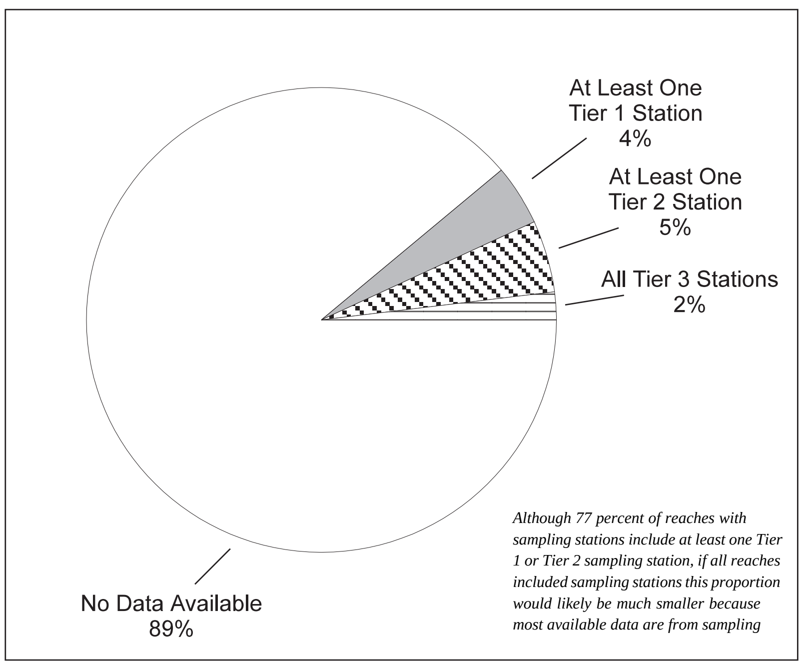

Figure 1. National Assessment: Percent of River Reaches That Include

Figure 2. Watersheds Containing Areas of Probable Concern for Sediment Contamination (APCs).

Table 1. USGS Cataloging Unit Number and Name for Watersheds Containing APCs.

Map #	Cataloging Unit Number	Cataloging Unit Name
1	1090001	Charles
2	1090002	Cape Cod
3	1090004	Narragansett
4	2030103	Hackensack-Passaic
5	2030104	Sandy Hook-Staten Island
6	2030105	Raritan
7	2030202	Southern Long Island
8	2040105	Middle Delaware-Musconetcong
9	2040202	Lower Delaware
10	2040203	Schuylkill
11	2040301	Mullica-Toms
12	2060003	Gunpowder-Patapsco
13	2070004	Conococheague-Opequon
14	3040201	Lower Pee Dee
15	3060101	Seneca
16	3060106	Middle Savannah
17	3080103	Lower St. Johns
18	3130002	Middle Chattahoochee-Lake Harding
19	3140102	Choctawhatchee Bay
20	3140107	Perdido Bay
21	3160205	Mobile Bay
22	4030102	Door-Kewaunee
23	4030108	Menominee
24	4030204	Lower Fox
25	4040001	Little Calumet-Galien
26	4040002	Pike-Root
27	4040003	Milwaukee
28	4050001	St. Joseph
29	4060103	Manistee
30	4090002	Lake St. Clair
31	4090004	Detroit
32	4100001	Ottawa-Stony
33	4100002	Raisin
34	4100010	Cedar-Portage
35	4100012	Huron-Vermillion
36	4110001	Black-Rocky
37	4110003	Ashtabula-Chagrin

Table 1. (Continued)

Map #	Cataloging Unit Number	Cataloging Unit Name
38	4120101	Chautauqua-Conneaut
39	4120103	Buffalo-Eighteenmile
40	4120104	Niagara
41	4130001	Oak Orchard-Twelvemile
42	4150301	Upper St. Lawrence
43	5030101	Upper Ohio
44	5030102	Shenango
45	5040001	Tuscarawas
46	5120109	Vermilion
47	5120111	Middle Wabash-Busseron
48	6010104	Holston
49	6010201	Watts Bar Lake
50	6010207	Lower Clinch
51	6020001	Middle Tennessee-Chickamauga
52	6020002	Hiwassee
53	6030001	Guntersville Lake
54	6030005	Pickwick Lake
55	6040001	Lower Tennessee-Beech
56	6040005	Kentucky Lake
57	7010206	Twin Cities
58	7040001	Rush-Vermillion
59	7040003	Buffalo-Whitewater
60	7070003	Castle Rock
61	7080101	Copperas-Duck
62	7090006	Kishwaukee
63	7120003	Chicago
64	7120004	Des Plaines
65	7120006	Upper Fox
66	7130001	Lower Illinois-Senachwine Lake
67	71401001	Cahokia-Joachim
68	7140106	Big Muddy
69	7140201	Upper Kaskaskia
70	7140202	Middle Kaskaskia
71	8010100	Lower Mississippi-Memphis
72	8030209	Deer-Steele
73	8040207	Lower Ouachita

Table 1. (Continued)

Map #	Cataloging Unit Number	Cataloging Unit Name
74	8080206	Lower Calcasieu
75	8090100	Lower Mississippi-New Orleans
76	10270104	Lower Kansas
77	11070207	Spring
78	11070209	Lower Neosho
79	12040104	Buffalo-San Jacinto
80	17010303	Coeur D'Alene Lake
81	17030003	Lower Yakima
82	17090012	Lower Willamette
83	17110002	Strait of Georgia
84	17110013	Duwamish
85	17110014	Puyallup
86	17110019	Puget Sound
87	18030012	Tulare-Buena Vista Lakes
88	18050003	Coyote
89	18050004	San Francisco Bay
90	18070104	Santa Monica Bay
91	18070105	Los Angeles
92	18070107	San Pedro Channel Islands
93	18070201	Seal Beach
94	18070204	Newport Bay
95	18070301	Aliso-San Onofre
96	18070304	San Diego

sults for the 805 sampling stations where both data types are available. The toxicity test data indicate whether significant lethality to indicator organisms occurs as a result of exposure to sediment. Tier 1 classification for aquatic life effects from sediment chemistry data correctly matched toxicity test results for about three-quarters of the sampling stations, with the remainder balanced between false positives (12 percent) and false negatives (14 percent). In contrast, when Tier 2 classifications from sediment chemistry data are added in, false negatives drop to less than 1 percent at the expense of false positives (increases to 68 percent) and correctly matched sampling stations (drops to 30 percent). This result highlights the fact, already discussed above, that classification in Tier 2 is very conservative, and it does not indicate a high probability of adverse effects to aquatic life. If bioassay test results for chronic toxicity endpoints were included in the NSI evaluation, the rate of false positives would likely decrease and correctly matched sampling stations would likely increase for both tiers.

Data related to more than 230 different chemicals or chemical groups were included in the NSI evaluation. Approximately 40 percent of these chemicals or chemical groups (97) were present at levels that resulted in classification of sampling stations as Tier 1 or Tier 2. The contaminants most frequently at levels in fish or sediment where associated adverse effects are probable include PCBs (58 percent of the 5,521 Tier 1 sampling stations) and mercury (20 percent of Tier 1 sampling stations). Pesticides, most notably DDT and metabolites at 15 percent of Tier 1 sampling stations, and polynuclear aromatic hydrocarbons (PAHs) such as pyrene at 8 percent of Tier 1 sampling stations, also were frequently at levels where associated adverse effects are probable.

Dry weight measures of divalent metals other than mercury (e.g., copper, cadmium, lead, nickel, and zinc) in sediment were not used to place a sampling station in Tier 1 without an associated measurement of acid volatile sulfide, a primary mediator of bioavailability for which data are not often available in the database. As a result, metals other than mercury (which also include arsenic, chromium, and silver) are solely responsible for only 6 percent of Tier 1 sampling stations and overlap with mercury or organic compounds at an additional 6 percent of Tier 1 sampling stations. In contrast, metals other than mercury are solely responsible for about 28 percent of the 15,922 Tier 1 and Tier 2 sampling stations and overlap with mercury or organic compounds at an additional 28 percent of Tier 1 and Tier 2 sampling stations. The remaining 44 percent of Tier 1 and Tier 2 sampling stations are classified solely for mercury or organic compounds.

Two important issues in interpreting the results of sampling station classification are naturally occurring "background" levels of chemicals and the effect of chemical mixtures. Site-specific naturally occurring (or background) levels of chemicals may be an important risk management consideration in examining sampling station classification. This is most often an issue for naturally occurring chemicals such as metals and PAHs. In addition, although the sediment chemistry screening levels for individual chemicals are used as indicators of potential adverse biological effects, other co-occurring chemicals (which may or may not be measured) can cause or contribute to observed adverse effects at specific locations.

Because PCBs were the contaminants most often responsible for Tier 1 classifications in the NSI evaluation, and because EPA took a precautionary approach (described in Chapter 2) in evaluating the effects of PCB exposure, the Agency conducted two separate analyses of PCB data to determine the impact of the precautionary approach on the overall classification of NSI sampling stations. EPA first examined the effect of excluding PCBs entirely from the NSI evaluation. If PCBs were excluded, the number of Tier 1 stations would be reduced by 42 percent, from 5,521 to 3,209 stations. The number of Tier 2 stations would be increased by 18 percent, from 10,401 to 11,957 stations. This increase reflects the movement of stations formerly classified as Tier 1 into Tier 2. In the second PCB evaluation, EPA evaluated the effect on the overall results of using a less precautionary noncancer screening value (rather than the cancer screening value) for predicting human health risk associated with PCB sediment contamination. When the noncancer screening value was used, the number of Tier 1 stations decreased by 12 percent, from 5,521 to 4,844 stations, and the number of Tier 2 stations increased by 4 percent, from 10,401 to 10,802 stations.

Conclusions and Recommendations

The characteristics of the NSI data, as well as the degree of certainty afforded by available assessment tools, allow neither an absolute determination of adverse effects on human health or the environment at any location, nor a determination of the areal extent of contamination on a national scale. However, the evaluation results strongly suggest that sediment contamination may be significant enough to pose potential risks to aquatic life and human health in some locations. The evaluation methodology was designed for the purpose of a screening-level assessment of sediment quality; further evaluation would be required to confirm that sediment contamination poses actual risks to aquatic life or human health for any given sampling station or watershed.

EPA's evaluation of the NSI data was the most geographically extensive investigation of sediment contamination ever performed in the United States. The evaluation was based on procedures to address the probability of adverse effects on aquatic life and human health. Based on the evaluation, sediment contamination exists at levels where associated adverse effects are probable (Tier 1) in some locations within each region and state of the country. The water bodies affected include streams, lakes, harbors, nearshore areas, and oceans. At the Tier 1 level, PCBs, mercury, organochlorine pesticides, and PAHs are the most frequent chemical indicators of sediment contamination.

The results of the NSI data evaluation must be interpreted in the context of data availability. Many states and EPA Regions appear to have a much greater incidence of sediment contamination than others. To some degree, this appearance reflects the relative abundance of readily available electronic data, not necessarily the relative incidence of sediment contamination.

Although the APCs were selected by means of a screening exercise, EPA believes that they represent the highest priority for further ecotoxicological assessments, risk analysis, temporal and spatial trend assessment, contaminant source evaluation, and management action because of the preponderance of evidence in these areas. Although the procedure for classifying APCs using multiple sampling stations was intended to minimize the probability of making an erroneous classification, further evaluation of conditions in watersheds containing APCs is necessary because the same mitigating factors that might reduce the probability of associated adverse effects at one sampling station might also affect neighboring sampling stations.

EPA chose the watershed as the unit of spatial analysis because many state and federal water and sediment quality management programs, as well as data acquisition efforts, are centered around this unit. This choice reflects the growing recognition that activities taking place in one part of a watershed can greatly affect other parts of the watershed, and that management efficiencies are achieved when viewing the watershed holistically. At the same time, the Agency recognizes that contamination in some reaches in a watershed does not necessarily indicate that the entire watershed is affected.

Watershed management is a vital component of community-based environmental protection. The Agency and its state and federal partners can address sediment contamination problems through watershed management approaches. Watershed management programs focus on hydrologically defined drainage basins rather than areas defined by political boundaries. Local management, stakeholder involvement, and holistic assessments of water quality are characteristics of the watershed approach. The National Estuary Program is one example of the watershed approach that has led to specific actions to address contaminated sediment problems. Specifically, the Narragansett (Rhode Island) Bay, Long Island Sound, New York/New Jersey Harbor, and San Francisco Bay Estuary Programs have all recommended actions to reduce sources of toxic contaminants to sediment. Numerous other examples of watershed management programs are summarized in *The Watershed Approach: 1993/94 Activity Report* (USEPA, 1994g) and *A Phase I Inventory of Current EPA Efforts to Protect Ecosystems* (USEPA, 1995b).

Available options for reducing health and environmental risks from contaminated sediment include physical removal and land disposal; subaqueous capping; *in situ* or *ex situ* biological, physical/chemical, or thermal treatment to destroy or remove contaminants; or natural recovery through continuing deposition of clean sediment. Assuming further investigation reveals the need for management attention to reduce risks, the preferred means depends on factors such as the degree and extent of contamination, the value of the resource, the cost of available options, likely human and ecological exposure, and the acceptable time period for recovery. If risk managers anticipate a lengthy period of time prior to recovery of the system, state and local authorities can consider options such as placing a fish consumption advisory on water bodies or portions of water bodies where a significant human health risk exists.

Some of the most significant sources of persistent and toxic chemicals have been eliminated or reduced as the result of environmental controls put into place during the past 10 to 20 years. For example, the commercial use of PCBs and the pesticides DDT and chlordane has been restricted or banned in the United States. In addition, effluent controls on industrial and municipal point source discharges and best management practices for the control of nonpoint sources have greatly reduced contaminant loadings to many of our rivers and streams.

The feasibility of natural recovery, as well as the long-term success of remediation projects, depends on the effective control of pollutant sources. Although most active sources of PCBs are controlled, past disposal and use continue to result in evaporation from some landfills and leaching from soils. The predominant continuing sources of organochlorine pesticides are runoff and atmospheric deposition from past applications on agricultural land. For other classes of sediment contaminants, active sources continue to contribute substantial environmental releases. For example, liberation of inorganic mercury from fuel burning and other incineration operations continues, as do urban runoff and atmospheric deposition of metals and PAHs. In addition, discharge limits for municipal and industrial point sources are based on either technology-based limits or state-adopted standards for protection of the water column, not necessarily for downstream protection of sediment quality. Determining the local and far-field effects of individual point and nonpoint sources on sediment quality usually requires site-specific in-depth study.

The primary recommendation of this report to Congress is to encourage further investigation and assessment of contaminated sediment. States, in cooperation with EPA and other federal agencies, should proceed with further evaluations of the 96 watersheds containing APCs. In many cases, it is likely that much additional investigation and assessment has already occurred, especially in well-known areas at risk for contamination, and some areas have been remediated. If active watershed management programs are in place, these evaluations should be coordinated within the context of current or planned actions. Future assessment efforts should focus on areas such as the 57 water body segments located within the 96 watersheds containing APCs that had 10 or more sampling stations classified as Tier 1. The purpose of these efforts should be to gather additional sediment chemistry and related biological data, and to conduct further evaluation of data to determine human health and ecological risk, to determine temporal and spatial trends, to identify potential sources of sediment contamination and determine whether potential sources are adequately controlled, and to determine whether natural recovery is a feasible option for risk reduction.

Other recommendations resulting from the NSI evaluation include the following:

- *Coordinate efforts to address sediment quality through watershed management programs.* Federal, state, and local government agencies should pool their resources and coordinate their efforts to address their common sediment contamination issues. These activities should support efforts such as the selection of future monitoring sites, the setting of priorities for reissuance of National Pollutant Discharge Elimination System (NPDES) permits and permit synchronization, pollutant trading between nonpoint and point sources, and total maximum daily load (TMDL) development.

- *Incorporate a weight-of-evidence approach and measures of chemical bioavailability into sediment monitoring programs.* Future monitoring programs should specify collection of AVS and SEM measurements where metals are a concern and site-specific total organic carbon (TOC) measurements where organic chemicals are a concern. Future sediment monitoring programs should also collect tissue residue, biological effects, and biological community measurements as well as sediment chemistry measurements.

- *Evaluate the NSI's coverage and capabilities and provide better access to information in the NSI.* EPA should consider whether to design future evaluations of NSI data to determine the temporal trends of contamination and to identify where and why conditions are improving or worsening. EPA should consider whether to expand the NSI to provide more complete national coverage of sediment quality data. EPA should also consider increasing the number of water bodies for evaluation and expanding the suite of biological and chemical information available to evaluate each site. EPA should continue its efforts to make the NSI data and evaluation results more accessible to other agencies and to the states.

- *Develop better monitoring and assessment tools.* EPA should continue to update the NSI evaluation methodology as new assessment tools become available and the state of the science evolves. In the context of the budget process, EPA and other federal agencies should evaluate whether to request funding to support the development of tools to better characterize the sources, fate, and effects of sediment contaminants.