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**PRELIMINARY CHARACTERIZATION OF WATER QUALITY  
OF THE MOBILE BAY NATIONAL ESTUARY PROGRAM  
(MBNEP) STUDY AREA**

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**Submitted to:**

**Mobile Bay National Estuary Program  
440 Fairhope Avenue  
Fairhope, Alabama 36532**

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**Prepared by:**

**Emery E. Baya, P.E.  
Lee S. Yokel, M.S.  
Carl A. Pinyerd, III, CPSS, CHMM  
Thompson Engineering Testing, Inc.  
P.O. Box 9637  
Mobile, AL 36691**

**Eldon C. Blancher, Ph.D.  
Susan A. Sklenar, M.S.  
TAI Environmental Sciences, Inc.  
1717 Old Shell Road  
Mobile, AL 36604-1323**

**Wayne C. Isphording, Ph.D.  
Department of Geology/Geography  
University of South Alabama  
Mobile, AL 36688**

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## **1.0 EXECUTIVE SUMMARY**

### ***Introduction***

The Mobile Bay National Estuary Program (MBNEP) contracted this study to compile, assess, and integrate known information sources and data sets related to water quality for the MBNEP area. This study has been performed parallel to corollary baseline characterization efforts for living resources and habitat loss, and in conjunction with development of an overall Data and Information Management System (DIMS) to support these efforts. The baseline studies are intended to ensure that: 1) the MBNEP characterization is focused on the highest priority information needs, and 2) that assessments are obtained on information gaps to properly evaluate the possible problems prior to delineation of the Comprehensive Conservation Management Plan (CCMP). Specific objectives of this Preliminary Characterization of Water Quality were identified as follows:

- Conduct a literature baseline survey of all existing water quality information for the MBNEP study area. Evaluate literature for similarity and/or redundancy.
- Identify and evaluate the existing water quality data sets for the MBNEP study area and comment on validity.
- Identify data gaps from the existing water quality data sets.
- Recommend additional water quality data collection and/or analysis for identified gaps and/or for parameters, areas, or problems incurred from nonexistent, lacking, or unreliable data/analysis.
- Produce a historical water quality data characterization summary.

To address these objectives, project team members from Thompson Engineering with TAI Environmental Sciences, and supported by Wayne C. Isphording, Ph.D., have striven to incorporate all known water quality information sources into a user-friendly format for assessing the current water quality of the Mobile Bay estuarine system. An electronic Information Record Database was established to catalog and manage the many diverse information resources that have been compiled from a comprehensive search of literature and data pertaining to water quality in the MBNEP area. This database is comprised of over 850 information records identifying existing data sets and information sources, and has been used by project team researchers to evaluate the water quality information and identify data gaps. The electronic database will be installed on the MBNEP computer system, and copies can be made on CD-ROM for distribution by MBNEP to interested parties. In the future, should MBNEP choose, this database can be maintained and updated, and be made accessible on the Internet.

### ***Description of Information Research and Database Development***

A comprehensive literature review and search for documents, studies and publications that relate to water quality for the Mobile Bay National Estuary Program (NEP) area was performed during the course of this study. This included both search and inquiry of existing publications at agencies as well as a computerized search of library holdings at selected university and research locations. The review included not only a search for written documents, reports and maps, but focused on obtaining electronic versions of documents and data. Search of the Internet for agency database holdings and accessibility was also a priority.

In order to compile and manage the data obtained in a useful form, a computerized database was developed for this project. Three major software systems were utilized in the course of this project; the Lotus Notes (Domino) system, ESRI's ArcView GIS software for spatial displays with QuadBase map images supported by Southern GIS, and Microsoft Office. The latter Microsoft software was used to maintain compatibility with the MBNEP data system currently under development. In addition, files attached to the Notes database use Adobe Acrobat and Netscape Navigator software. The Lotus Notes system was used as the main database and groupware engine.

Three databases, a Discussion Database, a Contact Database, and the Information/Record Database were prepared for this project to enter the various information collected during the course of the study. These databases were used to facilitate project coordination and compile information from previous studies to evaluate existing data for characterization of the various water quality issues pertaining to the MBNEP area.

The Information/Record Database is the primary database product of this study. It is the central repository of the collected documents and data. It contains the citations, abstracts, and other identification information for each record. It also contains the geographic references and attachments such as scanned documents, spreadsheets, databases and links to homepages on the Internet.

More detailed descriptions of the information research and database development are contained in Section 3 of the report and in supplemental Appendices I and II. Appendix V provides a complete bibliography of citations in the Information Record Database.

### ***Description of MBNEP Study Area***

Mobile Bay's local, regional, and national significance centers on its abundant natural resources which provide a wealth of recreational and commercial uses. The Mobile Bay and Delta are subjected to an unusually large number of major uses with national implications. These include the Tennessee-Tombigbee Waterway, Port of Mobile, fisheries, tourism and recreation, and coastal development. Local ecosystems have been subjected to increasing pressure from a variety of proliferating activities including commercial and recreational fishing, silviculture, oil and gas extraction, shipping and channel excavation, industrial construction and wastes, residential development,

municipal waste treatment discharges, and nonpoint source runoff (South Alabama Regional Planning Commission, 1995).

Located in the extreme southernmost segment of Alabama and at the terminus of the Mobile River Drainage Basin, the Mobile Bay National Estuary Program (MBNEP) area is entirely located within the State of Alabama and includes portions of two counties, Baldwin and Mobile (see Figures 4-1 and 4-2 in text). This area essentially comprises the local watersheds of these two counties that drain into Mobile Bay and Mississippi Sound, and the adjacent state waters of the Gulf of Mexico. Not included within the MBNEP boundaries, but a dominant influence on many factors affecting water quantity and quality, is the larger Mobile River Basin that drains more than 43,000 square miles. By comparison, the local watersheds of Mobile and Baldwin Counties encompass about 1,720 square miles exclusive of open water areas.

Obviously, water quality conditions of the estuary are significantly influenced by upstream river inputs from the entire drainage basin above the MBNEP boundary. Compared to the average upstream flow of riverine inputs (62,000 cubic feet per second), average local watershed runoff has been estimated on the order of 9%. Generalized estimates of average annual sediment and nutrient loadings display similar proportions. However, it should not be inferred that water quality conditions throughout the estuary are completely dominated by upstream basin inputs. Firstly, the water quality characteristics of local streams and tidal embayments such as Fowl River, Dog River, and Weeks Bay/Fish River are predominantly influenced solely by activities within their respective watersheds. Secondly, for the estuarine system as a whole, certain critical water quality conditions (e.g. nutrient enrichment, dissolved oxygen levels) occur during late summer months when upstream river discharge is usually low. Therefore, under such conditions, inputs from local sources may be much more significant to the entire system.

In addition to hydrologic characteristics, an understanding of sedimentological features of the system is important for assessment of water quality conditions in the MBNEP area. The Mobile-Tensaw River Delta complex is the largest internal bay-head delta complex in the United States, and Mobile Bay constitutes the primary depositional basin for the system. An estimated 4.85 million metric tons of sediment annually enter the estuary, with 33% deposited in the Delta and 52% in the Bay (the remainder being transported to the Gulf of Mexico and Mississippi Sound) (Isphording *et al.*, 1996). Sedimentation and transport processes are important to water quality not only due to physical impacts (e.g. water clarity), but because many pollutants (such as heavy metals and pesticides) have an affinity for clay-size sediments and thus migrate and deposit in patterns correlated to sediment. Since the bay is a natural "trap" for clay-size sediments, such pollutants, if introduced to the estuary, may remain for a very long time period. It is of interest to note in this regard that episodic hurricane events may cause substantial re-suspension of sediments and move them beyond the estuary into the Gulf. Isphording (1994) estimated that Hurricane Frederic in 1979 removed nearly 300 million metric tons of sediment, effecting a "natural cleansing" that substantially reduced the levels of contaminants in bay sediments at that time.

Groundwater provides an important source of drinking water (public and private) within the MBNEP study area. Most public water supply systems utilize groundwater, except the Mobile Area Water and Sewer System which serves the metropolitan area of Mobile (which uses surface water sources outside the MBNEP boundaries) and the Prichard Water Works Board.

Groundwater within the MBNEP area is sourced in two ways: (1) shallow well unconfined aquifer withdrawal and (2) deep well confined aquifer withdrawal. Shallow wells typically tap Pliocene/Pleistocene alluvial and coastal deposits that are generally recharged by area rainfall. Major confined aquifers within the NEP study area are within the Lower Miocene. Groundwater levels reported by the USGS have remained stable in recent years. Seasonal patterns in unconfined aquifers reveal highest levels in April and lowest levels in September.

Groundwater supplies for coastal areas depend on freshwater zones which are in close proximity to naturally-saline groundwater. Salt-water encroachment is a primary groundwater concern for coastal areas. Salt-water encroachment may be indicated in a coastal area by an increasing chloride content in water produced by a public deep-well system.

Natural groundwater quality problems may include high levels of iron, manganese, sulfur compounds, dissolved solids, and other water quality parameters. Pollution concerns include septic tanks, waste sources, agriculture, storage tanks, and other sources. The entire study area is considered to be susceptible to contamination from the surface due to the permeability of the underlying sediments (Mooty, 1988).

More detailed descriptions of the MBNEP area is given in Section 4.1 of the report. Also discussed therein are current water quality standards and use classifications. With the exception of the Mobile Harbor segment (lower Mobile River, lower Chickasaw Creek, lower Three-Mile Creek and Industrial Canal) and Three-Mile Creek, which are classified as "Agriculture and Industrial" (A&I), all surface waters of the MBNEP area are classified as "Fish and Wildlife" (F&W) or higher. Several areas are designated with the higher uses of "Swimming and Whole Body Contact" (S) and/or "Shellfish Harvesting" (SH). Three relatively small stream segments are classified as "Public Water Supply" (PWS), and one area, Weeks Bay, has been given the special designation of "Outstanding National Resource Water" (ONRW). The water use classifications for the MBNEP area are depicted on Figure 4-3 in the text.

For geographic evaluation of water quality data sets and to facilitate discussion within the report, the MBNEP study area was segmented into "sub-areas". With minor exceptions, the sub-area delineations are consistent with the USGS Hydrologic Cataloging Unit system and with a sub-watershed delineation system prepared by the U. S. Department of Agriculture, Natural Resources Conservation Service (NRCS) [formerly Soil Conservation Service (SCS)]. It has further been attempted to be consistent with commonly used conventions for spatial delineation within the Mobile Bay and Delta

regions. The intent is to provide a geographic framework oriented towards primary local watersheds and waterbodies in the MBNEP area, by which selected factors influencing the status of water quality conditions in respective sub-areas may be considered. The sub-areas are described in Section 4.2 of the text, and depicted on Figure 4.6. In Appendix III, maps and tabulations displaying selected characteristics of each sub-area (as related to water quality) are presented.

### ***Principal Water Quality Data Sources***

We have identified approximately 115 Data Systems/Models/Databases currently in the MBNEP Information Record database. Many of these systems are accessible via the Internet through web pages that are identified in the individual Information Records. The principal water quality data systems and databases identified are listed in Table 5-1 of the text. This table lists the current databases that are either accessible on the Internet or have electronically recorded data and are accessible for previous, ongoing and future monitoring data.

A number of principal assessments, characterizations and monitoring programs can be relied upon to characterize and evaluate the water quality conditions for the MBNEP area. Some of these can be classified as "historical" in that they provide a comprehensive characterization, but may be out of date. Other characterizations have been developed over several years of regular monitoring and assessments performed by various organizations. Collectively, they represent the best body of knowledge from which to assess current water quality status of the estuary. Major water quality evaluations for the MBNEP area include:

- ❖ Mobile & Baldwin Counties, Alabama Water Quality Management Plan (the 208 Study). South Alabama Regional Planning Commission 1978, 1979, 1982, and 1983.

This study provided a comprehensive watershed and water body monitoring and analysis, including deterministic modeling of the Mobile Bay and adjacent areas. The primary limitations of this effort are that it has been 20 years since this program was undertaken, and that it provides only dated information of perhaps limited use in a comprehensive characterization of contemporary water quality issues.

- ❖ ADEM's ALAMAP-C program.

ALAMAP-C is a relatively new program supplementing ADEM's traditional coastal trend station data with data collected using a statistically-designed strategy similar to the USEPA EMAP program. It provides a more comprehensive and statistically sophisticated approach of water quality data collection than addressed in the 305(b) reports. Limitations include lack of annual monitoring for some parameters, and somewhat limited temporal data collection.

❖ ADEM's Biennial Water Quality Reports to Congress ("305b reports").

This ongoing process of evaluating stream segments by ADEM is undertaken every two years and provides an assessment of water quality within all the waters of Alabama. These are termed "305(b)" reports in reference to that section of the Clean Water Act. Corollary reporting includes biennial "Section 303(d)" lists which identify those waters not currently supporting designated uses and establishes priority rankings and schedules for Total Maximum Daily Load (TMDL) development. The "305(b)" reporting provides a current status update of various stream segments, and assesses whether these segments are meeting their designated water use classifications. However, since the report covers the entire state, a principal limitation is that only summary information is included for specific areas.

*Note: At the publication of this report for MBNEP, the latest 305(b) report was issued in 1996 (the 1998 report being expected in the near future). A draft 1998 303(d) list was issued in March, 1998 and is pending finalization. Throughout our report, we have referenced locations within the MBNEP area which were identified by the 1996 305(b) assessment as exhibiting water quality impairment. We have not attempted to update that information with the "draft 303(d) list" since it has not been issued in final form. Therefore, some information presented on specific sub-areas may require updating in the near future. We recommend that the MBNEP review the forthcoming 305(b) assessment and final 303(d) listing, when they become available, for appropriate considerations in CCMP development.*

### **Water Quality Issues**

Initial efforts of the MBNEP process involved technical and citizen input to identify priority issues to be considered during development of the Comprehensive Conservation Management Plan (CCMP). Through participation of the MBNEP Water Quality Workgroup, water quality issues were grouped into five major categories:

- Pathogens
- Toxic Chemicals
- Nutrient and/or Organic Overloading
- Physical and/or Hydrologic Modifications
- Erosion and Sedimentation

A principal objective of this preliminary water quality characterization for the MBNEP study area was to maintain a focus on these priority issues. The identification of data sets compiled within the Information Record Database has been structured to relate to priority

issues. Subsequent discussion will summarize data sets and historical water quality characterization information as related to each issue category.

### **Pathogens**

Pathogens are viruses, bacteria and protozoans that cause diseases in humans, plants and other animals. Pathogens commonly found in marine waters include those causing gastroenteritis, salmonellosis and hepatitis A. Vibrios are naturally occurring bacteria found in some estuarine waters and can produce severe symptoms, particularly in unhealthy individuals. Potential sources of pathogens include: marine waste from ballast discharges; marine waste from recreational and commercial vessels; municipal sewage treatment systems (public STPs); private STPs (including industrial); illegal disposal methods; on-site sewage disposal systems (e.g., septic tanks); domestic pets, wildlife and farm animals; and upstream river inputs (beyond MBNEP area).

The issue of pathogens was addressed with regard to temporal and spatial characteristics using the MBNEP water quality database. Sample matrix, document type and pathogen sources were also discussed. Presently, the Information Record Database has about 270 document entries classified under the pathogen issue, which related directly to two parameters: microbiological indicators and pathogens.

The incidence of pathogens directly effects shellfishing areas and swimmable waters. Database searches suggested that monitoring in “swimmable waters” was not as comprehensive compared with shellfishing areas. ADEM (1996) assessed 451 square miles of shellfishing waters and found 412 square miles did not fully support the designated use classification. Pathogen indicators were the major contributors. During 1994 – 1995, the coastal waters of Mississippi Sound, Mobile Bay, portions of Fowl River, Deer River/Theodore Canal and Dog River, Three-Mile Creek and Chickasaw Creek Watersheds, and the Weeks Bay Watershed were affected by higher than normal pathogen indicator levels.

Temporally, the interest in pathogens dates back to the early 1900s. As inferred from Information Record Database document numbers, a dramatic increase in pathogen related research occurred during the 1970s. Generally, 1970s data collection focused on fairly short temporal and spatial scales. The initiation of regular monitoring studies began in the late 1970s and continues today. Data records from the 1980s incorporate numerous agencies such as the Alabama Department of Environmental Management (ADEM), U.S. Environmental Protection Agency (EPA) and Geological Survey of Alabama (GSA), suggesting increased federal and state resources for monitoring. During the 1980s, research by the Food and Drug Administration (FDA) Laboratory on Dauphin Island began to focus on Gulf Coast shellfish related pathogens. The FDA laboratory continues to play a vital role in the research and understanding of pathogen related issues. Another increase in research effort appears to have occurred during the 1990s. During this period, a strong focus on comprehensive monitoring programs and watershed studies is apparent. These monitoring programs will help develop a better understanding of water quality

parameters (including pathogens) and will provide a base for future monitoring efforts and trend studies.

Studies relating to the issue of pathogens generally have focused on short temporal and spatial scales. Research and monitoring efforts also tended to focus on the economically important shellfisheries. Numerous area-wide monitoring efforts are currently collecting pathogen data that will provide a base for future studies and interpretations. Additional data collection efforts should focus on increasing the frequency of data collection as well as the number of sampling locations in order to provide a comprehensive data set for the MBNEP waters.

### **Toxic Chemicals**

All living systems use and recycle a variety of naturally occurring chemicals. Changing the normal balance of chemical concentrations in an ecosystem can jeopardize the health and reproductive capacity of the organisms in that ecosystem. Chemicals that cause damaging effects are called "toxics". Some of these chemicals are polycyclic aromatic hydrocarbons (PAHs), toxic metals, polychlorinated biphenyls (PCBs), and pesticides. Several classes of toxic chemicals collect in sediments. Bottom-dwelling animals are exposed to these chemicals, which pass through the food web. In some locations, health officials have warned people not to eat fish caught in contaminated areas.

Some potential sources of toxic chemicals include point-source industrial discharges; municipal sewage treatment plants (public STPs); urban/suburban runoff; agricultural runoff; silvicultural runoff; upstream river inputs; contaminated sediments; atmospheric deposition; oil and gas exploration and production; marine waste-commercial shipping/port facilities; and hazardous waste/Superfund sites and landfills.

Numerous information/data (I/D) records compiled within this study were categorized as relating to the issue of "toxic chemicals" (about 360). The I/D records range in publication date from 1966 to the present, indicating a long-recognized concern for this issue during contemporary and recent periods. Not unexpectedly, historical data prior to 1970 are very limited. Of the I/D records, around 220 have publication dates between 1970 and 1989, and about 130 have publication dates of 1990 or later.

Based on review of information records and data sets pertaining to the toxic-chemicals issue, a considerable information base is demonstrated for many of the known or potential impacts or sources identified as priority concerns by the MBNEP. A notable exception is the lack of data (specific to the MBNEP area) related to atmospheric deposition. In view of the findings of mercury contamination in predatory fish (e.g., largemouth bass) in watersheds with no known sources of mercury (e.g., Fish River, Fowl River), the lack of atmospheric deposition data for the MBNEP area makes definitive conclusions of cause-effect relationships difficult. This situation, however, is not unique to the area and the problem is being researched on a regional and national scale. Therefore, the need for toxic chemical atmospheric deposition data specific to the



MBNEP area will depend in large part on the applicability and transferability of findings from ongoing research efforts elsewhere.

Nonpoint source (NPS) pollution represents another potential source of toxic chemicals for which limited quantitative data exist specific to the MBNEP area. However, investigations related to NPS pollution from toxic chemicals (as well as conventional pollutants) have increased in recent years, particularly within the last decade. Notable studies and programs for the MBNEP area include ADEM's coastal watershed characterization studies and biennial assessments incorporated within "305b" reports, ongoing NRCS sub-watershed NPS screening/ranking studies (which are near completion), cooperative studies conducted as part of the Weeks Bay Watershed Project, and urban stormwater monitoring/assessment programs performed by local governments as part of the Mobile-Baldwin Counties Municipal Separate Storm Sewer (MS4) Stormwater Consortium. Although quantitative data are limited, these initiatives are increasing the knowledge base from a watershed characterization and problem identification perspective. Nevertheless, without a base level of area-specific quantitative examination, it will remain difficult to adequately assess the status and relative significance of NPS pollution concerns, much less trends over time.

With respect to upstream river inputs, long-term data records of major riverine discharges entering the MBNEP area are available, as are records for many pollutant parameters. Additionally, at least from an area-wide perspective, sediment input and deposition processes have been characterized sufficiently to allow a generalized understanding of the system as a whole. In these regards, upstream river inputs of flow and sediment are clearly dominant factors affecting major components of the area (i.e., Mobile Bay and Delta). However, data relating to toxic chemicals contributions from upstream river inputs are more limited, and the relative significance of same warrants further assessment. In this regard, coordination and communication by the MBNEP with the USGS NAWQA program, which is initiating a comprehensive assessment for the Mobile River Drainage Basin is recommended.

Considerable data on toxic chemicals contributions is available related to point sources, hazardous waste sites, landfills, and industrial facilities in general. This is not surprising considering the emphasis given to toxic chemicals issues in recent years resulting from NPDES, RCRA, CERCLA (Superfund) and other regulatory programs. The data sets available and continuing to be developed under the purview of such regulatory programs are viewed to be generally adequate to meet MBNEP objectives and needs for development of the CCMP.

Review of information records indicate a substantial volume of data pertaining to contaminated sediments within the MBNEP area. Portions of the available data sets have been used by EPA to classify Mobile Bay as an "Area of Probable Concern" with respect to contaminated sediments. This classification was given as part of the National Sediment Quality Survey, which is recognized as a "screening level" assessment approach only, and should not be construed to confirm that sediment contamination poses actual risks to human health or aquatic resources. EPA through its EMAP program and

ADEM through its ALAMAP-C program have also issued recent reports categorizing the status of contaminated sediments of the area. In these assessments, the contamination status of sediments is ranked from "poor" to "good" for the various sub-regions investigated.

The screening-level assessments may be adequate from the standpoint of identification of "contaminated sediments" as an issue of concern within the MBNEP; however, they are not considered adequate in and of themselves to fully address related issues. One shortcoming, based on review of available information records compiled for this study, is that a substantial volume of data appears to exist which has not directly been evaluated in the screening assessment characterization. More rigorous examination of the full data sets may allow more definitive conclusions regarding contamination levels, spatial distribution, and temporal trends.

More importantly, there remains scientific uncertainty (and controversy) as to the relationship of total chemical contaminant concentrations in sediment and adverse affects on aquatic life. This uncertainty continues to hinder the development and acceptance of sediment quality standards or criteria based on total chemical concentrations. Toxic chemical sediment information, while being available for many years, is mostly restricted to "total levels" and is non-specific as to bio-availability. Hence, even where data is available, inadequate information is provided as to the potential for impact on the biota. Data is needed throughout the entire watershed area on this aspect in order to truly assess the health of both the bay and the delta.

Sediment-phase bioassay toxicity testing and more comprehensive ecotoxicological evaluations are more complex to conduct, and thus more expensive. Accordingly, such data are much more limited for the MBNEP than sediment chemical concentration data. The available data sets may not prove adequate to sufficiently address concerns related to contaminated sediments in the estuary.

Chemical contaminant data for biological (tissue) matrices such as fish and oysters are available for several portions of the MBNEP area. Notable data resources include ADEM's fish tissue monitoring program and NOAA's "Mussel Watch" program which includes oyster monitoring at three locations in Mobile Bay. Also of note is a 1993-1994 EPA study of the Mobile River, which was performed to assess potential contamination from four Superfund NPL sites located along the river, two of which are in the MBNEP area and located near Cold Creek swamp. A fish consumption advisory had been previously issued in 1992 for Cold Creek swamp by the Alabama Department of Public Health (ADPH), based on ADEM fish tissue monitoring due to the pollutant mercury. The EPA Mobile River study indicated that the risk to the general public was marginal or within EPA criteria, but that a potential risk would exist to a "subsistence fisherman". A potential ecological risk to the belted kingfisher or similar birds was also noted. As discussed earlier, fish consumption advisories due to mercury have also been issued by ADPH (based on ADEM fish tissue monitoring) for watersheds where no known sources have been identified.

The NOAA "Mussel Watch" (oyster) monitoring stations exhibit "high" levels of certain metals and pesticides at Dog River and Hollingers Island reefs, but not at Cedar Point reef. The NOAA "high" classification is based on nationwide statistics of concentration levels, and is not derived from human health or ecological impact considerations. Trend analyses by NOAA indicate decreasing levels of certain pesticides and PCB's in Mobile Bay, with no statistically-significant trends (up or down) noted for metals.

### **Nutrient and/or Organic Overloading**

The major nutrients, typically carbon, nitrogen and phosphorus, are key components in the functioning of aquatic and marine ecosystems. The lack of nutrients limits growth and production of primary producers (plants) but in excess they can cause very undesirable conditions such as low dissolved oxygen and excessive growth of nuisance algae and aquatic plants. The excess discharge of nutrients and the concomitant accumulation of nutrients and organics in systems is known as the process of eutrophication, which literally means "excessive feeding".

The excessive discharge of organic compounds in large quantities from point sources is usually prevented by wastewater treatment and controls; however the buildup of organics still occurs through the production of organic materials in the watershed, and its production in the waterbodies themselves through the eutrophication process above.

The mineral nutrients, especially phosphorus and nitrogen have been used for more than 100 years in the fertilization of crops. When discharged in an uncontrolled manner into aquatic and marine systems, they can also stimulate excessive growth of plants, both microscopic and macrophytic, leading to similar problems as from the discharge of organic materials. A large biomass of living and/or decomposing plant material can use all the oxygen in a system resulting in impacts to water quality and aquatic life. Thus the key indicators in detecting problems from excessive nutrient loading are the measure of microscopic algal biomass, the plant pigment chlorophyll *a*, the dissolved oxygen (DO) levels in the mid and bottom waters, and levels of mineral and organic nutrients.

Over 290 information records relating to nutrient overloading exist in the database. About 210 of these date between 1970 and 1998. However, many of the information records have only limited useful information, in particular the older data sets.

A preliminary characterization of the nutrient overloading issue in the Mobile Bay NEP area is possible from the summary reports published by others. The characterization of nutrient overloading issues in the various portions of the MBNEP area as described in those publications was used for the summary here. This summary discusses only these areas where nutrient overloading problems are evident in the data.

Overall for the nutrient overloading/organic enrichment issue for Mobile Bay, the estuary was rated good to fair for the period 1993-95 by ADEM (Carlton *et al.* , 1998). Nevertheless, low dissolved oxygen levels for a large portion of the Bay indicates this issue is of key concern. Over 55% of Mobile bay had bottom dissolved oxygen levels

below 4 mg/l and 30% showed dissolved oxygen levels below 2.0 mg/l which represented poor conditions. Overall, it should be noted, that dissolved oxygen standards were actually met, on average, in 95% of coastal waters, when the entire coastal area is considered. Occurrence of low dissolved oxygen is clearly associated with salinity stratification and higher summer temperatures in Mobile Bay, Lower Mobile River and Chickasaw Creek. This occurrence of diel hypoxia has been described at 80% of the stations in eight Northern Gulf of Mexico estuaries (Summers and Engle, 1993).

The Fowl River (East and West) is classified as Fish and Wildlife/Swimmable by ADEM(1996). It is listed by ADEM (1996) as partially meeting its designated uses, with nutrient and organic loading as problems, presumably from pasture and stormwater runoff.

The Dog River watershed was the subject of a study conducted by ADEM during 1993 which included some intensive surveys of various stations within the watershed. Indications from the ADEM trend station and from the intensive sub-basin studies show that elevated nutrient levels chronically exist within at least the incoming streams and the upper portion of the tidally-influenced reach, especially during high stormwater flow (ADEM 1994).

The Lower Mobile River and Chickasaw Creek areas are classified as Agricultural and Industrial (A&I) use classifications. However, because of recent litigation, the USEPA has recently published in the Federal Register (FR/63:43-10799, 5 March 1998) a proposed rule to upgrade and classify these stream segments as Fish and Wildlife.

The Lower Mobile River currently has some infrequent exceedences of the A&I DO standard (less than 3.0 mg/l DO) during the "low flow" time of the year (September), but generally is currently fully meeting its designated use according to the 1996 305b report (ADEM 1996). The lower Chickasaw Creek and Three Mile Creek currently are only partially meeting designated A&I use, due in part to low DO levels observed during periods of low flow and salinity stratification caused by a salt wedge encroachment in the channel from Mobile Bay. A listed contributing cause for these segments (Chickasaw and Three Mile) not meeting their designated use is organic enrichment/DO.

The Mobile-Tensaw River Delta areas are classified as Fish and Wildlife with portions (Tensaw River) classified as Swimmable. Portions of the Tensaw River do not fully meet their use designations, in part due to nutrient and organic enrichment (ADEM 1996). The recent ALAMAP-C report (Carlton *et al.*, 1998) lists the Mobile-Tensaw Delta and the Tensaw River as being classified overall as fair with regard to nutrients, with some areas showing low DO and high chlorophyll *a*.

The Three Mile Creek and Chickasaw Creek watersheds only partially meet current use designation, in part due to nutrient and dissolved oxygen limitations (ADEM 1996). The affected portions of these watersheds are generally in the lower stream segments where the impacts from urban and agricultural runoff are expressed in high nutrients and low DO, especially during periods of high runoff.

Adequate data exist to provide rough estimates for many types of comparisons of nutrient overloading issues within Mobile Bay and for the MBNEP areas as a whole. Through the EMAP, ADEM trend stations and the ALAMAP-C programs, data for overall indications of these parameters seem sufficient. Lacking are long term, that is without significant data gaps, monthly datasets for parameters such as Chlorophyll *a* and the various nutrient parameters such as nitrate, nitrite ammonia, and Total Kjeldahl Nitrogen. This information will be necessary to adequately calibrate and verify water quality models for the MBNEP system. Several studies have been proposed to collect this information, such as the renewal and continuation of the USGS data collection efforts performed by the Dauphin Island Sea Lab (Pennock, 1994). Additional data collection efforts should focus on filling additional data gaps should the monthly data collection efforts be resumed.

Status and trends of dissolved oxygen within the Mobile Bay system could be synthesized by combining a series of “snapshots” taken from existing studies such as the historical work of Dauphin Island Sea Lab researchers and the ALAMAP efforts, and combined into a comprehensive analysis of dissolved oxygen. Numerous studies have demonstrated the dissolved oxygen deficits within Mobile Bay and in its tributary streams (Lower Mobile River, Dog River, Chickasaw Creek). To synthesize this information into a comprehensive “status and trends” would require calibration and verification of a model capable of adequately simulating dissolved oxygen for the period when the “208” water quality management plan was developed (1976-80), and then performing the procedure again for a more recent period (1994-96).

A similar process for simulating nutrient and chlorophyll *a* status and trends could be undertaken using again land use and ambient data taken during the “208” studies, compared to a synthesis of data from more recent datasets (ALAMAP-C and Pennock’s data, for example). Using these as a beginning point, a model capable of simulating nutrient and phytoplankton (chlorophyll *a*) for 1976-80 period and again for more recent data sets would be instructive.

### **Physical and/or Hydrologic Modification**

By definition, estuaries require freshwater inflow. However, alteration of the natural flow regimes and/or salinity patterns in the tributaries can have significant effects on the water quality and health distribution of living resources in the receiving estuaries. In addition to changing the salinity regime in receiving waters, channels and overdraft of coastal aquifers can cause localized saltwater intrusion. Decreasing water flows allow the tide to push saltwater further upstream, into freshwater habitats. Most freshwater plants and animals are not tolerant of salty water. Also critical is the quality of the freshwater flowing into receiving estuaries. Agriculture, forestry, and the increase of impervious surfaces due to development can increase stormwater runoff.

There are currently about 470 documents in the Information Record Database catalogued as being related to the hydrologic modification issue. The large number of records suggests that a considerable amount of information exists related to the issue. However,

because most information sources are likely to have at least some data pertaining to water flow or similar parameters, many of the records thus categorized probably contain only limited data comprehensively related to the issue.

Primary information resources for data related to the physical and hydrologic modification issue include the U. S. Geological Survey (USGS), the U. S. Army Corps of Engineers, Mobile District (USACE-Mobile), the National Oceanic and Atmospheric Administration (NOAA), and the Dauphin Island Sea Lab (DISL). USGS, USACE-Mobile, and NOAA maintain flow and tidal gaging stations providing long-term records for the area. Additionally, because of the Corps' role in navigation and related interests, USACE-Mobile has conducted a number of studies and evaluations pertaining to channel construction and maintenance, and dredged material disposal. These have involved several modeling efforts (physical and numerical) in connection with navigation projects.

Researchers at DISL have performed and published many studies pertaining to circulation, salinity, and related hydrodynamic features of Mobile Bay. Their efforts over the past quarter century have considerably advanced the base of knowledge pertaining to the dynamics of the estuary.

Information records that pertain to circulation patterns, salinity gradients, and related hydrodynamic features within Mobile Bay are abundant. A key word search for "salinity" identifies some 280 documents. Adding the term "circulation" still leaves about 180 records. These information records range in publication dates from 1954 to 1998.

With respect to data adequacy pertaining to altered flow patterns and/or salinity, the information records which have been reviewed include many prior research studies and modeling projects characterizing various hydrologic, circulation, and/or salinity patterns within portions of the MBNEP estuarine area, particularly for Mobile Bay proper. Additionally, historic and ongoing data acquisition programs which measure riverine discharges entering the area, and tidal stages at selected locations, provide long-term records relating to principal hydrodynamic factors affecting the system. This body of information demonstrates a knowledge base which may be viewed as adequate for an understanding of general flow and salinity patterns of the estuary; however, which may not necessarily be sufficient for critical evaluation of future activities and for informed decision-making by management agencies. The MBNEP and participating agencies with responsibilities and interests in water quality management have recognized, as a high priority, the need to initiate an updated water quality modeling effort for the MBNEP area. Although hydrodynamic and water quality models have been applied in the past, none have been maintained for present day utility. The available data sets may prove very useful for future hydrodynamic modeling efforts envisioned by the MBNEP; however, their overall adequacy will be dependent upon the specific requirements of the model(s) selected and the specific areas and detail of coverage.

With respect to data adequacy pertaining to watershed alterations, the information records which have been reviewed indicate the limitations of quantitative data which have been

acquired or comprehensively evaluated for the MBNEP area (for example, data on increased impervious surfaces or channelized stream segments within delineated watersheds). However, the available data sources reflect an increased emphasis on watershed-based evaluations and data acquisition programs, particularly within the last decade. Notable among the available data resources are several "local" watershed studies performed by ADEM, special studies and evaluations performed in connection with the Weeks Bay Watershed Project, and ongoing programs of the Mobile-Baldwin Counties Stormwater Consortium governments. For many areas, this information base provides at least qualitative characterizations of the effects of watershed alterations on water quality and aquatic resources. However, the lack of quantitative data limits the ability to make meaningful comparisons of such alterations over time.

Insofar as potential water quality impacts caused by shoreline modifications, available data sets for the MBNEP area are lacking. Information records do indicate a body of work related to shoreline changes and trends, and these data resources (which are expected to be more comprehensively evaluated in habitat loss characterization) may prove useful for corollary examination of possible effects on water quality.

### **Erosion and Sedimentation**

Erosion is a naturally occurring geomorphic process that can be greatly accelerated by anthropogenic processes including agriculture, construction, silviculture, and urban development. Soil erosion is often an important contributor to non-point source pollution and can have significant impacts on water quality.

Climatic conditions of the central Gulf Coast region produce the highest rainfall erosive factors in the United States. Erosion problems are further compounded by the fine-grained and/or unconsolidated nature of the soil and slopes of rolling hills and coastal ravines, which make the MBNEP area highly susceptible to erosion and sedimentation concerns. Uncontrolled or poorly managed stormwater runoff, improper construction techniques, and topographic modification greatly add to the potential of problems within the area. Sediments may be transported into bodies of water altering flow patterns in addition to causing turbidity and water quality problems. Urban developments increase the amount of imperviousness within watersheds, which increases the volume and velocities of stormwater runoff resulting in increased erosion of stream banks and bottoms.

The MBNEP contains some the most rapidly developing areas in the state of Alabama. Throughout any given year, there are continuously ongoing construction activities that produce denuded soil surfaces exposed to precipitation. Without appropriate control measures many of these construction sites can be highly susceptible to erosion.

Soil erosion can significantly impact the water quality of tributary streams, rivers and tidal embayments. Soil erosion and the subsequent transported sediments can increase both the suspended solids in the water column and dissolved constituents. Mineral

nutrients that typically have a low solubility, such as phosphorus, can be transported into the estuarine environments adsorbed to soil particles.

There are approximately 260 Information Records compiled within this study that were characterized as related to erosion and sedimentation. As might be expected from the recent increase in concerns related to the erosion and sedimentation issues, the majority of data and information related to erosion and sedimentation have been collected between 1970 and the present.

The classification and mapping of superficial soils is presented in the Soil Surveys of Baldwin County (SCS, 1964) and Mobile County (SCS, 1980). The erosion hazard for each mapping unit or soil series is tabulated in the surveys.

ADEM's biennial 305(b) report (1996) includes NPS assessment and listings of impaired waterbodies, which relates in general to erosion and sedimentation issues. Data within the report is restricted to general summaries and therefore of limited utility in examining specific problems of sub-watershed areas. However, several coastal watershed studies have been performed and provide more complete information of interest to the subject. In Mobile County, these include the Dog River watershed and the Chickasaw Creek watershed. In Baldwin County, ADEM has performed a similar study on Bon Secour watershed. ADEM's watershed studies provide an overview of land-use practices and effects of development on aquatic resources, and include descriptive (qualitative) information pertaining to erosion and sedimentation as well as other nonpoint sources. Nevertheless, these studies include only limited quantitative data directly related to the issue.

Comprehensive studies including quantitative data on the erosion and sedimentation issue are very limited for the MBNEP area. However, two Baldwin County watersheds have had noteworthy investigations performed: D'Olive Bay and Weeks Bay. Isphording, *et al.*, (1984) investigated the impact of large-scale development projects on the rate of sedimentation in D'Olive Bay. Construction of suburban developments greatly increased in the 1960's and accelerated soil erosion within the D'Olive Bay watershed. Until the late 1960's the D'Olive Bay reportedly had a depth of approximately four feet. Isphording's work indicated a deposition rate of approximately 0.1 foot per year within D'Olive Bay. As such, D'Olive Bay was at risk for being filled with sediments derived from human activities within a relatively short period of time.

The Weeks Bay/Fish River watershed has been intensively studied in part as a result of the National Estuarine Reserve Program for Weeks Bay. The Draft Management Plan for the Weeks Bay Watershed (Lynn, 1997) summarizes non-point source pollution problems caused by stormwater runoff erosion and wave erosion. The relationship between landscape and land use characteristics within the Fish River watershed was compared with non-point source parameter inputs in a study performed by Basnyat, *et al.*, 1996. The study relates the 1) stream and river concentrations of chemical inorganic parameters to the mineralogical composition of watershed soils and, 2) soil erosion as



contributing factor controlling the concentrations of these parameters in the waters of the Fish River.

Overall, with respect to data adequacy related to the erosion and sedimentation issue, little quantitative data relating erosion rates in upland areas to the quantity of sediment transported into tributaries and embayments was determined to exist for the MBNEP area based on the literature and data sources reviewed. Erosion and sedimentation impact data could be improved by obtaining more quantitative information related to erosion and sediment transport phenomena. It is generally assumed that if soil erosion is controlled, then sedimentation will also be controlled. However, it is impossible to eliminate all erosion. Effective management of erosion and sedimentation within the MBNEP will require estimates of acceptable sedimentation rates. Once an acceptable level of sedimentation is established, calculations of soil loss under various land management programs can be made. This could include characterization of soil loss that results from anthropogenic activities including construction, farming and silviculture by linking the various human activities to the type of soils, topography and conservation practices. The final step should involve the development of “sediment delivery ratios” for eroded material to bodies of water at risk.

### **Groundwater**

While groundwater is not identified as a separate issue *per se* in the MBNEP process, the effects of the before-mentioned issues also apply to groundwater resources. Because of the uniqueness of groundwater related data sets, individual discussion of this information is appropriate.

As noted earlier, groundwater supplies are used for public and private drinking water in south and north Mobile County and throughout Baldwin County. These groundwater supplies are mostly recharged by rainfall infiltration within the local area. Due to the relatively shallow depths to groundwater and the permeable characteristics of most soils, groundwater throughout the MBNEP is considered susceptible to contamination.

Information on groundwater has been collected since the 1800's in various formats. The Geological Survey of Alabama and U.S. Geological Survey have kept well records since close to the turn of the century. While different forms of data exist prior to 1970, few summary or technical works were identified. Contributions greatly increase in the seventies and the decades of the 80's and 90's have near equal amounts of work with some works referencing earlier archived materials. Groundwater used by public water systems is strictly monitored through a variety of programs. Information available at the federal level may be found through the U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey (USGS). Standard monitoring data as well as research and special endeavors by the USGS are kept electronically. USGS produces yearly water resource publications that highlight gaging station data as well as selected groundwater sources throughout the state. In addition to these yearly works, selected areas are studied. Of note, the recent Baldwin County assessment (Pearman, *et al.* 1996) is the most

comprehensive and up-to-date work available. Other studies on Mobile County and Dauphin Island are dated and need renewed evaluations.

The State of Alabama also collects groundwater data. ADEM has groundwater information in several areas. The Wellhead Protection Program is designed to comply with the federal mandate for safe drinking water. Information accessibility is through the ADEM Montgomery office by site specific file search. Reports submitted for systems in compliance are archived in physical files while an electronic database is in development for non-compliance information. Also of significance was the recent work "Ground water monitoring for pesticides in Alabama: a compilation of studies 1989-1993," the purpose of which was to investigate the presence of pesticides in private/residential and/or irrigation wells with regards to agricultural practices.

The Geological Survey of Alabama (GSA) supports the Wellhead Protection Program by working with communities who request their expertise in complying with the program. GSA has extensive files (as early as 1900) on groundwater levels in both counties and is working to make these available in an electronic format. Also under development is an extensive geochemical database that will cover biological and soil parameters in addition to surface and ground waters. GSA performs a number of contracts for state agencies and municipalities while doing their own research. Their accumulated data and analyses are reported in various publications released on a continual basis.

Additionally, groundwater protection regulatory programs dealing with solid waste landfills, hazardous waste (RCRA), and Superfund (CERCLA) have generated volumes of site-specific information. Information and data pertaining to such sites is generally available through report and file search at applicable agencies (namely, ADEM and EPA).

Generally, an abundant amount of information is available for groundwater, although it exists in a variety of forms. Comprehensive compilation of the information would be cumbersome, yet valuable trends may be established. Ongoing work to compile and coordinate data acquisition conducted by the GSA, USGS, and ADEM warrants support.

Public water supplies are monitored on a regular basis for any well supplying water to more than 25 people. Overall, the information reviewed indicates few known quality problems with public groundwater supplies serving MBNEP area communities.

Except when a new private well is constructed, individual water well systems are not routinely monitored. Data related to potential contamination of private water wells appears very limited.

Septic tank information is available but is difficult to use. No comprehensive information concerning septic releases and groundwater quality exists. While the soils, depth to water table, and vicinity of surface water are utilized in the approval of septic tank construction, the number of septic tanks within an area is not correlated. Thus, there is no way to readily assess the area's ability to accommodate the amount of septic effluent it receives.

Private and irrigation wells in agricultural areas are not regularly tested, therefore data concerning potential contamination by pesticides or fertilizers may not be adequate to fully assess related concerns.

Water withdrawal and saltwater intrusion have a limited amount of information available. In particular, information for the Dauphin Island area is dated and warrants additional work with the increase in population. Mobile County information, especially along the west side of Mobile Bay and adjacent to Mississippi Sound, is limited and warrants updated studies. Even though Baldwin County has had more recent studies, rapid development pressures along its coastal regions support the need for continued evaluation and assessment.

### ***Data Gaps and Recommendations***

One of the primary objectives of this project was to identify data gaps, in order to recommend where the MBNEP might best allocate its funding resources to address priority water quality issues. Data gaps identified are outlined in Table 6-1 and discussed in Section 6.1 for each water quality issue. Section 6.2 describes recommendations for additional data acquisition. Primary data gaps identified, and related recommendations are summarized below.

- ❖ The lack of a comprehensive area-wide monitoring program to fully assess swimming/water contact and recreational areas for exposure to pathogens was identified as a data gap, and more comprehensive monitoring is recommended.
- ❖ Better compilation and dissemination of information related to septic tanks appear warranted. Limited quantitative data exist which definitively assess impacts of septic tanks on surface waters or groundwaters. Septic tank information is available but is cumbersome to access and to use. Thus, it is difficult to assess an area's ability to accommodate the amount of septic effluent it receives.
- ❖ A comprehensive study of the sediment contamination issue within Mobile Bay should be undertaken, especially in light of the level of concern expressed by the EPA in their National Sediment Quality Survey. Although much information on sediment contaminant levels exists, much uncertainty remains in our understanding of potentially-related human health or ecological risks, if any. Initially, a thorough review of existing data for the MBNEP areas is suggested. While such review is needed to guide any further data acquisition, additional sediment toxicity evaluations and/or risk assessments appear warranted at this time.
- ❖ No comprehensive assessments of nonpoint source loadings (nutrients, sediments, or toxics) have been performed for the MBNEP area as a whole. A top priority item should be to synthesize our understanding of nonpoint source contributions. This should be undertaken to better estimate nonpoint source loads from the various local coastal watersheds draining into Mobile Bay, and provide comparisons with contributions from point sources, upstream river input, and atmospheric deposition.

Evaluations which compare present loadings with historical conditions are also needed to better define trends over time. This analysis would be useful for local and state agencies in developing Total Maximum Daily Load (TMDL) calculations.

- ❖ Local measurements of atmospheric deposition of nutrients and toxic chemicals are lacking. A study is warranted to at least establish baseline characteristics of this potentially important source.
- ❖ Also, a priority should be the development of a comprehensive Nutrient Loading Analysis/Nutrient Budget for the entire Mobile Bay system. While not yet severe on a widespread basis, the potential for worsening eutrophication problems exists. Increased frequency and better coordinated monitoring related to this issue appears warranted. More importantly, there is a need for water quality predictive modeling to allow a more complete understanding of the processes involved.
- ❖ Followup studies relating to saltwater intrusion of coastal aquifers appear warranted to support the water management efforts in these developing areas.
- ❖ There is a need for a fully-coordinated regional technical monitoring and research plan to better define the cause-effect relationships relative to priority issues, optimize ongoing efforts to assess status and trends of important water quality indicators, and facilitate sharing of the knowledge gained. The recently proposed comprehensive monitoring strategy is viewed to provide an excellent "building block" for such.

## **2.0 INTRODUCTION**

### **2.1 Scope and Objectives**

Although the estuary has been the subject of many prior studies to characterize its physical, chemical, biological, and sedimentological components and processes, the Mobile Bay National Estuary Program (MBNEP) recognized that little work had been done to integrate the wealth of information on the individual components and processes into a characterization framework. Therefore, in conjunction with corollary baseline efforts for characterization of living resources and habitat loss, MBNEP contracted this study to compile, assess, and integrate known information sources and data sets related to water quality for the area. This effort was intended to ensure that: 1) the MBNEP characterization is focused on the highest priority information needs, and 2) that assessments are obtained on information gaps to properly evaluate the possible problems prior to delineation of the Comprehensive Conservation Management Plan (CCMP). Specific objectives of this study were identified as follows:

- Conduct a literature baseline survey of all existing water quality information for the MBNEP study area. Evaluate literature for similarity and/or redundancy.
- Identify and evaluate the existing water quality data sets for the MBNEP study area and comment on validity.
- Identify data gaps from the existing water quality data sets.
- Recommend additional water quality data collection and/or analysis for identified gaps and/or for parameters, areas, or problems incurred from nonexistent, lacking, or unreliable data/analysis.
- Produce a historical water quality data characterization summary.

To address these objectives, we have strived to incorporate all known information sources into a user-friendly format for the purpose of assessing the current water quality of the Mobile Bay estuarine system. The literature baseline survey has entailed a comprehensive, methodical, and focused search of available literature, information, and data related to the surface and groundwater quality in the MBNEP study area. The second phase involved the identification and evaluation of existing data sets including all information pertaining to those watersheds which drain immediately into Mobile Bay. All literature, reports, and data identified in the first phase were classified according to parameters studied as they apply to water quality, and priority issues identified by the MBNEP Water Quality Workgroup. Once the information had been compiled and catalogued, identification of data gaps was evaluated. The evaluation took into consideration ongoing and planned data acquisition efforts. With the data gaps identified, recommendations are then made for additional data collection and analyses. A historical review of water quality data characterization is provided for the identified priority issues.

## **2.2 Relationship to Other Studies**

During the course of this investigation, other information-gathering efforts were underway. These included characterization of Living Resources and Habitat Losses of the estuary; as well as the study of Human Uses affecting the system, and a Regulatory and Baseline Program analysis. Additionally, recommendations for an overall Data Information and Management System (DIMS) were being developed as these "baseline" efforts progressed. As our estuarine system is a dynamic and integrated one, it goes without question that these efforts all overlap. We have attempted to coordinate our work and share information with those many others who have also been actively involved in compiling and managing the myriad of inter-related data which exist for our estuary.

## **2.3 Overview and Organization of Report**

The organization of the report begins with a description of computer programs used and a more detailed review of the Lotus Notes database system developed to manage the records collected (Section 3). The reader is then introduced to general characteristics pertaining to the MBNEP area. Sub-watershed areas, which are used to search the database for spatial representation of data sources, are defined and information is included which describes the particular features of the areas pertaining to selected water quality characteristics (Section 4). With the introduction to the methods and description of the study area complete, available information sources are summarized and important water quality initiatives at the Federal, State, Local, and research levels are discussed. Then, existing historical data resources are discussed in detail as applicable to the identified priority water quality issues (Section 5). Finally, information gaps are identified and recommendations for future work are offered (Section 6).

### **3.0 DESCRIPTION AND USE OF WATER QUALITY INFORMATION RECORD DATABASE**

A comprehensive literature review and search for documents, studies and publications that relate to water quality for the Mobile Bay National Estuary Program (NEP) area was performed during the course of this study. This included both search and inquiry of existing publications at agencies as well as a computerized search of library holdings at selected university and research locations. The review included not only a search for written documents, reports and maps, but focused on obtaining electronic versions of documents and data. Search of the Internet for agency database holdings and accessibility was also a priority.

#### **3.1 Procedures used to Compile Records**

To investigate the research efforts of local, state and federal agencies, a list of organizations and researchers was compiled and a questionnaire was mailed as a preliminary inquiry. This inquiry was in many cases followed by a telephone interview and, for principal information sources, a site visit to more comprehensively examine the agency/individual reference sources. The compilation was initiated by contact and interview with individuals at particular agencies that provide water quality information or have performed water quality studies within the area.

A record of each agency contacted was maintained, along with a compiled list of the documents obtained, cited or referenced by each group contacted. A full description of the information collected is described below within the contacts database description. A list of principal organizations within the Contacts database is included (Appendix I).

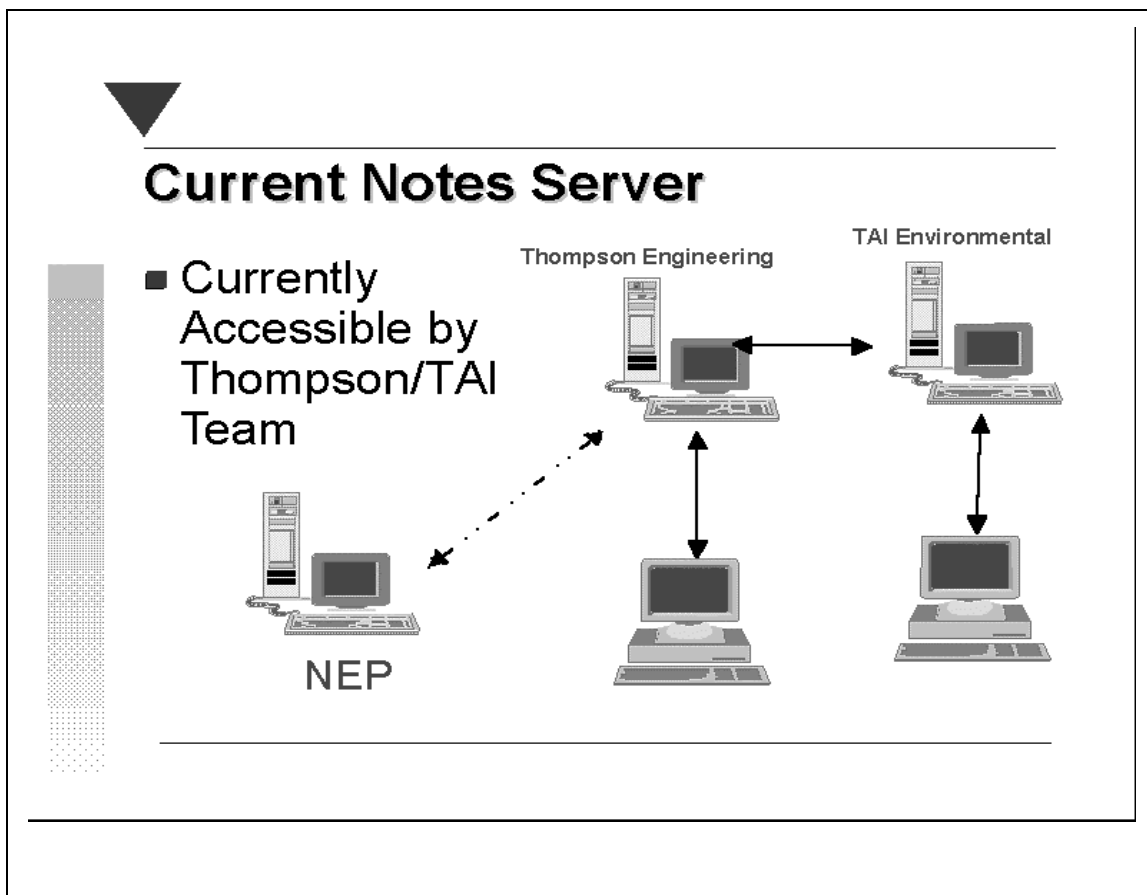
#### **3.2 Software System Used**

In order to compile and manage the data obtained in a useful form, a computerized database was developed for this project. Three major software systems were utilized in the course of this project; the Lotus Notes (Domino) system, ESRI's ArcView GIS software for spatial displays with QuadBase map images supported by Southern GIS, and Microsoft Office. The latter Microsoft software was used to maintain compatibility with the MBNEP data system currently under development. In addition, files attached to the Notes database use Adobe Acrobat and Netscape Navigator software. The Lotus Notes system was used as the main database and groupware engine in that all Contacts, Discussion and Information Records databases were compiled using this system. The MBNEP databases are described in more detail below.

All workstation software used for this project operated under the Windows 95 operating system for compatibility with systems at the MBNEP office and other cooperating institutions. For this project, the main Lotus Notes server software was installed on a Windows NT system for its robustness and stability. However, the server system is compatible with the Windows 95 and is scalable across multiple UNIX platforms. Access to the system was under the secure Lotus Notes administration system and provided for documentation of database activity. Workstation access to the server was either by local LAN (at TAI) or via modem connection (from Thompson Engineering).

Access by modem was also available to researchers working on portable laptop computers when in the field or at home.

The main database server was developed and maintained at the TAI offices and was connected directly via LAN to the TAI workstations (Figure 3-1). The workstations at Thompson Engineering replicated with the TAI server on a nightly schedule. This would create an additional copy of the database including all updated records, on each workstation and the server as well.



**Figure 3-1. Current Notes Server Configuration**

The Thompson Engineering/TAI project team used portable computers to collect information and data while on interviews. These were also replicated on a nightly basis. The only exception to nightly replication was the workstation at Dr. Isphording's office at USA, which was replicated via ZIP drive technology, and was performed approximately on a weekly basis. The replication protocol provided consistent updating across the various workstations and provided for redundancy in the event of machine failure.



While it was proposed to install a copy of the database at the MBNEP office during the course of the project, appropriate hardware was not initially available to accomplish this task. In lieu of this installation, as requested by MBNEP, we will provide a copy of the LotusNotes database to MBNEP which can be used with LotusNotes workstation software. Additionally, we will provide copies on CD-ROM also useable on a PC with LotusNotes workstation software, for distribution by MBNEP to interested parties. In the future, should MBNEP choose, this database can be maintained and updated, and be made accessible on the Internet through a Lotus Domino server.

### 3.3 Database Descriptions

Three databases, a Discussion Database, a Contact Database and the Information Records Database were prepared for this project to enter the various information collected during the course of the study. These databases are generally displayed in Figure 3-2.

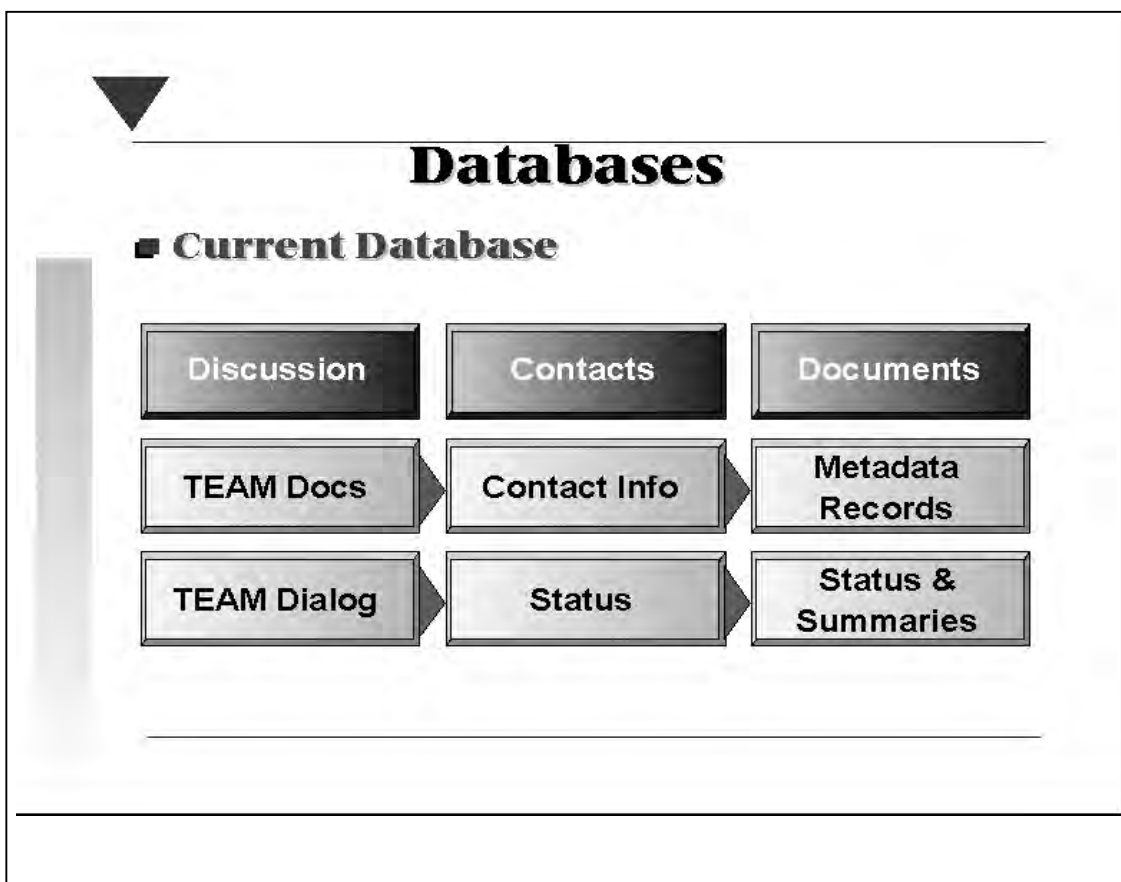


Figure 3-2. Databases used for the MBNEP Water Quality Characterization.

The Discussion database contains ongoing discussions and notes entered by the various Thompson Engineering/TAI investigators about various topics during the course of the project. It contained memos and ideas to improve the various program elements as the project progressed and served as a log of the activity and project progress. It consisted of a threaded discussion documenting ongoing development issues such as parameters within the main document database (Information Record Database), problems with database access, entry and editing. Also, it was frequently used during the development of the views which are a primary method by which searches are implemented within Notes. In this way, ongoing issues were disseminated to the entire project team during database development.

The second database was the Contacts Database which includes various agencies and individuals who were considered as potential contacts by the Thompson Engineering/TAI team during database development. The records included the name, address, phone numbers and other pertinent information for each of the agency contacts interviewed. Documentation of meetings, phone calls, and action items related to the data collection were maintained. When a particular item of relevance was needed to be reviewed immediately by another team member, the document was also forwarded via email. This insured that prompt notification of the various items were promptly disseminated to the appropriate team members and allowed for constant project tracking and documentation.

The third database created for this project was the Information/Record Database which is the primary database product of this study. It is the central repository of the collected documents and data. It contains the citations, abstracts and other identification information for each record. It also contains the geographic references and attachments such as scanned documents, spreadsheets, databases and links to homepages on the Internet.

A Information/Data (ID) record was prepared for each report, study, publication or item of interest, located during the search phase of this project. This information was entered into the Lotus Notes database for subsequent tracking and categorization. The information records include as a minimum the identification record information containing the primary metadata as agreed upon by the MBNEP data management committee. The database can be queried by any of the major issue categories, by date, by location, by title and by author. This allows for a flexible query engine for subsequent researchers.

The MBNEP development process has involved technical and citizen advisory committee participants in issue oriented workgroups. The Water Quality Workgroup at early stages of this study identified a list of priority issues for the MBNEP area. In order to maintain a focus toward the primary water quality issues identified by the Mobile Bay NEP, all literature, reports and data records identified during the literature research phase were classified into five major "issue" category areas:

1. Pathogens
2. Toxic Chemicals

3. Nutrient Overloading
4. Physical & Hydrologic Modifications
5. Erosion & Sedimentation

It was anticipated that these categories will become one of the major keys used in the issues identification within the MBNEP Water Quality Information Record Database.

### **3.4 Types of Information Records**

Three major types of data records were used as main categories for compilation of the Information Record database:

- Data System/ Model/Databas
- Summary/Review Publications
- Technical Reports or Publications

Initially, "Data System/Model" and "Database" categories were catalogued separately, but it was decided that distinctions between the two were minimal and therefore they were combined.

Sample outputs of each of the Information Record category data types are provided in Appendix II, and are further described below. Each record type varies slightly but has the minimal meta-data information as proposed by the MBNEP data management subcommittee. The additional information provided is pertinent to each of the data records so that efficient and complete queries and searches can be performed.

The Data System/ Model/ Database record category is used to describe and document other data systems, including static and online data where water quality information may be obtained or model systems that are related to those data systems. Examples of such data are the federal database systems STORET and WATSTOR and database query systems containing data such as the BASINS system. Many of these databases have associated Internet web sites and thus the database also includes a link to the appropriate homepage where entry into the data system can be accomplished. This type of record was also used to identify modeling programs and the availability of the programs and their location. This will be useful to future researchers working on the water quality modeling project under consideration by the MBNEP.

The record category also has appropriate information to identify and describe data, generally machine readable, which are available through various federal, state and local entities but is not necessarily published or maintained on a public system. In some cases, these data may be published in some of the national systems (such as data collected by ADEM is also entered the STORET system) but may be more accessible directly. In others, the only source of the compiled information may exist on a spreadsheet or database at one agency office. This category may also include "proprietary" or "pre-publication" data which may need some quality assurance measures before it will be accessible on another system, but can be obtained for more timely analysis.

The Summary/ Review Data Record category describes summary and review publications which may generally describe a program or a study but which relies on data and analysis that exists in one or more of the other categories. In many cases these documents only summarize and refer to data and are not the primary location one would look to find the detailed or raw data used.

The Technical Publication Record type provides information on technical publications and studies produced by the various entities who work on Mobile Bay and its watershed. This includes primarily published articles and agency reports that are accessible through libraries and agencies. It includes the “gray literature” reports produced by local agencies, universities, industry and other groups that may have a very limited circulation but provide pertinent information on some aspect of water quality.

The various database records described above provide a wealth of information to researchers accessing the various data elements.

### **3.5 Information Record Descriptor Fields**

The information record descriptor fields are a series of fields upon which the various records can be sorted, displayed, searched, viewed and categorized. In addition to the title, author and full citation, these informational fields also include:

Data Information Record Type

MBNEP Issue Category

Sample Type (Matrix)

Parameter Group

Dates:

    Date of Publication

    Date of Collection

Location by:

    Quadrangle

    Latitude & Longitude (if available)

    UTM Coordinate (if available)

    MBNEP Area

These identifiers can be used to query the database (described below) to select the most appropriate information, data and reports that the individual researcher is seeking. Subsets of the data can be used to further develop information on a particular topic.

An additional modifier of the Information Record Database includes the "Comments/Limitations" field of the information/data set. This modifier comments on the completeness and/or applicability of the information contained in the record, from the record provider or researcher. This is necessary, since one MBNEP researcher may desire to search the information base at a different resolution than another. Also, various QAQC identifiers were used to establish the completeness of each record for the internal review process that was maintained during the record entry process.

Additional descriptive information in the Information Record database includes a full title of the document, the author of the document, including contact information, a complete and consistent citation of the document and an abstract of the information. The abstract is indexed and searchable by free-form search, thus the entire text of the abstract and titles can be reviewed for keyword searches.

The availability and form of the original information or data (hard copy report, database, maps, etc.) is also indicated on the data record. If the information program is an ongoing project, it is also recorded on the data record.

Finally, in many cases it was possible to attach the original document to the Lotus Notes database directly. For example, digital files such as wordprocessing documents, spreadsheets, databases (Access, Approach, dBase & Paradox), scanned images, maps and Adobe Acrobat files can all be attached to the rich text abstract field of the data records. Thus, if digital information for a particular information record were readily available, they were attached directly to the information base. This will be useful for the future use of the informational database since attaching additional files can be performed in the future, as additional ongoing projects and tasks provide various data and information.

### **3.6 Data Input Forms**

Data input into the data records was accomplished through the use of "Forms" which automate and evaluate the data entry process. The major advantage of the input forms can be the use of specified categorical entry fields, such as the Issue and Parameter Group fields. Since these categorical fields are either selected from a checkbox or button, erroneous data entry from misspelling, etc. is minimized. Also, each Form can be customized for each record type so that redundant information is entered automatically. The creation of input Forms simplifies data entry and provides for more robust error checking and validation of data during entry. Examples of the input Forms with associated checkboxes and description of information to be entered in each field are presented in Appendix II.

### **3.7 Search and Query Techniques**

The Information Record database has query capabilities so that lists or reports of the accessible information are available. The system is capable of inquiry so that various sorting strategies are available. These are referred to as Views of the database. Examples of various Views are presented in Appendix II for an information base that is sorted by author, title, category and parameter group.

Search and query techniques within the database are also performed using customized "views" of the database which are simply database reports of the data variables. The records can be sorted and identified as to each descriptor field as the user desires. Full text indexing of the various fields is performed, allowing the user to search the database on a word, group of words, phrase or sentence. Categorical variables (such as record type and issue category) were designed to narrow the search and, provide the user with a more concise grouping of information records focused toward the users needs. The various

customized searches performed can be saved by the user for subsequent use. Thus, searches can be refined by an iterative execution of searches through different views.

## **4.0 DESCRIPTION OF THE MBNEP STUDY AREA**

### **4.1 General Characteristics**

#### **4.1.1 Location**

Located in the extreme southernmost segment of Alabama and at the terminus of the Mobile River Drainage Basin (Figure 4-1), the Mobile Bay National Estuary Program (MBNEP) area includes portions of two counties, Baldwin and Mobile. These counties contain several municipalities; notably the City of Mobile metropolitan area on the west side of Mobile Bay and the smaller cities to the east commonly referred to as the Eastern Shore (Figure 4-2). The boundaries within the MBNEP study area are those defined by the MBNEP Management Conference, "the northern boundary will be the Mobile and Baldwin County boundaries, the eastern boundary will be the divide between the Mobile and Perdido watersheds, the southern boundary will be the State Territorial Sea (3-mile limit), and the western boundary will be the Alabama State Line in eastern Mississippi Sound and the Mobile-Escatawpa River watershed division northward". Mobile Bay influences the Mississippi/Alabama continental shelf under high flow conditions and therefore the boundaries were extended to the three-mile limit. Although waters of Little Lagoon on the Fort Morgan Peninsula in Baldwin County drain into the Gulf of Mexico and are catalogued by the USGS within the Perdido Bay Basin, they are understood to be included within the study area (MBNEP Management Conference Agreement and MBNEP Program Office). However, the drainage area feeding Little Lagoon from east of Highway 59 (i.e., the Shelby Lakes area) is understood to be outside the MBNEP area.

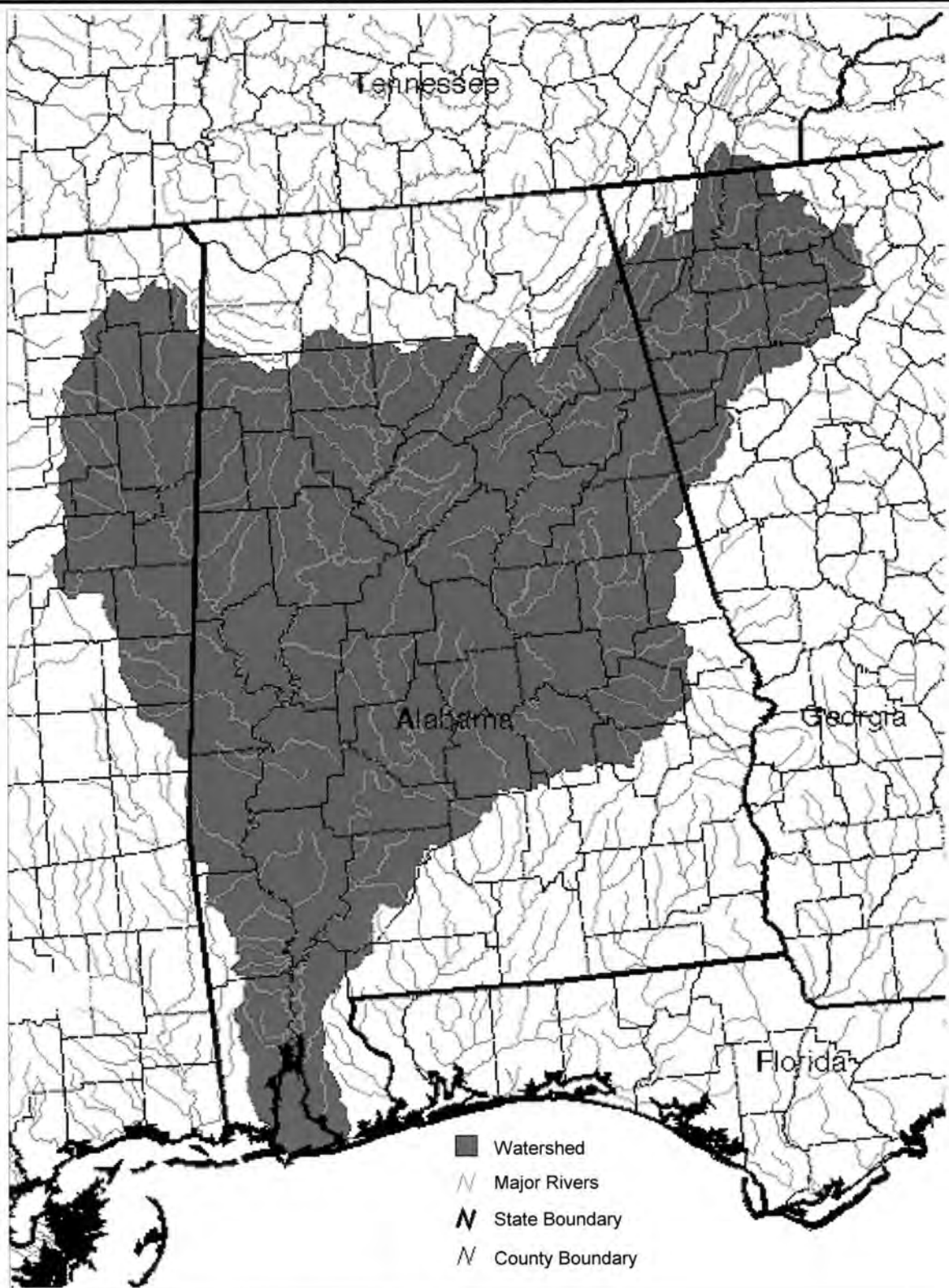
#### **4.1.2 Climate**

The MBNEP study area is sub-tropical with moderately long hot summers, short mild winters, and abundant rainfall. The Gulf of Mexico to the south and the large continental mass of the United States to the north influence the study area. Prevailing winds fluctuate between seasons, ranging from southeastward in the spring, southwestward in the summer, and northerly during the fall and winter (Smith, 1986).

Warm temperatures can be expected from about early May to mid-September with "Indian Summers" a usual occurrence. A frost-free season may last greater than 200 days. Freezing temperatures are infrequent in the winter and temperatures below 20° F are rare. Heat extremes in the summer infrequently average 100° F. The average annual temperature is 68° F.

The average growing season is about 275 days beginning in the early spring and extending well into the fall. Two crop cycles are produced each year. Wheat, oats, rye, and winter grasses are grown during the winter season, whereas corn, soybeans, potatoes, and cotton are primary summer crops.

Area average rainfall is among the highest within the continental United States for metropolitan areas. Annual rainfall averages 65 inches per year and can be punctuated by hurricanes, tropical storms, and El Niño events. The driest period of the year is typically between the months of August and November. The quality of the precipitation in Alabama is monitored at a state-central,

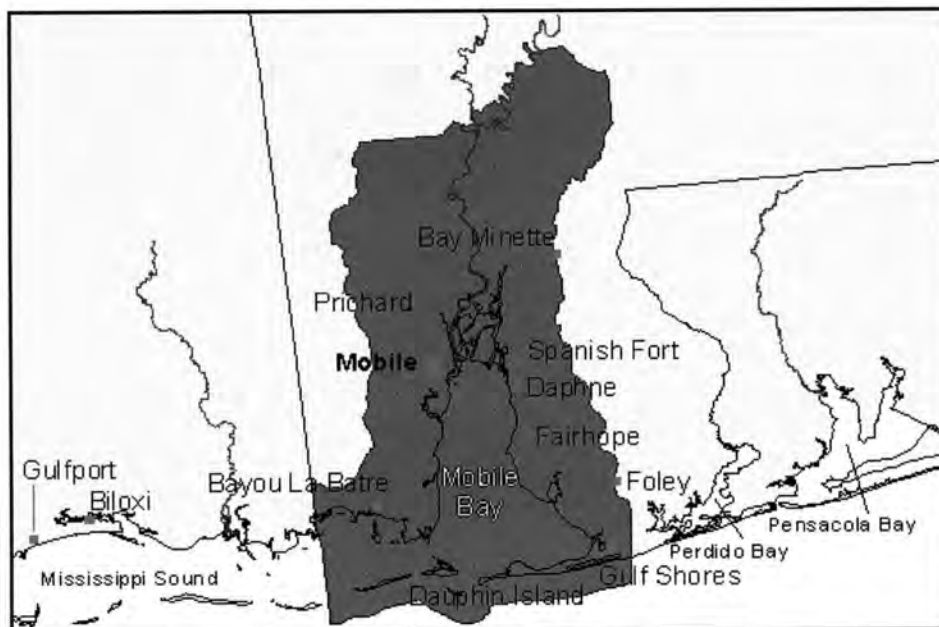
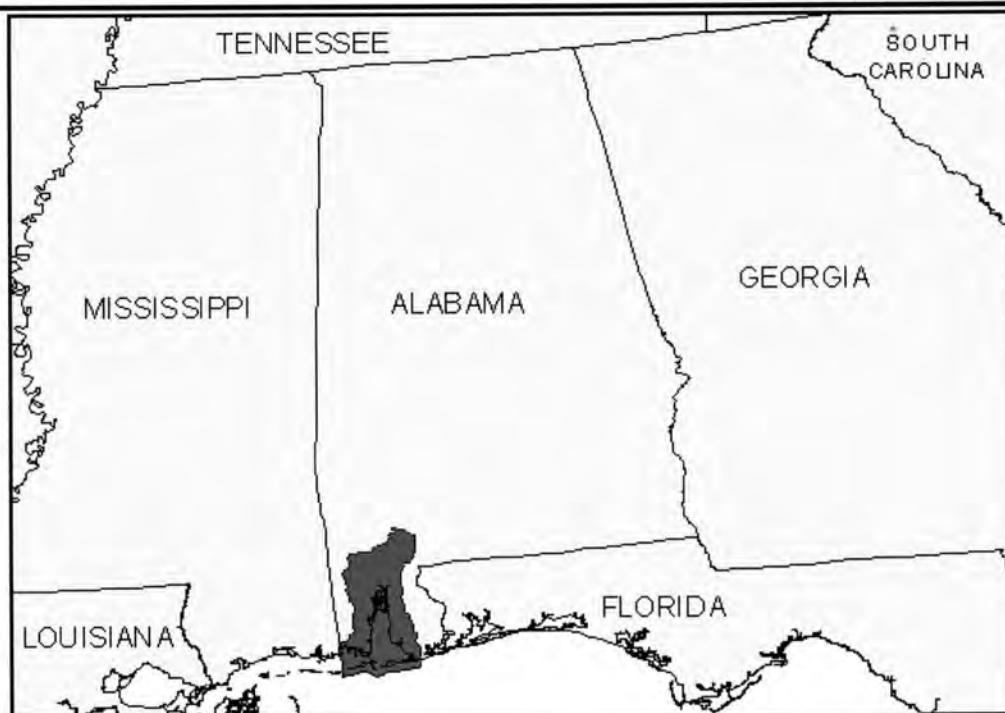


**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI** ENVIRONMENTAL  
SCIENCES, INC. 

**Figure 4-1**  
**Mobile River Drainage Basin**





- USA (land)
- NEP Study Area
- Major Rivers
- State Boundary
- Cities & Towns



**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI** ENVIRONMENTAL  
 SCIENCES, INC. 

**Figure 4-2  
MBNEP Vicinity Map**

rural site, by the U.S. Geological Survey (USGS). While water quality information from this site varies according to weather, specific conductance values have ranged from 5.4 to 48 microsiemens per centimeter, pH has ranged from 4.11 to 6.67, and sulfate concentrations have ranged from 0.06 to 5.4 mg/L (Pearman, *et al.* 1997). Atmospheric deposition associated with precipitation has little documentation in the NEP study area.

#### 4.1.3 Physical and Geologic Features

The study area topography ranges from rolling hills and valleys of tributaries to low-lying areas draining into sloughs, bayous, marshes and bays. Topographic highs are associated with the Springhill area of Mobile County and the Ecor Rouge bluff of the Eastern Shore in Baldwin County. This bluff area is known to be one of the most significant highs in the immediate coastal area. The Mobile Bay is approximately 31 miles long and 10 miles wide with an average depth of 10 feet. The area comprising the Mobile, Tensaw, Blakeley, Spanish, Raft, Middle, and Apalachee Rivers is commonly known as “the Delta,” and referred to as the Mobile-Tensaw Delta. This vast area is approximately 280 square miles (Smith, 1988).

The Mobile Bay and Delta are components of a submerged river valley; drowned during climatic warming after the most recent ice age. The Delta’s broad alluvial plain north of Mobile Bay consists of yazoo tributaries and meandering streams. The Alabama and Tombigbee Rivers join to form the Mobile River (near the northern boundary of the MBNEP area) as the stream channels approach the Delta. Once in the Delta the channel divides separating the Mobile River from the Tensaw River. Because of the very slight channel gradient in the present distributaries, salt or brackish water has been reported above the two county lines. To the west, and contained within the MBNEP boundaries, is a portion of Mississippi Sound. This area has drowned valleys that are less pronounced.

At the lower end of Mobile County and extending offshore is a series of barrier islands. The Ft. Morgan peninsula in Baldwin County comprises a tidal inlet and spit that is migrating westward and ends at the entrance to Mobile Bay at Main Pass. To the west of Main Pass is Dauphin Island, Alabama. Dauphin Island is located in the confluence of Mobile Bay, the Gulf of Mexico, and Mississippi Sound. Directly south of Dauphin Island and Main Pass is Sand Island. This barrier island has migrated significantly since historical times and comprises far less emerged land than shown in historical records.

The physiographic province for the MBNEP study area represents the southernmost extent of the Alabama Coastal Plain consisting typically of Miocene, Pliocene, Pleistocene or younger sediments. The geologic formations of the Alabama Coastal Plain form a wedge of seaward thickening sedimentary deposits. The oldest geologic unit exposed is the Lower Miocene Undifferentiated which is characteristically composed of clay, sand, and sandy clay, light-gray, yellowish-gray, yellow, and white, laminated to thin-bedded, and massive. It is also known as the Mobile Clay in the Mobile-Baldwin county area and is equivalent to the Hattiesburg Clay in neighboring Mississippi and the Pensacola Clay to the east in the Florida Panhandle. Stratigraphically it overlies the Tampa Limestone which is not exposed in Alabama or western Florida. The Mobile Clay is an obvious marker bed throughout both state counties. This unit thickens southwestward and is fossiliferous, gray to green in color, glauconitic, and may contain beds and lenses of sand (Raymond, 1985). The Upper Miocene Ecor Rouge is composed of sands, clayey sands, and silts (Isphording, 1977). The next successively younger unit is the

Pliocene Citronelle Formation composed of characteristically dark-reddish-brown to orange sand and quartz gravel with local clay balls and clay partings. Yellowish-brown iron oxide-cemented sandstone can be used to differentiate the base of the formation from the older Ecor Rouge Formation. The Pleistocene units are alluvial and terrace deposits. These materials are typically composed of white, gray, brownish-red, and orange, fine- to coarse-grained sand that is gravelly in many exposures. Lenticular beds of light-gray, orange, and yellow sandy clay occur locally. Alluvial deposits consist of alluvium, beach, estuarine, swamp, stream, and deltaic deposits and include white, gray, black, orange, and brown, very fine- to coarse-grained sand, clayey sand, sandy clay, and peat. They may include variable amounts of organic material. Gravel may occur locally and is Holocene in age (Smith, 1986).

Surface soils reflect the underlying alluvial deposits ranging from wet loamy alluvial sand and muck to fine and very fine sandy loam to loamy fine sand (USDA, 1990). The majority of soils are loamy fine sands and sandy fine loams occurring on 0° to 5° slopes. The sediments within the northern portion of the Mobile Bay are predominately silts, clayey silts, delta front sands and silty sands transported into the estuary by the Mobile River system. These materials reflect the local stratigraphic make-up as well as those materials brought in from agricultural and development uses. The central and southern portions of the Bay consist of varying amounts of silty clay and clay. A band of sand occurs around the Bay margins.

An estimated 1.4 million metric tons of suspended material mix with shelf contents seaward of the barrier islands. Sedimentation rates within Mobile Bay average approximately 0.5m per 100 years though this may be highly variable and is difficult to measure. Isphording and Flowers (1990) reported an average yearly sedimentation rate for the entire bay to be 4.9 to 5.0 mm per year.

#### **4.1.4 Surface Water Hydrology**

Mobile Bay constitutes the primary depositional basin for the Mobile River system, which is the sixth largest river system in the United States, in terms of drainage area, and the fourth largest in terms of discharge. The rivers discharging into the bay drain a watershed of more than 43,000 square miles, which includes more than two-thirds of the State of Alabama, and portions of Mississippi and Georgia. The mean discharge of the contributory river system is 62,000 cubic feet per second (cfs), and principally includes the Tombigbee/Black Warrior and Alabama/Coosa/Tallapoosa river systems (Isphording and Flowers, 1990). The Mobile-Tensaw River Delta complex is the largest internal bay-head delta complex in the United States (Isphording, *et al.*, 1996).

Within the MBNEP area, local watersheds consist of several major sub-drainage areas that influence conditions of local streams and tidal embayments, Mobile Bay, and Delta region. These include Dog River, Fowl River, Weeks Bay, Bon Secour River, and others. Spatial delineation of the study area was based on the current USGS hydrologic units and Natural Resources Conservation Service (NRCS; formerly the Soil Conservation Service or SCS) sub-watersheds. A description of these delineations are described in Section 4.2.

A complex system of environmental components affects the Mobile Bay and Delta. Natural or man-made alterations in natural flow regimes in the tributaries can have significant effects on receiving water bodies. In addition to changing salinity levels, inflow provides nutrients and sediments (trace metals and minerals) that can affect the overall productivity of the estuarine cycle.

Discharge from local watersheds has been examined in selected areas. Mean, maximum, and minimum streamflow for water year 1996 were recorded from Fish River, Alabama near Silver Hill in Baldwin County and Chickasaw Creek, Alabama near Kushla in Mobile County by the USGS (Pearman, *et al.* 1997). A 26-year record for Fish River shows an annual mean of 194 cfs. Maximum peak discharges were 9,810 cfs with a recurrence interval of < 25 years. Minimum 7-day averages are 75 cfs with a recurrence interval of < 2 years. Chickasaw Creek has a recorded history for 45 years. Annual mean streamflow is 386 cfs. Peak maximum discharge has been 10,800 cfs with recurrence intervals of <10 years and minimum 7-day averages are 82 cfs with a recurrence interval of < 2 years. Recent yearly base flows were normal to above normal in the area. Peak discharges remained within historical extremes.

If the above-described local watershed flow records are expressed on a unit area basis, the Fish River watershed (55.3 square miles above Silver Hill) has an annual mean discharge of 3.51 cfs per square mile. Similarly, the Chickasaw Creek watershed (125 square miles above Kushla) has an annual mean discharge of 3.09 cfs per square mile. Extrapolating an overall average of 3.22 cfs per square mile, the local watersheds of Mobile and Baldwin Counties draining to the Mobile Bay (approximately 1,720 square miles, exclusive of open water areas) are estimated to contribute an annual mean discharge of 5,540 cfs. Not unexpectedly, this estimate comprises a small proportion (9 %) of total annual discharge compared to the average 62,000 cfs contributed by the Mobile River Drainage Basin upstream of the MBNEP study area. However, the amount of freshwater flow into Mobile Bay through the Mobile River system ranges widely from about 10,200 cfs during dry weather to more than 530,000 cfs during flooding conditions.

Between 75% to 85% of the discharge from Mobile Bay flows into the Gulf of Mexico through Main Pass, with the remainder flowing through Pass aux Herons into eastern Mississippi Sound. Mobile Bay's salinity regime ranges from a bay wide influence of high salinity Gulf of Mexico waters during extended periods of low river discharge, to dominance by freshwater under flooding river conditions (Schroeder and Lysinger, 1979). Freshwater influence is highly variable given the river system's dependence on local climatic conditions that do not always reflect wet or dry seasons.

The bay's thermal regime is well defined as it is directly related to atmospheric temperatures. Recorded water temperatures range from 32° F to 91.4° F. Circulation patterns are difficult to predict but are influenced by lunar tides, river discharge, and wind induced tides. Typically, incoming tidal waters enter through the east Main Pass, flow to the northeast, and exit along the west side of the Main Pass. During periods of high river discharge, down-bay waters follow the Mobile Ship Channel and may even flow toward the eastern side of the Bay (Schroeder and Lysinger, 1979).

Total annual sediment load entering the Mobile River from the Alabama and Tombigbee Rivers is estimated at 4.76 million metric tons per year. Including contributions from adjacent watersheds downstream of the confluence of these rivers, a total of 4.85 million metric tons per

year is estimated to enter the Mobile-Tensaw Delta and Mobile Bay system. Approximately 33% of these materials remain in the Delta, while 3.26 million metric tons enter the bay. Most of this sediment load is trapped within the bay (on the order of 2.5 million metric tons per year), whereas the remainder (about 16% of the total load entering the delta) is discharged to the Gulf and Mississippi Sound (Isphording *et al.*, 1996).

#### 4.1.5 Groundwater Hydrology

Groundwater provides an important source of drinking water (public and private) within the MBNEP study area. Most public water supply systems utilize groundwater, except the Mobile Area Water and Sewer System which serves the metropolitan area of Mobile (which uses surface water sources outside the MBNEP boundaries) and the Prichard Water Works Board. Groundwater hydrology in the MBNEP area can be generally described according to three locations: Baldwin County, Mobile County, and areas with special exceptions. These exceptions include Dauphin Island, Alabama and Gulf Shores, Alabama, both of which have unique subsurface hydrologic situations.

Groundwater within the MBNEP area is sourced in two ways: (1) shallow well unconfined aquifer withdrawal and (2) deep well confined aquifer withdrawal. Shallow wells typically tap Pliocene/Pleistocene alluvial and coastal deposits and are generally recharged by area rainfall. Often tapped is the Pliocene Citronelle Formation which can crop at the surface (Springhill area Mobile) and is up to 200 feet thick. Stratigraphically different yet hydraulically connected are the Upper Miocene and Pliocene aquifers and most wells tap these units. The Mobile Clay, a mostly impervious unit, separates shallow groundwaters from deeper confined aquifers. Major confined aquifers within the NEP study area are within the Lower Miocene. Groundwater levels reported by the USGS have remained stable in recent years. Seasonal patterns in unconfined aquifers reveal highest levels in April and lowest levels in September. Given the shallow southerly dip of the beds, recharge of the units for Mobile County is north and west of many city wells. Recharge for Baldwin County shallow wells typically is in the geographic highs which separate the Mobile and Perdido watersheds.

All of the water supply for Baldwin County is derived from well water. Public supply wells mostly tap the Miocene/Pliocene aquifer system. Wells tapping the Miocene series typically yield up to 1,000 gallons per minute. Wells from the Pliocene deposits yield up to 700 gallons per minute. Infrequently some wells, in the southernmost part of the county, tap the Holocene and Pleistocene alluvial deposits. Their reliability is heavily dependent on local groundwater recharge and generally yield up to 10 gallons per minute. Typical well depths range from 30 feet to 1,500 feet with an average range between 200 to 400 feet deep. Groundwater is also heavily used for self-supplied domestic, agricultural, and recreational purposes (Robinson, *et al.*, 1996).

Surface water is the main public supply for the metropolitan areas of Mobile and Prichard. However, wells are utilized for supplies in the southern and northern portions of Mobile County. Most wells throughout Mobile County typically tap the Miocene with a moderate number sourcing the Pliocene Citronelle Formation. Well depths are similar to those as in Baldwin County.

Dauphin Island is 6.3 square miles in area and is situated at the confluence of the waters of Mobile Bay, the Mississippi Sound, and the Gulf of Mexico in Mobile County, Alabama. Freshwater is confined to the upper 100 feet of a surficial unit consisting of alluvial, low terrace, and

coastal deposits. The zone has the form of an elliptical "lens" oriented east-west along Dauphin Island. The zone is approximately 15 miles long and varies in width and depth. Seasonal evapotranspiration losses, variations in rainfall, and the presence of salt water affect its symmetry. The storage capacity of the fresh groundwater "lens" is small, roughly twice the annual rainfall. Salt-water encroachment is a primary groundwater concern for coastal areas. Salt-water encroachment may be indicated in a coastal area by an increasing chloride content in water produced by a public deep-well system. The wells tap a shallow interval of Miocene siliciclastics (sand and gravel beds) which are 200 to 300 feet below land surface and is semi-confined by clay layers (Chandler and Moore, 1982).

Gulf Shores, Alabama, is located east of the Fort Morgan Peninsula. The MBNEP boundary passes southward through the middle of the town. Gulf Shores' water supply, like that of Baldwin County, is groundwater. Well levels have recently declined where the groundwater levels are less than 5 feet above sea level (Robinson, *et al.*, 1996). The Fort Morgan area receives most of its water from Gulf Shores, although some private wells exist. This slender spit is influenced both by Mobile Bay and the Gulf of Mexico. Recent local interest has focused on potential problems with saltwater encroachment for the Gulf Shores area.

Natural groundwater quality problems may include high levels of iron, manganese, sulfur compounds, dissolved solids, and other water quality parameters. Pollution concerns include septic tanks, waste sources, agriculture, and storage tanks. The entire study area is considered to be susceptible to contamination from the surface due to the permeability of the underlying sediments (Mooty, 1988).

#### **4.1.6 Land Use and Population**

Mobile Bay's local, regional, and national significance centers on its abundant natural resources which provide a wealth of recreational and commercial uses. The Mobile Bay and Delta are subjected to an unusually large number of major uses with national implications. These include the Tennessee-Tombigbee Waterway, Port of Mobile, fisheries, tourism and recreation, and coastal development. Local ecosystems have been subjected to increasing pressure from a variety of proliferating activities including commercial and recreational fishing, silviculture, oil and gas extraction, shipping and channel excavation, industrial construction and wastes, residential development, municipal waste treatment discharges, and nonpoint source runoff (South Alabama Regional Planning Commission, 1995). The density in Alabama is 79 persons per square mile compared to the U.S. average of 69 per square mile. Distribution is 60 percent urban, 40 percent rural.

The Mobile Bay area's growth has been one of increasing concern as it contributes to environmental issues. The latest Census Bureau estimates indicate that Baldwin County's population climbed from 98,280 in 1990 to 128,842 in 1997 (Mobile Register, 1998). Baldwin County is the largest by area and second fastest growing county in the State. Mobile County is the second largest by population and contains the second largest city within the State of Alabama, Mobile, with a population of 196,278 (Alabama Department of Economic and Community Affairs, 1998). This number excludes other areas within Mobile County yet reflects and estimated 325,000 people within the MBNEP area.

Baldwin County has a total of 167,832 acres in farmland supporting crops and livestock

(Agricultural Census, 1992). Some 35,000 head of cattle and 542,000 hens and pullets contribute to the economy and potentially the environment. Mobile County's land total in agriculture usage is slightly less with approximately 104,342 acres. Cattle number around 21,000 head and hens and pullets around 77,000 birds.

Comprehensive area-wide land use statistics have not been compiled for either county since the 1970's. At that time, agriculture and forestry were the largest uses of land for the two counties. Conversion of these lands to urban or suburban areas has occurred over the past twenty years. An up to date, comprehensive, land use evaluation is needed for the two counties.

#### **4.1.7 Water Quality Standards and Use Classifications**

##### **4.1.7.1 Surface Waters**

The U.S. Environmental Protection Agency (EPA) is the primary Federal agency responsible for developing and implementing Clean Water Act (CWA) programs. Section 303 of the CWA states that water quality standards are to be developed for all surface waters in the United States. Standards are developed through the delineation and support criteria of stream segment use. All states may develop their own site-specific guidelines provided they support the existing Federal guidelines. These guidelines cover all general areas of public and private use including navigation, industry, and recreation.

In concert with the Federal mandates, Alabama's water quality standards are comprised of two principal elements, water quality criteria and water use classifications. These can be found in the Alabama Department of Environmental Management (ADEM) Administrative Code, chapters 335-6-10 and 335-6-11.

Water quality criteria provide the tools and means to determine and manage the best uses of waters within the State. Standards are established for parameters fundamental in determining water quality and that can be easily monitored, and compared to generally available data. The specific parameters or criteria used include: best uses of said water body; conditions related to best usage; other potential usage; conditions related to other usage; sewage, industrial waste or other wastes; pH; temperature; dissolved oxygen; toxic substances; taste or odor attributable to said wastes; bacteria; radioactivity; and turbidity.

These criteria are utilized to support the following eight water use classifications for the State of Alabama: (1) Public Water Supply; (2) Swimming and other whole body water-contact sports; (3) Shellfish Harvesting; (4) Fish and Wildlife; (5) Agricultural and Industrial Water Supply; (6) Industrial Operations; (7) Navigation; and (8) Outstanding Alabama Water. Also recognized in ADEM's regulations is a special designation of "Outstanding National Resource Water." Local county and city municipalities have not developed stricter guidelines and follow the ADEM criteria. Two principle parameters for differentiation among use classifications are dissolved oxygen (DO) and bacterial indicators (fecal coliform), both of which affect the living resource base as well as human health. Standard levels specified for the referenced classifications are as follows:

<b>Classification</b>	<b>Dissolved Oxygen</b>	<b>Fecal Coliform (colonies/ml)</b>
Public Water Supply	5.0 mg/l	mean 2000/100ml
Swimming and Whole Body Contact	5.0 mg/l	mean 100/100ml*
Shellfish Harvesting	5.0 mg/l	14/100ml **
Fish and Wildlife	5.0 mg/l	mean 1000/100ml***
Agricultural and Industrial	3.0 mg/l	n/a
Industrial Operations	3.0 mg/l	n/a
Navigation	2.0 mg/l	n/a
Outstanding Alabama Water	5.5 mg/l	mean 100/100ml

\* 200/100ml for non-coastal water

\*\* Shellfish Sanitation Program Manual

\*\*\*200/100ml during summer

The special designation “Outstanding National Resource Water” does not establish separate water quality criteria, but provides additional use restrictions such as point source discharges and mandatory non-point source (NPS) Best Management Practices (BMPs).

With the exception of the Mobile Harbor segment (lower Mobile River, lower Chickasaw Creek, lower Three-Mile Creek and Industrial Canal) and Three-Mile Creek, which are classified as Agriculture and Industrial (A&I), all surface waters of the MBNEP area are classified as Fish and Wildlife (F&W) or higher. Several areas are designated with the higher uses of “Swimming and Whole Body Contact” (S) and/or “Shellfish Harvesting” (SH). Three relatively small stream segments are classified as “Public Water Supply” (PWS), and one area, Weeks Bay, has been given the special designation of “Outstanding National Resource Water” (ONRW). Fish and Wildlife classified waters may be considered swimmable if a sanitary survey conducted by the local health authorities finds no sign of immediate threat and the mean fecal coliform count meets the criteria. The water use classifications are depicted on Figure 4-3.

With respect to use designations, two segments within the MBNEP area are currently subject to some controversy. Notably, for the A&I segments (Lower Mobile River, Chickasaw Creek, Three Mile Creek), EPA has recently announced a requirement to upgrade to F&W. However, ADEM contends that the F&W classification is probably not attainable because of a number of factors, including lower DO levels due to saline waters present in the segment. Another area, which has recently received attention and publicity, is the Public Water Supply (PWS) segment of Eight-Mile Creek used for the Prichard drinking water supply.

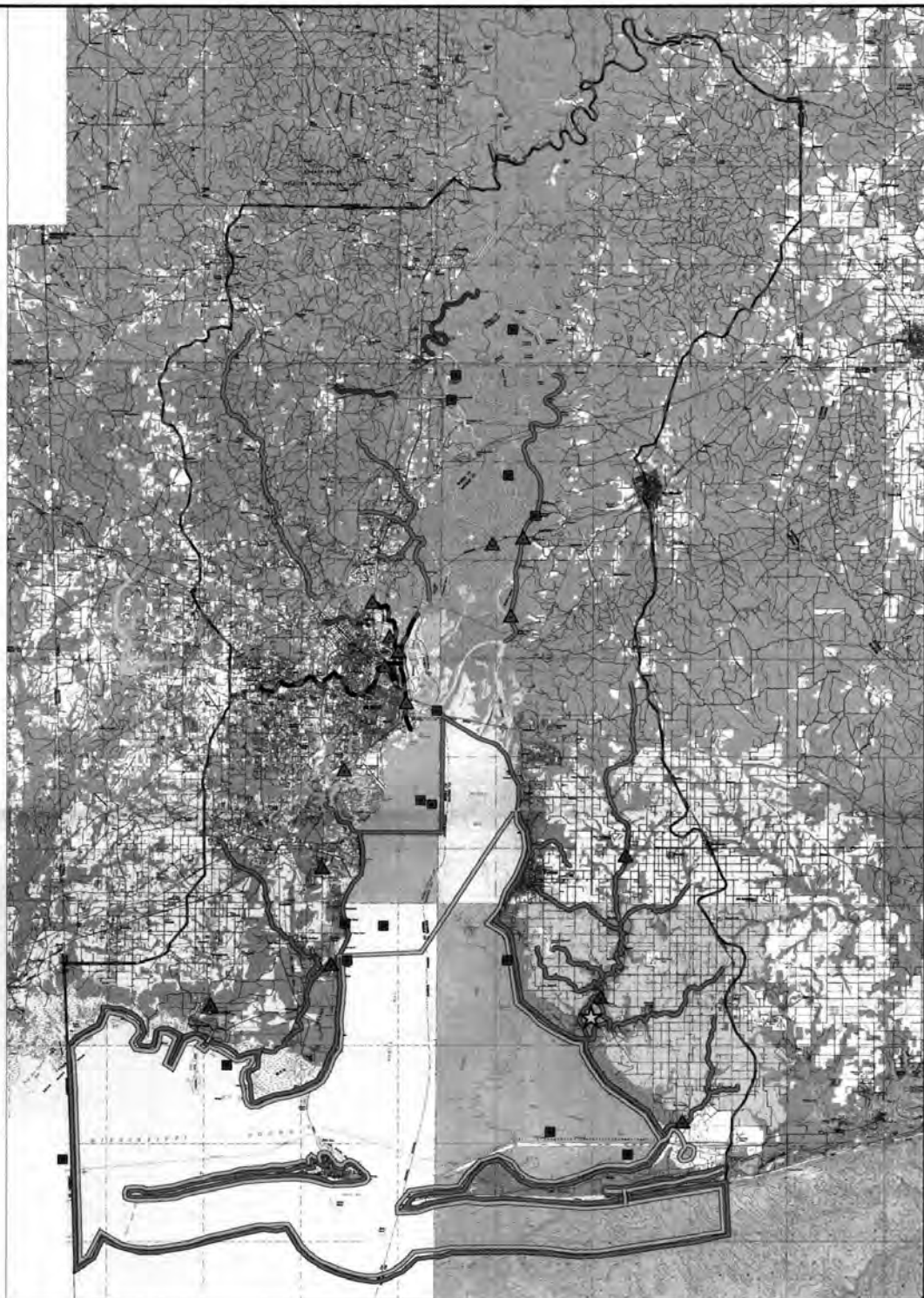




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Preliminary Characterization of Water  
Quality of the MBNEP Study Area

Figure 4-3  
ADEM Water Use Classifications and Long-Term  
ADEM Water Quality Monitoring Stations  
Within the MBNEP Study Area



- ★ Outstanding National Resource Water
- ADEM Permanent Coastal EMAP (ALAMAP-C) Station
- ▲ ADEM Ambient Trend Station
- ≡ Shellfish Harvesting
- ≡ Swimming and Whole Body Water Contact
- ≡ Public Water Supply
- ≡ Agriculture & Industry
- ≡ MBNEP Boundary



5 0 5 10 15 Miles

SCALE: (1 : 425,000)

NOTE: "Fish and Wildlife" water use classification is not separately depicted, but is applicable to all waters in the MBNEP area except those classified as "Agriculture and Industry".

#### **4.1.7.2 Groundwater**

The EPA has suggested a strategy involving a three-part classification system for groundwaters in the United States. Class I is for special ground waters which are highly vulnerable to contamination due to the areas' hydrological characteristics. Sensitive uses identified with these systems include drinking water and ecologically vital sources that contribute to stream baseflow. Class II is for current and potential sources of drinking water and water having other beneficial uses. Class III is for groundwaters not considered potential sources of drinking water, and those that may have a limited beneficial use.

ADEM has not yet developed and implemented a water use classification system for Alabama groundwaters. However, groundwaters are considered “waters of the State” and are subject to general regulatory protection under the Alabama Water Pollution Control Act. Furthermore, there are several regulatory control programs implemented at Federal and State levels which focus on groundwater protection (e.g., hazardous waste, underground storage tanks, landfills).

In compliance with the Safe Drinking Water Act, ADEM has developed a statewide Wellhead Protection Program. This program is designed to identify potential sources of contamination for a water system source and to develop a water use management plan. Public water supplies are also monitored for a list of possible contaminants on a regular basis. These include chemical, organic, and radionuclide constituents. ADEM works with the systems to maintain compliance and thus provide safe water to their communities.

## **4.2 Description of Sub-areas and Selected Characteristics Related to Water Quality Considerations**

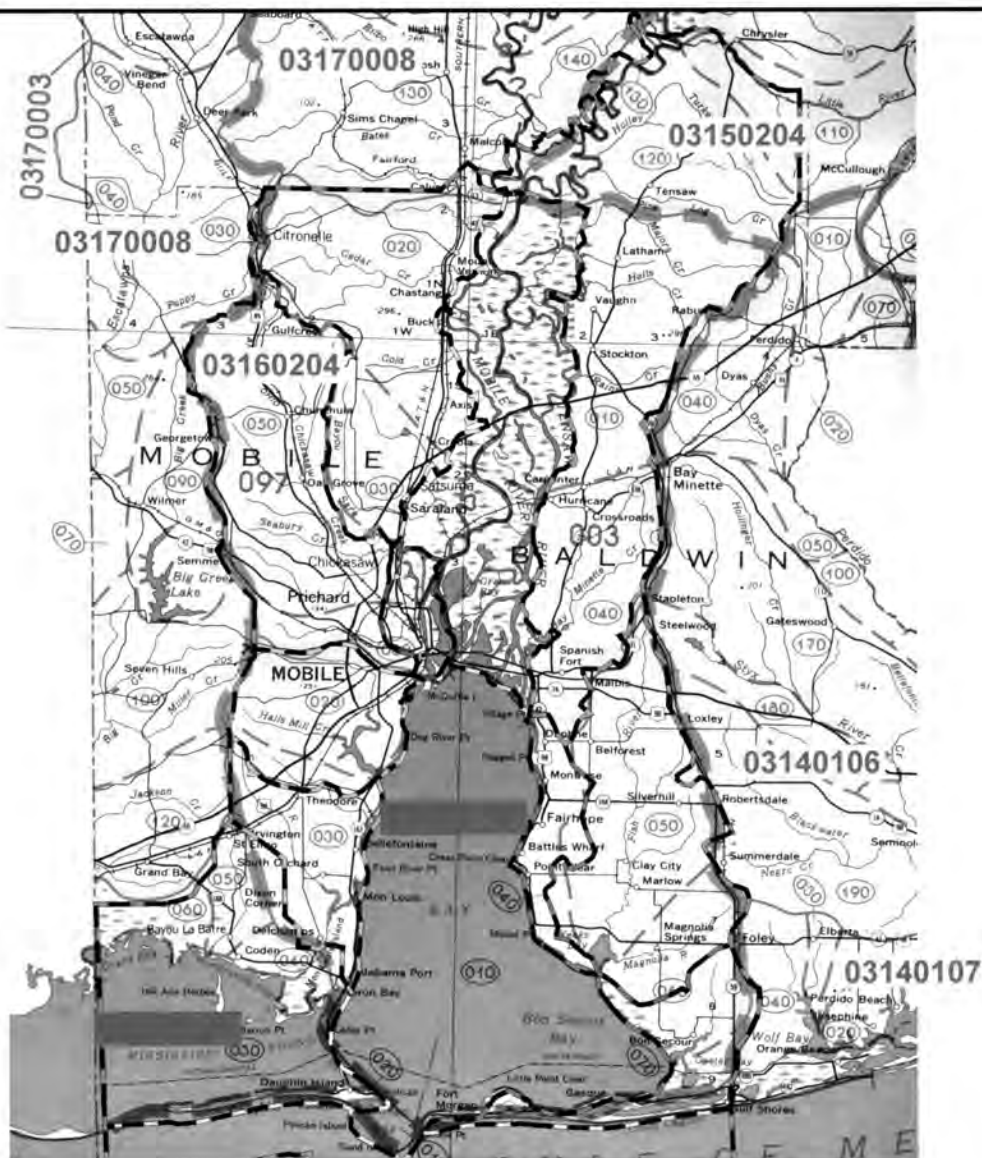
### **4.2.1 MBNEP Sub-areas Delineation**

To facilitate discussion of water quality information within this report, the MBNEP study area has been segmented into “sub-areas”. With minor exceptions, the sub-area delineations presented herein have been made consistent with the USGS Hydrologic Cataloging Unit system and with a sub-watershed delineation system prepared by the US Department of Agriculture, Natural Resources Conservation Service (NRCS) [formerly Soil Conservation Service (SCS)]. It has further been attempted to be consistent with commonly used conventions for spatial delineation within the Mobile Bay and Delta regions.

Most of the MBNEP study area is comprised of two USGS Hydrologic Units: HU 03160205 - Mobile Bay (comprised of Mobile Bay proper and local watersheds draining from the east and west) and HU 03160204 - Mobile-Tensaw (north of Mobile Bay and comprised of the Mobile-Tensaw Delta and local watersheds draining from the east and west). The northern boundary of HU 03160204 (Mobile-Tensaw) is nearly coincident with the northern Mobile County political boundary (the MBNEP boundary); however, the extreme northern portion of Baldwin County lies to the north of the Mobile-Tensaw hydrologic unit and is within HU 03150204 - Lower Alabama. The southernmost portion of Mobile County (Mississippi Sound and Dauphin Island) lies within HU 03170009 - Mississippi Coastal. The southern shore of Baldwin County draining to the Gulf of Mexico (e.g., the Little Lagoon area west of Gulf Shores within the MBNEP area) lies within HU 03140107 - Perdido Bay.

The NRCS sub-watershed system (United States Department of Agriculture, Soil Conservation Service, 1985-Revised 1993) sub-divides the USGS Hydrologic Units into open water and watershed areas designated by a three-digit code. Figure 4-4 displays the NRCS convention for the MBNEP area in relation to the MBNEP sub-areas. Also of interest is the relative proportion of the areas which are subject to existing Coastal Zone Management jurisdiction as delineated by the 10-foot contour (Figure 4-5).

The MBNEP “sub-areas” used in this report draw upon the systems described above, with certain exceptions as noted. Also included in the descriptions are the primary USGS 7.5-minute quadrangles relating to the sub-areas, which have been used to search the Lotus Notes Information Record database for spatial representation as discussed later in this report. The groupings of quadrangles are generally consistent with the sub-area, but exact correlations are not possible since the sub-areas incorporate watershed boundaries, which are of course not coincident with USGS quadrangle boundaries. The MBNEP sub-areas in relation to the USGS 7.5-minute quadrangles are displayed on Figure 4-6 and are described in the tabulations which follow.



03140107 – USGS Hydrologic Cataloging Unit Number

(010) – SCS (NRCS) Sub-Watershed Number

~ MBNEP Boundary



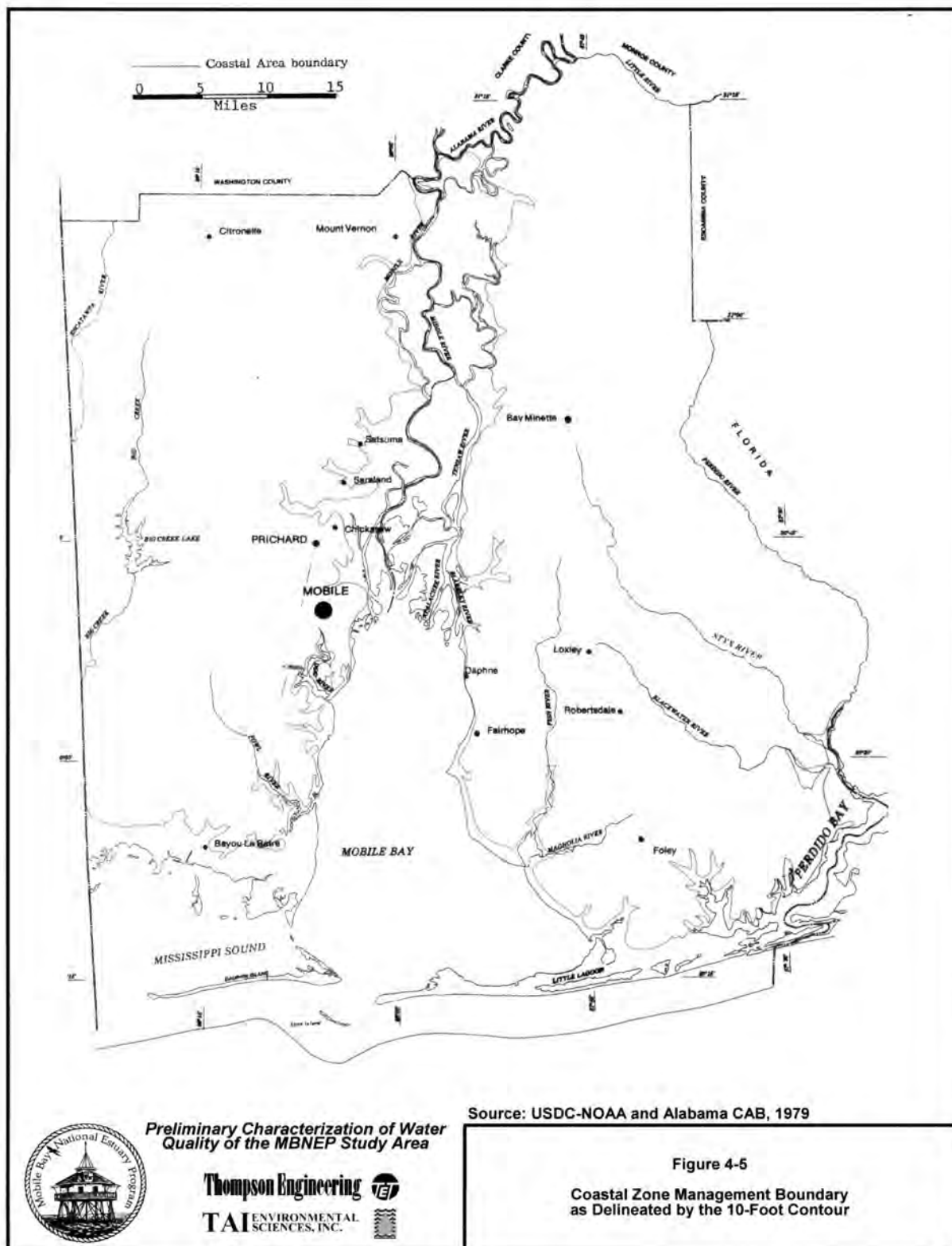
**Preliminary Characterization of Water Quality of the MBNEP Study Area**

**Thompson Engineering**  
**TAI ENVIRONMENTAL SCIENCES, INC.**

Source: US Dept. of Commerce, Soil Conservation Service, 1995

**Figure 4-4**

**MBNEP Sub-areas in Relation to USGS Hydrologic Units and NRCS Sub-Watershed Boundaries**



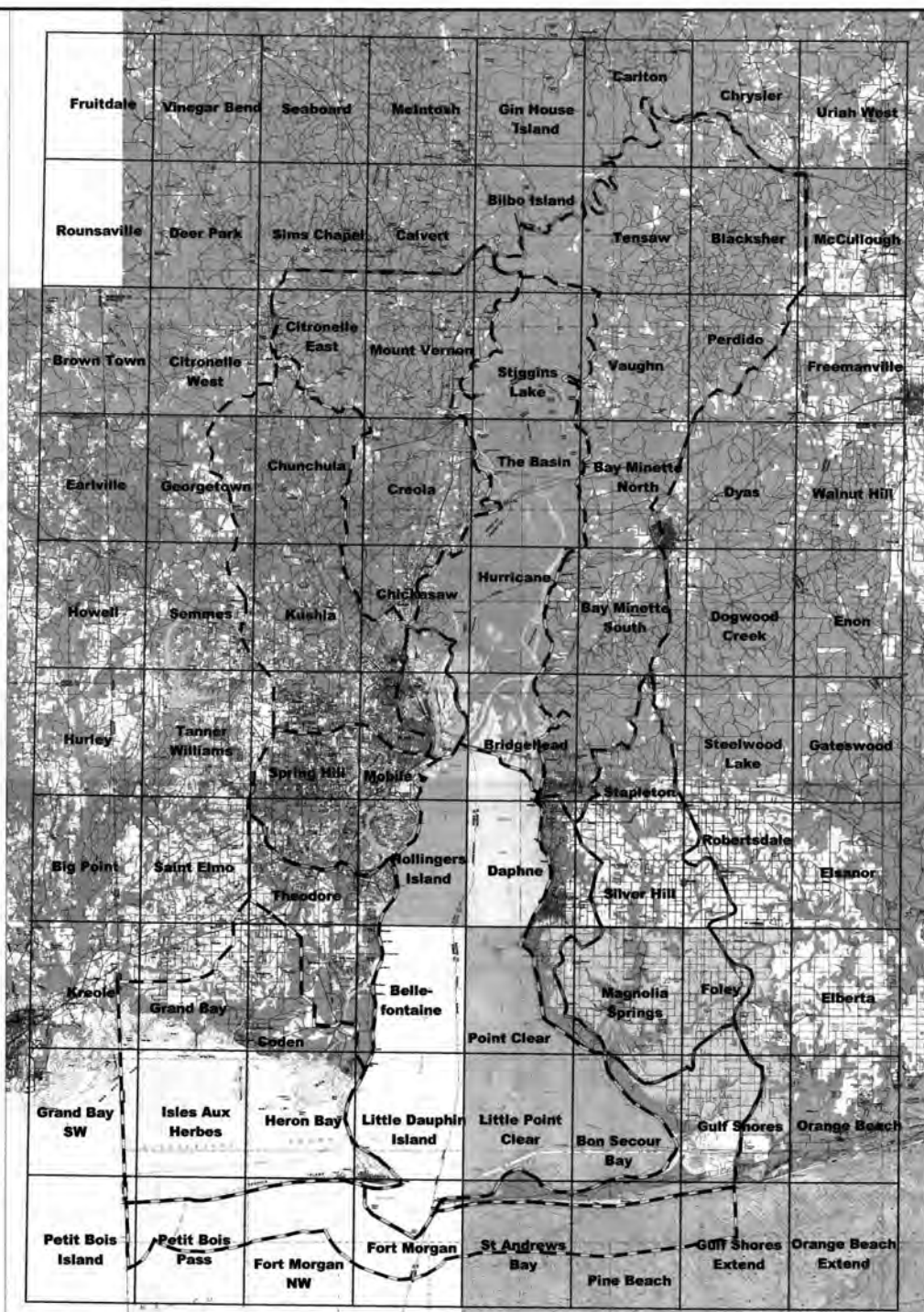


Preliminary Characterization of Water Quality of the MBNEP Study Area

**Thompson Engineering**  
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MBNEP Boundary and Sub-areas in Relation to 7.5 Minute USGS Quadrangles

Figure 4-6



- 1:24,000 Quad Sheet Index
- Offshore Sub-area
- Mobile Bay Sub-area
- Lower Mobile River (Mobile Harbor) Sub-area
- Mobile-Tensaw Delta Sub-area
- Mississippi Sound & Dauphin Island Sub-area
- East Fowl River & Deer River Watersheds Sub-area
- Dog River Watershed Sub-area
- Three-Mile Creek and Chickasaw Creek Watersheds Sub-area
- Bayou Sara, Cold Creek & Cedar Creek Watersheds Sub-area
- Bon Secour River Watershed & Ft. Morgan Peninsula Sub-area
- Eastern Shore Watersheds Sub-area
- Weeks Bay Watershed Sub-area
- North Baldwin County Watersheds Sub-area



5 0 5 10 15 Miles

SCALE: (1 : 460,000)



**MBNEP Sub-area: “Offshore”**

USGS Hydrologic Unit: None  
 NRCS Sub-watersheds: None

Remarks: The “Offshore” MBNEP segment extends from the Dauphin Island, Sand Island, and Ft. Morgan Peninsula shorelines southward to the 3-mile limit (Note: This sub-area does not include Pelican Bay).

USGS Quadrangles: Petit Bois Island, Petit Bois Pass, Fort Morgan NW, Fort Morgan, Saint Andrews Bay, Pine Beach, Gulf Shores Extended

**MBNEP Sub-area: “Mobile Bay”**

USGS Hydrologic Unit: HU 03160205 - Mobile Bay  
 NRCS Sub-watershed: 010 - Mobile Bay

USGS Hydrologic Unit: HU 03170009 - Mississippi Sound  
 SCS Sub-watershed: 010 - Pelican Bay

USGS Quadrangles: Little Dauphin Island, Little Point Clear, Bon Secour Bay, Bellefontaine, Point Clear, Hollingers Island, Daphne

Remarks: The boundaries include all bay waters generally south of McDuffie Island (Mobile Co.) and Village Pt. (Baldwin Co.)

Note: The NRCS system included Pelican Bay within the “Mississippi Coastal” hydrologic unit, but it was considered more logical to include it as part of “Mobile Bay” sub-area.

**MBNEP Sub-area: “Mississippi Sound and Dauphin Island”**

USGS Hydrologic Unit: HU 03170009 - Mississippi Coastal  
 NRCS Sub-watersheds: 020 - Dauphin Island  
 030 - Mississippi Sound  
 040 - West Fowl River  
 050 - Bayou La Batre  
 060 - Little River

USGS Quadrangles: Kreole, Grand Bay SW, Grand Bay, Isles aux Herbes, Heron Bay

Remarks: Boundaries include Dauphin Island proper, and mainland areas from West Fowl River to Irvington, and east of Grand Bay.

**MBNEP Sub-area: "East Fowl River and Deer River Watersheds"**

USGS Hydrologic Unit: HU 03160205 - Mobile Bay  
NRCS Sub-watershed: 030 - Fowl River

USGS Quadrangles: Coden, Bellefontaine, Theodore, Hollingers Island, Saint Elmo

Remarks: Boundaries include south to Alabama Port, west to Irvington, and north to the drainage divide between Deer River and Halls Mill Creek; also includes Theodore Ship Channel (inland portion).

**MBNEP Sub-area: "Dog River Watershed"**

USGS Hydrologic Unit: HU 03160205 - Mobile Bay  
NRCS Sub-watershed: 020 - Halls Mill Creek

USGS Quadrangles: Theodore, Hollingers Island, Spring Hill

Remarks: Boundaries include just north of Deer River and the Theodore Ship Channel, west to Mississippi divide before Miller Creek; northwest to the Airport and east to McDuffie Island

**MBNEP Sub-area: "Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three-Mile Creek"**

USGS Hydrologic Unit: HU 03160204 - Mobile-Tensaw  
NRCS Sub-watershed: 050 - Chickasaw Creek (tidally influenced portion)  
060 - Three-Mile Creek (tidally influenced portion)

USGS Quadrangles: Mobile, Chickasaw

Remarks: This segment includes the Lower Mobile River from its mouth (above McDuffie Island) to Spanish River (just south of Twelve-Mile Island); lower Chickasaw Creek from Mobile River to Highway 43; and lower Three-Mile Creek,



including Industrial Canal, from Mobile River to approximately Dr. Martin Luther King Drive. Boundaries may also be followed west along Hwy 43 east of I-65, south to just north of McDuffie Island, north along Spanish River.

Note: This segment generally coincides with tidally influenced waters classified as “Agricultural and Industrial” (A&I).

**MBNEP Sub-area: “Mobile-Tensaw Delta”**

USGS Hydrologic Unit: HU 03160204 - Mobile-Tensaw  
NRCS Sub-watersheds: 010 - Upper Tensaw River (tidally influenced portion)  
020 - Cedar Creek (tidally influenced portion)  
030 - Bayou Sara (tidally influenced portion)  
040 - Lower Tensaw River (tidally influenced portion)

USGS Quadrangles: Bridgehead, Hurricane, The Basin, Stiggins Lake, Bilbo Island

Remarks: This segment includes the Delta Region below the 10-foot contour (excluding the Lower Mobile River segment) downstream of the confluence of the Tombigbee and Alabama Rivers (i.e. formation of the Mobile River), extending south through D’Olive Bay on the eastern side. Boundaries may also be traced from just east of McDuffie Island north along the Spanish River to east of Saraland/Satsuma, through Bucks, Mount Vernon and west of the Mobile River; north just below the Alabama and Tombigbee River confluence; Baldwin County south along the Delta border and west of Hwy 205, through Hurricane to Village Point just north of Daphne.

**MBNEP Sub-area: “Three-Mile Creek and Chickasaw Creek Watersheds”**

USGS Hydrologic Unit: HU 03160204 - Mobile-Tensaw  
NRCS Sub-watersheds: 050 - Chickasaw Creek (non-tidal portion)  
060 - Three-Mile Creek (non-tidal portion)

USGS Quadrangles: Kushla, Chunchula, Georgetown, Semmes, Citronelle West

Remarks: These watersheds drain into the “Lower Mobile River” segment. Boundaries are passing to the west of Bayou Sara north just above Gulf Crest on Hwy 45; west through Georgetown to the Airport and east of Puppy Creek and Big Creek.

**MBNEP Sub-area: “Bayou Sara, Cold Creek, and Cedar Creek Watersheds”**

USGS Hydrologic Unit: HU 03160204 - Mobile-Tensaw  
 NRCS Sub-watersheds: 020 - Cedar Creek (non-tidal portion)  
 030 - Bayou Sara (non-tidal portion)

USGS Quadrangles: Creola, Mount Vernon, Citronelle East, Sims Chapel,  
 Calvert

Remarks: These watersheds drain into the “Mobile-Tensaw Delta” segment from the west. Boundaries follow north of Citronelle and east, just south of Calvert, to the confluence of the Alabama and Tombigbee Rivers.

**MBNEP Sub-area: “North Baldwin County Watersheds”**

USGS Hydrologic Unit: HU 03150204 - Lower Alabama  
 NRCS Sub-watersheds: 110 - Little River (partial)  
 120 - Pine Log Creek

Remarks: The above represents the extreme northern portion of Baldwin County.

- and -

USGS Hydrologic Unit: HU 03160204 - Mobile-Tensaw  
 NRCS Sub-watersheds: 010 - Upper Tensaw (non-tidal portion)  
 040 - Lower Tensaw (non-tidal portion)

Remarks: These watersheds drain into the “Mobile-Tensaw Delta” segment from the east, and include Bay Minette Creek and D’Olive Creek. Boundaries follow just south of Tensaw and the Pine Log Creek to the headwaters and west of Busby/Dyas Creek south through Rabun to Bay Minette to Stapleton along Hwy 31 to Village Point just north of Daphne.

USGS Quadrangles: Tensaw, Blacksher, Vaughn, Perdido, Bay Minette North, Bay Minette South, Stapleton, Carlton, Chrysler, McCullough

**MBNEP Sub-area: Eastern Shore Watersheds**

USGS Hydrologic Unit: HU03160205 - Mobile Bay  
NRCS Sub-watershed: 040 - Fly Creek

USGS Quadrangles: Daphne, Point Clear

Remarks: Includes Eastern Shore areas directly draining into Mobile Bay from approximately Daphne (not including D'Olive Creek) south to approximately Mullet Point. Boundaries may also be followed south of Village Point to include Daphne, Montrose, Fairhope, Battles Wharf, Point Clear, Mullet Point to the northern shore of Weeks Bay.

**MBNEP Sub-area: "Weeks Bay Watershed"**

USGS Hydrologic Unit: HU 03160205 - Mobile Bay  
NRCS Sub-watershed: 050 - Fish River  
060 - Magnolia River (partial)

USGS Quadrangles: Magnolia Springs, Silver Hill, Robertsdale, Foley

Remarks: The NRCS system included Bon Secour River in their "Magnolia River" watershed, but it was considered more logical herein to include the Magnolia River watershed within this "Weeks Bay Watershed" sub-area. This MBNEP segment is coincident with the "Weeks Bay Watershed Project" area funded by USEPA under Section 319 of the Clean Water Act. Boundaries may also be located starting at Stapleton moving south along Hwy 59 to Foley, South of Magnolia River just north of the Bon Secour tributary headwaters.

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**MBNEP Sub-area: “Bon Secour River Watershed and  
Ft. Morgan Peninsula”**

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USGS Hydrologic Unit:	HU 03160205
NRCS Sub-watershed:	060 - Magnolia River (partial) 070 - Bon Secour Bay
Remarks:	This segment includes the Bon Secour River watershed (included within the “Magnolia River sub-watershed” by NRCS), the Gulf Intercoastal Waterway west of Highway 59, Oyster Bay, and Ft. Morgan Peninsula draining to Mobile Bay.  -and-
USGS Hydrologic Unit:	HU03140107
NRCS Sub-watershed:	040 - Wolf Creek (partial)
Remarks:	This segment includes the Little Lagoon and Ft. Morgan Peninsula areas (west of Highway 59) draining directly to the Gulf of Mexico.
USGS Quadrangles:	Bon Secour Bay, Gulf Shores

#### **4.2.2 Selected Characteristics of Sub-areas Related to Water Quality**

In this section and related appended figures and tables, certain characteristics of each sub-area are summarized to display features that are generally applicable to considerations of water quality data. This overview is intended to provide a geographic framework oriented towards primary local watersheds and waterbodies in the MBNEP area, by which selected factors influencing the status of water quality conditions in respective sub-areas may be considered. This geographic framework is followed later in this report in the review of water quality data sets compiled within the Information Record Database. EPA's "BASINS" geographic information system (GIS) has been utilized to display selected data (for each sub-area) compiled within that database. The "BASINS" GIS (Better Assessment Science Integrating Point and Non-Point Sources) is a popular water quality assessment and analysis tool developed and being expanded by EPA. BASINS was originally released in 1996, and EPA is currently testing a "Beta" version of BASINS 2.0. This version of BASINS utilizes ArcView 3.0a GIS software, which was used in this study to create the MBNEP sub-areas as previously described. Thus, selected data within the BASINS database may be viewed for each individual sub-area. BASINS data within each sub-area which are displayed, include features such as environmental monitoring data (e.g., drinking water sources, water quality monitoring stations, USGS gaging stations, National Sediment Inventory (NSI) stations), and point source data (e.g., Permit Compliance System (PCS) discharge sites, Industrial Facility Discharge (IFD) sites, Toxic Release Inventory (TRI) sites and Superfund National Priority List (NPL) sites). When viewing public drinking water locations it is important to know that BASINS only identifies surface water supplies and not groundwater wells. BASINS data layers are further described in Table 4-1.

The locations of data points in BASINS within each MBNEP sub-area are displayed in figures presented in Appendix III. These include a series of maps for point source data locations, and another series for environmental monitoring data locations. At the time of preparation of this final report, specific geographic positioning data layers (i.e., latitude/longitude) transferable to the Southern GIS Quadbase were not yet available for water quality monitoring stations; therefore, the appended series of maps for environmental monitoring locations only include USGS gaging stations, drinking water (surface water) supply locations, and NSI stations. EPA reportedly will have the water quality station latitude/longitude files available through BASINS in the near future. It is noted the BASINS GIS also includes geo-spatial data layers, such as land use and soil classifications, which are not displayed in the referenced figures. It should also be noted that the data layers for BASINS are extracted from national databases maintained by EPA, and that erroneous locations of some data points are evidenced. Any rigorous use of the BASINS database should include a quality assurance review of applicable entries.

In addition to BASINS data, other characteristics of the MBNEP sub-areas are generally summarized as applicable. For example, such characteristics may include water use classifications, a general description of use/development of the watershed, coastal zone jurisdiction (i.e., below the 10-ft. contour), Mobile-Baldwin Counties MS4 (municipal stormwater) permit jurisdiction, proportion of the sub-area served by public water systems as opposed to private water wells, proportion of the sub-area served by public sewerage as opposed to septic tanks, and so forth. These characteristics are provided in tabulations for each sub-area, also included in Appendix III.

Table 4-1. Selected data layers contained within EPA'S BASINS GIS and displayed for MBNEP sub-areas

BASINS Data Product	Content Overview
<b>Drinking Water Supply (DWS) Sites</b>	<b>Include the location of public water supplies, their intakes, and sources of surface water</b>
<b>Water Quality Monitoring Stations Summaries</b>	Statistical summaries of water quality monitoring for 50 physical and chemical-related parameters. Parameter-specific statistics computed by station for 5-year intervals from 1970 to 1994. <i>(Note: This data layer is not currently displayed in the appended figures due to difficulties with coordinate conversion from EPA's beta version of BASINS 2.0)</i>
<b>Bacteria Monitoring Station Summaries</b>	Statistical summaries of water quality monitoring for 10 bacteria-related parameters. Parameter-specific statistics computed by station for 5-year intervals from 1970 to 1994. <i>(Note: This data layer is not currently displayed in the appended figures due to difficulties with coordinate conversion from EPA's beta version of BASINS 2.0)</i>
<b>National Sediment Inventory (NSI)</b>	Sediment chemistry, tissue residue, and benthic abundance monitoring data for freshwater and coastal sediments.
<b>U.S. Geological Survey (USGS) Gaging Stations</b>	Inventory of surface water gaging station data including 7-day Q10 low and monthly mean stream flow.
<b>Permit Compliance System (PCS) Sites and Computed Loadings</b>	NPDES permit-holding facility information. Contains parameter-specific loadings to surface water computed using the EPA Effluent Decision Support System (EDSS).
<b>Industrial Facilities Discharge (IFD) Sites</b>	Facility information on industrial point source dischargers to surface waters.
<b>Toxic Release Inventory (TRI) Sites, 1992 Release</b>	Facility information from the 1992 TRI public data release. Contains Y/N Flags for each facility indicating media-specific reported releases
<b>Superfund National Priority List (NPL) Sites</b>	Location of Superfund National Priority List Sites

## **5.0 IDENTIFICATION AND EVALUATION OF DATA SETS**

### **5.1 Principal Water Quality Data Systems and Databases**

In the ongoing process of locating existing water quality information, it was necessary to query major organizations and individuals with ongoing data acquisition and collection programs pertaining to the specific MBNEP water quality issues. These programs primarily involve Federal, State, local and research (academic institutions) initiatives whose funding provides for long term efforts. We have identified approximately 115 Data systems/Models/Databases collection efforts currently in the MBNEP Information Record database. Many of these systems are accessible via the Internet through web pages that are identified in the individual Information Records.

While query of the Information Records includes many specialty systems (such as the National Atmospheric Deposition Programs' database and query engine) that may be pertinent to the Mobile Bay area because of regional applicability, many of these information and data systems are of national scope with little or no data directly measured in the MBNEP area. Accordingly, we have identified as "principal" data and information systems those which contain information collected within the area on a consistent or long-term basis.

The principal water quality data systems and databases identified are listed in Table 5-1. This table lists the current databases that are either accessible on the Internet or have electronically recorded data and are accessible for previous, ongoing and future monitoring data. We have included some systems currently undergoing development for which data will be electronically available (such as GSA, DISL and EPIC) and have excluded agencies for which consistent and important water quality databases are available in paper-copy only (such as ADPH's monitoring data), but do not exist in electronic format.

Table 5-1. Principal Water Quality Data Systems and Databases.

Funding/Agency	Database System	Function	Issue	Internet Access
<b>FEDERAL</b>				
U. S. Environmental Protection Agency (EPA)	Storage-Retrieval System (STORET)	Data & Analysis	All	Yes CD ROM
	Permit Compliance System (PCS)	Data & Analysis	All	Yes
	BASINS GIS (See Section 4 for further description)	Data, Analysis & Modeling	All	Yes CDROM
	Environmental Monitoring & Assessment Program (EMAP)	Data Summary	All	Yes
	Index of Watershed Indicators (IWI) and other online summaries.	Data References and Summary	All	Yes
U. S. Geological Survey (USGS)	Water Storage-Retrieval (WATSTOR)	Data & Analysis	All	Yes CDROM
	Water Quality Network (WQN) -NASQAN - HBN	Data & Analysis	All	Yes CDROM
	National Water Information System (NWIS)	Data & Analysis	Hydro-graphic	Yes CDROM
National Oceanographic and Atmospheric Administration (NOAA)	Tidal and Current Database System	Data & Analysis	Hydro-graphic	Yes
	National Status & Trends (NS&T)	Data & Analysis	All	Yes
U.S. Army Corps of Engineers, Mobile District	Water Management	Data	Hydro-graphic	Yes
<b>STATE</b>				
Alabama Department of Environmental Management (ADEM)	ALAMAP-C	Data	All	No
	Coastal Program Ambient Trend Stations	Data	All	No
	PACE database (fish tissue, toxicity testing, macroinvertebrate)	Data	All	No
Geological Survey of Alabama (GSA)	Geochemical database	Data	All	Yes*
<b>LOCAL</b>				
Dauphin Island Sea Lab	Meteorological, current and other data	Data	All	No*
Bishop State Environmental Protection Information Center (EPIC)	Gulf of Mexico Program (GMP) EPIC database with links to the GMP Virtual Database Library	Data	All	Yes*

\* Program in Development



## **5.2 Principal Water Quality Assessments and Monitoring Programs**

A number of principal assessments, characterizations and monitoring programs can be relied upon to characterize and evaluate the water quality conditions for the MBNEP area. Some of these can be classified as “historical” in that they provide a comprehensive characterization, but they may be out of date. Other characterizations have been developed over several years of regular monitoring and assessments performed by various organizations. Collectively, they represent the best body of knowledge from which to assess current water quality status in the Mobile Bay NEP area.

### **5.2.1 Principal Water Quality Assessments and Characterizations**

The principal water quality evaluations performed in the MBNEP area include:

1. Mobile & Baldwin Counties, Alabama Water Quality Management Plan (the 208 Study) South Alabama Regional Planning Commission, 1978, 1979, 1982, and 1983.

This study provided a comprehensive watershed and water body monitoring and analysis, including deterministic modeling of the Mobile Bay and adjacent areas. It provides a suitable framework for water quality planning and a basis for many monitoring and assessment programs that followed. The primary limitations of this effort are that it has been 20 years since this program was undertaken, and that it provides only dated information of perhaps limited use in a comprehensive characterization of contemporary water quality issues.

2. ADEM Biennial Water Quality Reports to Congress (“305b reports”).

This ongoing process of evaluating stream segments by ADEM is undertaken every two years and provides an assessment of water quality within all the waters of Alabama. These are termed “305(b)” reports in reference to that section of the Clean Water Act. Corollary reporting includes biennial “Section 303(d)” lists which identify those waters not currently supporting designated uses and establishes priority rankings and schedules for Total Maximum Daily Load (TMDL) development. At the publication of this report for MBNEP, the latest 305(b) report was issued in 1996 (the 1998 report being expected in the near future). A draft 1998 303(d) list was issued in March, 1998 and is pending finalization.

The “305(b)” reporting provides a current status update of various stream segments, and assesses whether these segments are meeting their designated water use classifications. The reports provide an analysis of the water quality trend stations sampled by ADEM and serve as an early warning system of developing water quality issues. It also serves to provide documentation of water quality problems within the areas studied and the water quality improvements as well. However, since the report covers the entire State, a principal limitation is that only summary information is included for specific areas.

### 3. The ALAMAP-C program.

ALAMAP-C is a relatively new program supplementing the traditional coastal trend station data with data collected using a statistically-designed strategy similar to the USEPA EMAP program and additional ADEM monitoring information. It provides a more comprehensive and statistically sophisticated approach of water quality data collection than addressed in the 305(b) reports. Limitations include lack of annual monitoring for some parameters, and somewhat limited temporal data collection.

These three programs collectively represent the most comprehensive assessments of water quality for the MBNEP area which can be used to provide a characterization of water quality in Mobile Bay and its adjacent watersheds, and to provide an indication of trends observed in the various parameters.

### 5.2.2 Principal Ongoing and Future (Proposed) Monitoring Programs

Principal ongoing programs for monitoring data applicable to the various issues of interest to the MBNEP program are presented in Table 5-2. These data collection efforts are in part funded by several agencies. The funding source refers primarily to the final entity with responsibility for the program on a day to day basis. Ultimately, many of the programs are either grants or contracts from Federal agencies who have funded a large share of the efforts.

**Table 5-2. Principal Ongoing and Future (Proposed) Monitoring Programs for Each of the Major MBNEP Issue Categories.**

ISSUE	FUND SOURCE	ONGOING	FUTURE (PROPOSED)
<b>Pathogens</b>			
	State	ALAMAP-C	Additional frequency at ALAMAP-C Stations
	State	NPDES – Reporting	
	State	ADPH – Monitoring	
	State	ADEM Trend Stations	
	Federal/State	Weeks Bay Watershed Programs	
	Local	BayWatch	BayWatch expansion
<b>Toxic Chemicals</b>			
	Federal	EMAP	
	Federal	NS&T	
	Federal	SDWIS (drinking water)	
	State	ALAMAP-C	Additional frequency at ALAMAP-C Stations
	State	ADEM Trend Stations	
	State	ADEM Fish tissue, toxicity testing programs	
	State	NPDES Reporting	

**Table 5-2 (con't). Principal Ongoing and Future (Proposed) Monitoring Programs for Each of the Major MBNEP Issue Categories.**

ISSUE	FUND SOURCE	ONGOING	FUTURE (PROPOSED)
	Federal	USACE Ongoing Studies related to navigation and dredged material disposal	
<b>Nutrient Overloading</b>			
	Federal	EMAP	
	Federal	USGS NAWQA Program (study design)	Field studies to be initiated in FY99
	State	ALAMAP-C	Additional frequency at ALAMAP-C Stations.
	State	ADEM Trend Stations	
	State	NPDES Reporting	
	Local	Dauphin Island Sea Lab – Nutrient Data Collection	Additional Proposals for WQ
	Federal/State	Weeks Bay Watershed Programs	
	Local	Urban Stormwater (MS4) Monitoring	
<b>Erosion &amp; Sedimentation</b>			
	Federal	USACE, ongoing studies	COE and City of Mobile have studies planned for Dog River
	Federal/State	Weeks Bay Watershed Programs	
	Local	Urban Stormwater (MS4) Monitoring	
<b>Hydrologic Modification</b>			
	Federal	USACE, ongoing studies related to navigation and dredged material disposal	COE and City of Mobile have studies planned for Dog River
	State	ADEM Watershed Studies	Additional watershed studies are planned
	Federal	USGS -Gage Stations	
	Federal	NOAA –Tides and current	
	Federal	USACE – Tide and Gage Stations	
	Federal/State	Weeks Bay Watershed Programs	
	Local	Urban Stormwater (MS4) Monitoring	

### **5.3 Evaluation of Data Sets Organized by Water Quality Issue**

Initial efforts of the MBNEP process involved technical and citizens input to identify priority issues to be considered during development of the Comprehensive Conservation Management Plan (CCMP). Through participation of the Water Quality Workgroup, water quality issues were grouped into five major categories: pathogens; toxic chemicals; nutrient and/or organic overloading; physical and/or hydrologic modifications; and erosion and sedimentation. A principal objective of this preliminary water quality characterization for the MBNEP study area was to maintain a focus on these priority issues. The identification of data sets compiled within the Information Record database has been structured to relate to priority issues as previously described. The following subsections provide an evaluation of the data sets organized by issue category. Additionally, data sets relating to potential impacts on groundwater are presented separately.

#### **5.3.1 Pathogens**

##### **5.3.1.1 Introduction**

Pathogens are viruses, bacteria and protozoans that cause diseases in humans, plants and other animals. Pathogens commonly found in marine waters include those causing gastroenteritis, salmonellosis and hepatitis A. Vibrios are naturally occurring bacteria found in some estuarine waters and can produce severe symptoms, particularly in unhealthy individuals.

Pathogen contamination, as suspected from indicator organisms, may cause shellfishing areas and/or bathing beaches to be closed, primarily in areas within embayments or near tributaries where pathogen sources are greatest and water flushing is limited. Additional pathogen impacts include human illness from seafood consumption or water contact. Potential sources of pathogens have been identified to include:

- Marine waste from ballast discharges
- Marine waste from recreational and commercial vessels
- Municipal sewage treatment systems (public STPs)
- Private STPs (including industrial)
- Illegal disposal methods
- On-site sewage disposal systems (e.g., septic tanks)
- Domestic pets, wildlife and farm animals
- Upstream river inputs (beyond MBNEP area)

In the following sections, the issue of pathogens will be addressed with regard to temporal and spatial characteristics using the MBNEP water quality database. Sample matrix, document type and pathogen sources will also be discussed. Fecal coliform level is the standard indicator measurement used to determine pathogen contamination. Because historical measurements were often made as total coliforms, early monitoring and/or research studies may not directly relate to more recent monitoring and data collection efforts that reported data as fecal coliforms.

### 5.3.1.2 Information Record Database Inquiries

Tabulations of the number of database information records are compiled within Appendix IV. Presently, the Water Quality Information Record Database has approximately 870 records with about 270 document entries classified under the pathogen issue. The pathogen issue is related directly to two parameters: microbiological indicators and pathogens. Parameter searches resulted in about 160 microbiological indicator and 100 pathogen documents, with 70 records categorized under both parameters. Of the 270 pathogen issue records, about 50 were classified as summary/review publications, 150 as technical publications and 50 as data system/model/database. Document type classifications for the microbiological indicator parameter were approximately 130 technical publications and 40 as data system/model/database. Similarly, pathogen parameter entries were classified as: 80 technical publications and 20 as data system/model/database.

#### *Information Record Database Inquiries: Spatial Distribution of Data Records*

Two principal search techniques can be used to determine the spatial distribution of documents in the Information Database: location-on-map and quad selection. The location-on-map selection was primarily for records that did not contain specific site (station) locations for collected data. The location-on-map group included generalized areas such as “NEP Area”, “Baldwin County”, “Mobile Bay”, “Weeks Bay” and others. In contrast, the quad selection option related to studies having distinct locations that were identifiable within USGS 7.5-minute quadrangles. A menu selection of quadrangles within the MBNEP areas was utilized in the quad selection field. A third spatial documentation option was an entry table for documents containing specific latitude/longitude or UTM documentation. Documents containing latitude/longitude entries also contain appropriate quad selection information.

Information Database searches (Appendix IV) were conducted for the pathogen issue microbiological indicators parameter and pathogens parameter by location-on-map as well as document type. “NEP Area” and “Mobile Bay” were the most frequently selected areas for all three pathogen related topics. The pathogen issue search resulted in the majority of documents falling in the summary and technical publication categories. Documents classified as technical publications comprised the majority of data records under the parameter searches.

Records containing more specific spatial information were identified by searches conducted on quad selection as well as document type for the pathogen issue, microbiological indicators parameter and pathogens parameter. Groupings of USGS 7.5-minute quadrangles were selected to be generally consistent with previously described MBNEP sub-areas. Exact correlations between quadrangles and MBNEP sub-areas are not possible since the watershed boundaries are not coincident with 7.5-minute quadrangle delineations (Fig. 4-6). Appendix IV presents search results for MBNEP sub-areas for the pathogen related searches.

As expected, technical publications, containing detailed site descriptions, were the primary document type found for all three issue and parameter searches. Spatially, pathogen related data are principally concentrated in “Lower Mobile River” sub-area (n = 50) followed by: “Mobile Bay” (n = 44), “East Fowl River and Deer River watersheds” and “Dog River Watershed” (n = 40), “Weeks Bay Watershed” (n = 39), and Bon Secour River Watershed and Ft. Morgan Peninsula” (n = 39). The “North Baldwin County Watersheds” sub-area (n = 7) and “Three-Mile

Creek and Chickasaw Creek Watersheds” (n = 12) had the least number of documents containing pathogen data.

### ***Information Record Database Inquires: Sample Matrix Distribution of Data Records***

The Information Database sample matrix field contained five menu selections: water, sediment, wastewater, tissue (biological) and other. The sample matrix category was specified for documents containing specific sampling procedures. Pathogen and microbiological indicator data were generally collected from water samples, although combinations of sampling matrix types were also predominate in data records relating to the pathogen topic. Sediment and tissue were frequently involved in data collection while the wastewater and other categories occurred less frequently.

### ***Information Record Database Inquires: Temporal Distribution of Data Records***

Temporal distributions of the data records are presented in Appendix IV for the pathogen issue and microbiological indicators and pathogen parameters. The pathogen issue, microbiological indicators parameter and pathogen parameter classifications all show a gradual increase in document numbers from the 1800s followed by a dramatic increase beginning in the 1970s. This pattern suggests the importance of pathogen monitoring and research with regard to impacts and sources in the Mobile Bay NEP area.

#### **5.3.1.3 Review of Selected Information Records Related to the Pathogen Issue**

From the 1800s to 1914 only three summary documents containing lists of publications were referenced to the pathogen issue. The earliest referenced year of data collection was 1917. The South Alabama Regional Planning Commission 208 report (South Alabama Regional Planning Commission 1978) included a compilation of existing data (1917 - 1976) for the purpose of developing a comprehensive environmental baseline study to judge the effects of pollutants. A second historical document is the “Ecological characterization atlas of coastal Alabama: Map narrative” (Smith 1984) which included physical, biological and social data from 1917 - 1984 for coastal Mobile and Baldwin counties.

Beginning in the late 1940s the number of pathogen related documents begins to increase, suggesting an increased interest in pollution related issues. A fairly long-term study was conducted by the State of Alabama Water Improvement Advisory Commission (1952) to trace bacterial pollution from Mobile into Mobile Bay. The study focused on the bacterial quality of the area’s oyster producing waters. Gallagher *et al.* (1969) summarizes the effects of pollution on shellfish harvesting in Mobile Bay from 1949 - 1969.

Stream water pollution legislation requirements resulted in a two year statewide sampling study (1948 - 1949) by the State of Alabama Water Improvement Advisory Commission (1949). Survey parameters included industrial and municipal waste, chemical, bacteriological and physical determination, and biological studies. Two additional studies on bacterial pollution include State of Alabama Water Improvement Advisory Commission (1952) conducted from 1949 - 1950; and Bureau of Sanitation (1952) conducted from 14 - 25 April 1952.

Documents containing data collected during the 1960s include short term studies as well as compilations of existing data and current-day data systems. April *et al.* (1974) used total coliform group concentration data for Mobile Bay collected by the Alabama State Department of Health (January - August 1962) to verify a non-conservative species transport model for coliform bacteria in Mobile Bay. Additional documents with pathogen related data include Alabama Water Improvement Commission (1962) which contained bacteriological data (1960 - 1962) for the Tombigbee River; Nungesser *et al.* (1982) which summarized existing environmental resource information (1964 - 1980) of the Tennessee-Tombigbee corridor in Mobile and Baldwin Counties; Soil Survey of Baldwin County, Alabama (McBride *et al.* 1964) and; Soil Survey of Mobile County, Alabama (U. S. Department of Agriculture, Soil Conservation Service 1980) which contains soil data from 1969 - 1978. The U. S. Army Corps of Engineers (1985) investigated navigational improvements at Bayou La Batre based on data from 1965 - 1980 and also conducted a literature review (1968 - 1977) pertaining to the effects of dredging within the Mississippi Sound and adjacent area (U. S. Army Corps of Engineers 1978).

Two additional databases have compiled historical data from the 1960s to present day. The 1985 national shellfish register, prepared by National Oceanic and Atmospheric Administration (1985), contains data from 1966, 1971, 1974, 1980 and 1985 relating to the conditions and status of shellfish growing waters. The U. S. Environmental Protection Agency's Storage-Retrieval System (STORET) is a historical database system housing data (1960 - 1998) collected nationwide.

During June 1973, a waste source and water quality study was conducted (Lair 1974) for the Mobile River and its tributaries between Mobile Bay and the Spanish River. Sixty composite and/or grab samples were collected from 13 sites. The study's purposes were to collect industrial waste source data for evaluation of National Pollutant Discharge Elimination System Permits, "to conduct treatment efficiency studies at selected municipal waste treatment plants designated by the EPA Air and Water Division" and to "determine the feasibility of upgrading current lower water use classifications of the Mobile River, Chickasaw Creek, and Threemile Creek to the Fish and Wildlife Use Classification."

ASSESS, the statewide strategy, was developed and implemented in 1997 and includes ALAMAP-Coastal (circa 1993) and Upland (circa 1997) (ADEM 1997). Ambient water quality monitoring was actually initiated in 1974 at approximately 62 sites statewide, 9 of which were in the MBNEP study area. Eighteen additional sites were added between 1986 and the implementation of ALAMAP-Coastal in 1993 (Alabama Department of Environmental Management, No date).

Biennial reports (Alabama Water Improvement Commission 1973, 1975, 1977, 1979) and 305b reports (Alabama Water Improvement Commission 1976, 1977, 1979; Alabama Department of Environmental Management 1986, 1988, 1992, 1996) to Congress are prepared by ADEM concerning information regarding NPDES permitting and municipal waste. These reports assess the condition and status of various water bodies in the State of Alabama based on permanent and trend station data collection.

The 208 report was a major area-wide study conducted by the South Alabama Regional Planning Commission (1978) to develop a water quality management plan for Mobile and Baldwin Counties. Water and wastewater samples were collected in 1975, 1976, 1977 and 1978 from 33

to 66 sites. The study addresses water quality, standards and stream segment classification, point source and non-point source assessments, waste water treatment system needs, waste load allocations, social / economic analysis, and water quality model description. “Finally, it recommends certain agencies for designation as management agencies to implement these controls and specifies their responsibilities to assist in achieving the goals of P. L 92-500, as amended.”

EPA short term data collection studies include an intensive 3 day study at 15 sites on Dauphin Island measuring water quality, including fecal coliform levels, to determine the effectiveness of septic tank disposal systems in the Dauphin Island area (U. S. Environmental Protection Agency 1976); and a 3 month study conducted in Gulf Shores, Alabama (17 sites) to determine the effects on surface and ground waters of septic tanks / drainfields (U. S. Environmental Protection Agency 1977).

Gulf South Research Institute (1977 - Volumes 1, 3, 4, 6, 9, 10) conducted a study from the Pearl River, Mississippi to Panacea, Florida to prepare an overall assessment of the quality of the Mobile District maintenance dredging material. Sediment and water samples (n = 528) were collected in 28 harbors and rivers in 1972, 1973, 1974 and 1976. Sample analyses conducted included chemical, physical, bacterial, residue, elutriate (water and sediment) and other sediment characteristic parameters.

Two studies conducted in the early 1970s, U. S. Army Corps of Engineers (1972) and Lackey *et al.* (1973), focused on the effects of maintenance dredging in Mobile Bay, Alabama and directly addressed the issue of coliform bacteria. Although the issue of microbiological indicators was a primary concern of the study, measurements were made a total coliforms per 100 ml of water or subsurface mud rather than in present day standards (fecal coliforms: number per 100 ml).

The first pathogen related record in the Information Record Database directly focusing on research of *Vibrio cholerae* in shellfish dates from the late 1970s. DePaola *et al.* (1983) conducted a study throughout U. S. Gulf Coast waters from 1978 - 1980, which involved monthly sampling of shellfish, sediment and water to determine the frequency of non-O1 *Vibrio cholerae*. The presence of non-O1 *Vibrio cholerae* was greater in water compared with sediment or shellfish samples and was inversely related to salinity and directly related to temperature. “The presence of *V. cholerae* was not adequately indicated by the fecal coliform standards for shellfish-growing waters and market shellfish as established by the National Shellfish Sanitation Program.”

The 1980s showed a slight decline in the number of data records relating to pathogens compared with the 1970s. During 1982, the U. S. Environmental Protection Agency conducted an analysis of wastewater management in South Baldwin County, Alabama to “identify the most appropriate strategies for the management of wastewater generated in the Gulf Coast region of Baldwin County, Alabama” (U. S. Environmental Protection Agency 1990 - Draft; 1990 - EIS; 1990 - Appendices A to E; 1990 - Appendices F and G).

Pertinent documents for the early 1980s prepared by the Alabama Department of Environmental Management (ADEM) include a summary publication that reports on the status of ADEM’s efforts from 1984 - 1987 (Alabama Department of Environmental Management 1987).



The second earliest document in the database addressing the study of *Vibrio* pathogens is DePaola *et al.* (1990). The Food and Drug Administration Laboratory on Dauphin Island plays a vital role in the research of shellfish related pathogens. In the mid 1980s, DePaola *et al.* (1990) studied the presence of *Vibrio parahaemolyticus* in oysters and coastal waters from shellfish growing areas in Washington, California, Texas, Louisiana, Alabama, Florida, South Carolina, Virginia, and Rhode Island. *Vibrio parahaemolyticus* densities, aerobic plate counts and fecal coliform counts were determined for seawater and oysters collected from May 1984 - April 1987. Compared with water samples, oysters contained greater mean densities of fecal coliforms (10 X) and *V. parahaemolyticus* (100 X). Along the Gulf coast, the highest densities of *V. parahaemolyticus* occurred in the spring and summer months and related directly to water temperature.

With the exception of the National Oceanic and Atmospheric Administration's (1989) point source loading database, documents relevant to the 1985 - 1989 time period were prepared by the Alabama Department of Environmental Management. Pathogen related documents include: the State of Alabama non-point source assessment report (1988); two Alabama clean water strategy - water quality assessment reports (1989, 1992); a report on water quality trends and benthic macroinvertebrate communities of coastal Alabama (1989); two coastal program water quality trend reports (1991, 1992); a report on Portersville Bay (1992); the Norton Creek Survey (1988); and the coastal water trends monitoring program database (1992).

Compared with the 1980s, the 1990s showed an increase in pathogen related reports suggesting a renewed effort in pathogen related research. During the 1990s, long-term monitoring programs were initiated. The Baywatch Monitoring Program was initiated in the early 1990s. Weekly, volunteer citizens collect water samples and conduct water related measurements. Fecal coliform samples are collected monthly. The program now encompasses 25 sites in the Mobile Bay area (Marine Environmental Sciences Consortium 1993, Alabama Coastal Foundation, Inc. 1995, 1996, 1997).

A long-term monitoring and assessment program under the guidance of the Alabama Department of Environmental Management (ADEM) is the Alabama monitoring and assessment plan for Alabama's coastal waters (ALAMAP-C) (Alabama Department of Environmental Management 1994, Carlton *et al.* 1998). ALAMAP-C data are collected one time per year and cover 9 regions. Data are collected from a maximum of approximately 130 stations, which include 2 trend stations, and 18 fixed stations (returned to every year). One of the primary purposes of the ALAMAP-C program is to "provide data that may be used to indicate whether environmental standards are being met particularly for water designated as "fishable and swimmable".

The Alabama Department of Environmental Management (ADEM) has conducted watershed studies of the Dog River (Alabama Department of Environmental Management 1994, Halcomb 1996), Bon Secour River (1996) and Chickasaw Creek (1997). For each watershed an overview of the "land-use practices and the effects of development on the natural resources of the basin" was presented. In all three study areas, prime concerns dealt with the effects of storm water runoff and other non-point sources on the aquatic habitats.

In an effort to protect Weeks Bay, a designated Outstanding National Resource Water, the Weeks Bay Watershed Project initiated an intense monitoring program in 1993 to assess water quality conditions and develop a management plan for the watershed (Lynn 1997). The

Geological Survey of Alabama has monitored approximately 20 surface-water sites in Weeks Bay Watershed from 1994 to present and with plans to continue until 1999 (Geological Survey of Alabama 1995, 1995, 1995, 1995, 1996, 1997). Water quality parameters include pH, water temperature, specific conductance, turbidity, TDS, DO, BOD, Cl, NH<sub>3</sub>, NO<sub>3</sub>, TKN, PO<sub>4</sub>, P, flow, fecal coliform, fecal streptococcus and benthic animals. Biomonitoring data for the Weeks Bay Watershed (Geological Survey of Alabama 1995) were collected on 4 dates during April 1994 - June 1995 from 19 sites; and from 26 - 28 April 1994 for 9 sites in the Fish River Watershed (Geological Survey of Alabama 1994).

Two databases have been developed pertaining to data collection for the Weeks Bay Watershed. The first database includes trend data collected by the Weeks Bay water watch monitoring program from 30 sites (1995 - 1997) (Weeks Bay National Estuarine Research Reserve 1995, 1996, 1997). A fecal coliform database for the Fish River includes measurements collected every two weeks from 5 sites by the Weeks Bay fecal coliform monitoring program (May 1995 to present) (Weeks Bay National Estuarine Research Reserve 1995, 1996, 1997). Additional studies relating to the issue of pathogens include:

Geological Survey of Alabama. 1998. Results of surface-water sampling in the Tensaw River Watershed, Alabama: A report to the Alabama Department of Environmental Management for the period September 1, 1997 - October 31, 1997. Geological Survey of Alabama, Tuscaloosa, AL.

Mooty, W. S., J. L. Pearman, R. S. Moreland and A. E. Clark. 1996. Water quality of selected streams in Baldwin County, Alabama, September 1994 - April 1996. Water-resources report investigations report 96-4136. U. S. Geological Survey, of Montgomery, AL. 60 pp.

Thompson Engineering Testing, Inc. 1993. Stormwater characterization for municipal NPDES part 2 permit application Mobile - Baldwin Counties stormwater management area, volume I. Thompson Engineering Testing, Inc. Project #A92-135. Mobile, AL. 84 pp. and appendices.

Throughout the 1990s, the Food and Drug Administration (FDA) Dauphin Island Research Laboratory played a major role in researching pathogens and microbial indicator organisms. Research is primarily oriented to the shellfisheries within the coastal waters. Topics of study include toxigenic *Vibrio cholerae* introduction by cargo ships (McCarthy *et al.* 1992, 1994); *Vibrio cholerae* O1 ecology and isolation (DePaola *et al.* 1992, Motes *et al.* 1994); *Vibrio vulnificus* presence in fish (DePaol *et al.* 1994); phages infecting *Vibrio vulnificus* O1 (DePaola *et al.* 1997, DePaola *et al.* 1998); offshore suspension relaying to reduce levels of *Vibrio vulnificus* in oysters (Motes and DePaola 1996).

As indicated from the Information Record Database, the interest in pathogens dates back to the early 1900s. As inferred from document numbers (Appendix IV), a dramatic increase in pathogen related research occurred during the 1970s. Generally, 1970s data collection focused on fairly short temporal and spatial scales. The initiation of regular monitoring studies began in the late 1970s and continues today. Data records from the 1980s incorporate numerous agencies such as the Alabama Department of Environmental Management (ADEM), U. S. Environmental

Protection Agency and Geological Survey of Alabama (GSA), suggesting increased federal and state resources for monitoring. During the 1980s, research by the Food and Drug Administration (FDA) Laboratory on Dauphin Island began to focus on Gulf Coast shellfish related pathogens. The FDA laboratory continues to play a vital role in the research and understanding of pathogen related issues. Another increase in research effort appears to have occurred during the 1990s. During this period, a strong focus on comprehensive monitoring programs and watershed studies is apparent. These monitoring programs will help develop a better understanding of water quality parameters (including pathogens) and will provide a base for future monitoring efforts and trend studies.

#### **5.3.1.4 Characterization of Pathogen Issues in the Mobile Bay NEP Sub-areas**

The incidence of pathogens directly affects shellfishing areas and swimmable waters. A search on “shellfish or oysters or oyster” and “pathogens or microbiological indicators” resulted in 35 documents. Of these documents 14 were classified as summary / review publications. A search on “swimmable or swimming” and “pathogens or microbiological indicators” produced 9 documents. Six of these documents were prepared by the Alabama Department of Environmental Management and included the 305b reports to Congress. A third search on “water use classification” and “pathogens or microbiological indicators” resulted in 12 documents, including 4 summary / review publications. Conducted searches suggest that monitoring in “swimmable waters” is not as comprehensive compared with shellfishing areas.

During 1994 - 1995, river and stream water not fully supporting designated uses due to major and moderate/minor pathogen indicator contributions totaled 208 miles and 266 miles, respectively, statewide. Of the 610 square miles of assessed estuarine waters, 412 square miles of monitored waters were impaired for one or more uses (Alabama Department of Environmental Management 1996). ADEM (1996) assessed 451 square miles of shellfishing waters and found 412 square miles did not fully support the designated use classification. Pathogen indicators were the major contributors. Because of possible pathogens “shellfish beds were closed 16% of the time during 1994 and 1995.” Urban runoff/storm sewers and municipal point sources were cited as the major contributors to estuarine impairment.

#### ***Offshore Areas***

The offshore area (50 sq. mi.) of coastal Alabama currently supports its designated uses (Alabama Department of Environmental Management 1996). Although 21 documents were identified from Information Record Database searches, comprehensive and long-term data are minimal. Presently, the Baywatch Program (Alabama Coastal Foundation, Inc. 1996, 1997) is collecting data within the offshore area but sites are few.

#### ***Mississippi Sound and Dauphin Island***

The coastal waters of Mississippi Sound are mostly classified as Swimmable/Shellfish Harvesting/Fish and Wildlife (S/SH/F&W) (ADEM 1996). Pathogen and/or indicator (fecal coliform and *E. coli*) levels led to shellfish advisories for 143 square miles of Mississippi Sound waters during 1994 – 1995 (ADEM 1996). Information Record Database searches listed 26 documents relating to the Mississippi Sound Dauphin Island sub-area and pathogens. The most

relevant documents for pathogen information in this sub-area are recent ADEM and FDA publications.

### ***Mobile Bay***

During 1994 – 1995, pathogen levels in Mobile Bay led to shellfish advisories for 380 square miles of the Bay. Fecal coliform levels resulted in the closure of 2 square miles of swimming area within the Bay (ADEM 1996). The Information Record Database contains 44 documents with information on pathogens for the Mobile Bay sub-area. The most recent and comprehensive pathogen related data have collected by ADEM, the Alabama State Health Department, the Baywatch program and the FDA laboratory.

### ***East Fowl River, Deer River and Dog River Watersheds***

Portions of Fowl River, Deer River/Theodore Canal and Dog River are in non-support or partial support status of their Fish and Wildlife use classifications (ADEM 1996). Pathogens were identified in several creeks draining into Dog River. Current pathogen data for this area have been collected by ADEM (1995, 1996 and others; Halcomb 1996), the Baywatch Program (Marine Environmental Sciences Consortium 1991, 1992, 1993, 1995; Alabama Coastal Foundation, Inc. 1996, 1997), U. S. Geological Survey (1996) and Motes *et al.* (1994).

### ***Lower Mobile River - Chickasaw Creek***

Lower Mobile River - Chickasaw Creek is classified as Agricultural and Industrial (ADEM 1996). The area did not meet the designated use requirements but pathogens were not listed as a cause. A search of the Information Record Database produced 50 documents relating to the issue of pathogens. Current pathogen data for this area have been collected by ADEM (1996, 1997 and others), the Baywatch Program (Marine Environmental Sciences Consortium 1991, 1992, 1993, 1995; Alabama Coastal Foundation, Inc. 1996, 1997) and U. S. Geological Survey (1996 and others).

### ***Mobile-Tensaw Delta***

Impairment due to pathogens was not listed in the 305b report for the Mobile-Tensaw Delta (ADEM 1996). ADEM and the Baywatch program have collected current pathogen data for this area.

### ***Three-Mile Creek and Chickasaw Creek Watersheds***

This area is in partial support of the Fish and Wildlife/Swimmable designation (ADEM 1996). Six miles of Three-Mile Creek were in partial support due to moderate pathogen levels. Few data pertaining to pathogens are available for this area.

### ***Bayou Sara, Cold Creek and Cedar Creek Watersheds***

The most current pathogen data for the Bayou Sara, Cold Creek and Cedar Creek Watersheds have been collected by ADEM, U. S. Geological Survey and the Geological Survey of Alabama.

### ***North Baldwin County Watersheds***

Only 7 references within the Information Record Database related to the North Baldwin County Watersheds sub-area.

### ***Eastern Shore***

The Eastern Shore sub-area is designated as Fish and Wildlife and Swimming (ADEM 1996). Current pathogen data for this area have been collected by ADEM (1996 and others) and the Baywatch Program (Marine Environmental Sciences Consortium 1991, 1992, 1993, 1995; Alabama Coastal Foundation, Inc. 1996, 1997).

### ***Weeks Bay Watershed***

The Weeks Bay Watershed sub-area was in partial support of its uses (ADEM 1996). Pathogen levels affected 30 miles of the Fish River. Beginning in 1993, an intensive monitoring effort mostly by the GSA was initiated for the Weeks Bay Watershed and a management plan (Lynn 1997) was developed. The Information Record Database contains 39 records relating to pathogens and the Weeks Bay Watershed.

### ***Bon Secour River Watershed and Ft. Morgan Peninsula***

Water use classifications for portions of the watershed include Swimming, Shellfish Harvesting, and Fish and Wildlife (ADEM 1996). ADEM, the Baywatch Program and U. S. Geological Survey have collected the most recent pathogen data.

## **5.3.1.5 Identified or Potential Pathogen Sources**

### ***Marine Waste from Ballast Discharges***

A search of the database for Ballast and Cargo ships for pathogen related documents produced three records. These included McCarthy *et al.* (1992), McCarthy and Khambaty (1994) and Motes *et al.* (1994). All three studies addressed issue of toxigenic *Vibrio cholerae* entering Gulf of Mexico waters by cargo ship ballast and other nonpotable waters.

### ***Non-Point Source Runoff***

Non-point sources of pathogens include urban/suburban runoff and agricultural runoff. Several searches were conducted to identify documents relating to non-point source runoff and the pathogen issue:

- runoff and microbiologic\* = 15 documents
- runoff and pathogens = 19 documents
- agricultural and microbiologic\* or pathogens = 10 documents
- non-point and pathogens = 27 documents
- non-point and microbiologic\* = 17 documents

Note: \* = wildcard character

An examination of identified records produced numerous documents prepared by the Alabama Department of Environmental Management including water quality trends data reports (1989, 1991, 1992); water quality reports to congress (Alabama Water Improvement Commission 1976, 1977; Alabama Department of Environmental Management 1986, 1988, 1996); a non-point source assessment report (1988); the Mobile River study (1983); the Gulf Intracoastal Waterway enhanced monitoring (1991) and; surveys of Dog River (1994), Bon Secour River (1996) and Chickasaw Creek (1997) watersheds. Non-point sources of pollution in the Weeks Bay Watershed were also addressed in Miller-Way *et al.* (1996) and Geological Survey of Alabama (1994, 1995 and 1995). The U. S. Geological Survey (1976, 1977 and 1978) has also addressed the issue of non-point source runoff.

Mooty *et al.* (1996) evaluated the effects of non-point and point sources of pollution on selected Baldwin County streams from 1994-1996. Lastly, a comprehensive investigation conducted by the South Alabama Regional Planning Commission (1978) addresses the issues of water quality (including fecal coliform) and non-point sources of pollution in Mobile and Baldwin Counties.

### ***Point Source Inputs***

Point sources of pathogens include industrial (i.e., private sewage treatment plants, industrial wastewater) and municipal (i.e., sanitary sewers, sewage treatment plants) discharges. Searches conducted to identify documents relating to point source inputs and the pathogen issue were:

- industrial discharge and microbiologic\* = 3 documents
  - industrial discharge and pathogens = 3 documents
  - municipal discharge and microbiologic\* = 2 documents
  - municipal discharge and pathogens = 2 document
  - sewage and microbiologic\* = 6 documents
  - sewage and pathogens = 11 documents
  - point source and microbiologic\* = 18 documents
  - point source and pathogens = 29 documents

Note: \* = wildcard character

Knowledge of the impact of point source inputs on water quality dates back to the 1900s. The Stream Pollution Bill Act No. 523, S. 315 resulted in a State of Alabama Water Improvement Advisory Commission (1949) study of Alabama streams which included sampling of industrial and municipal waste; water quality chemical, bacteriological and physical determination; and biological studies. A second study (State of Alabama Water Improvement Advisory Commission 1952) continuing these efforts focused on bacterial pollution in Mobile Bay and surrounding coastal areas.

Additional point source related records included: a report on municipal and industrial waste waters discharged into the Mobile River (Lair 1974); the 208 report (South Alabama Regional Planning Commission 1978); a summary of point source discharges in coastal Alabama (National Oceanic and Atmospheric Administration 1989) and; the Alabama coastal ecological characterization atlas study (Smith 1984). Two recent Alabama Department of Environmental Management (1991, 1992) documents provide point source information for the Gulf Intracoastal Waterway and 1989 noncompliant Alabama streams.

### ***Upstream River Inputs***

Upstream river inputs from beyond the MBNEP area are not included in the Information Record Database. Upstream river studies by the National Oceanic and Atmospheric Administration and U. S. Geological Survey have addressed the nutrients related parameters and also contain pathogen related data.

### ***On-site Sewage Disposal Systems (septic tanks)***

The Information Record Database was searched for records relating to on-site sewage disposal systems and pathogens using these keywords:

- septic and microbiologic\* = 5 documents
- septic and pathogens = 8 documents
- sewage disposal system and microbiologic\* = 1 document
- sewage disposal system and pathogens = 1 document

Note: \* = wildcard character

Three soil surveys for Mobile County (U. S. Department of Agriculture, Soil Conservation Service 1980) and Baldwin County (McBride *et al.* 1964, U. S. Department of Agriculture, Soil Conservation Service 1990) provide data pertinent to septic tanks such as soil permeability, soil erosion potential and septic tank absorption fields.

The effects of septic tanks on water quality were studied on Dauphin Island, Alabama (U. S. Environmental Protection Agency 1976, Chandler and Moore 1982) and in Gulf Shores, Alabama (U. S. Environmental Protection Agency 1977). The 208 water quality management plan for Mobile and Baldwin Counties, Alabama (South Alabama Regional Planning Commission 1983) evaluated coastal area septic systems and the need for specific controls in coastal areas. Lastly, a water and wastewater management plan developed for west central Baldwin County (CH2M HILL 1996) will be used to identify water and wastewater needs.

### ***Potentially Minor Sources of Pathogens***

Marine waste from recreational and commercial vessels as well as domestic pets, wildlife and farm animals are generally considered to be potentially minor pathogen input contributors. Information Record Database searches found no related documents.

#### **5.3.1.6 Data Adequacy**

Studies relating to the issue of pathogens generally have focused on short temporal and spatial scales. Research and monitoring efforts also tended to focus on the economically important shellfisheries. Numerous area-wide monitoring efforts are currently collecting pathogen data that will provide a base for future studies and interpretations. Additional data collection efforts should focus on increasing the frequency of data collection as well as the number of sampling locations in order to provide a comprehensive data set for the MBNEP waters.



## 5.3.2 Toxic Chemicals

### 5.3.2.1 Introduction

All living systems use and recycle a variety of naturally occurring chemicals. Changing the normal balance of chemical concentrations in an ecosystem can jeopardize the health and reproductive capacity of the organisms in that ecosystem. Chemicals that cause damaging effects are called “toxics”. Since 1940, EPA estimates that more than 70,000 synthetic chemicals have been introduced to the marine environment. Some of these chemicals are polycyclic aromatic hydrocarbons (PAHs), toxic metals, polychlorinated biphenyls (PCBs), and pesticides. Several classes of toxic chemicals collect in sediments. Bottom-dwelling animals are exposed to these chemicals, which pass through the food web. “Hot spots” in some urban areas have been shown to alter the bottom-dwelling community, reduce its diversity, and cause disease in fish. In some locations, health officials have warned people not to eat fish caught in contaminated areas.

### 5.3.2.2 Identified or Potential Problems

Based on discussion of the MBNEP Water Quality Workgroup and review of toxic chemicals issues identified by EPA in other NEP areas, key problems potentially related to toxic chemicals have been enumerated as follows:

#### *Impacts (known or potential)*

- Lethal/sublethal effects on biological communities
- Health risks/consumption advisories
- Shellfish closures

#### *Sources (known or potential)*

- Point-source industrial wastewater discharges
- Point-source industrial stormwater discharges
- Municipal sewage treatment plants (public STPs)
- STP or sanitary sewer bypass, malfunction, or overflow
- Urban/suburban runoff
- Agricultural runoff
- Silvicultural runoff
- Upstream river inputs
- Contaminated sediments
- Dredging and dredge material disposal area (DMDA) discharges
- Atmospheric deposition
- Oil and gas exploration and production
- Marine waste – commercial shipping/port facilities
- Shipbuilding and repair facilities
- Hazardous waste/superfund sites and landfills
- Groundwater inputs
- Spills and illegal dumping

### 5.3.2.3 Information Record Database Inquiries

Numerous information/data (I/D) records compiled within this study were categorized as relating to the issue of “toxic chemicals” (about 360 out of over 850 I/D records). Of these, over 50 records are classified as a “data system/model/database over 80 as “summary/review publications”, and about 220 as “technical publications”. The I/D records (relating to toxic chemicals) range in publication date from 1966 to the present, indicating a long-recognized concern for this issue during contemporary and recent periods. Not unexpectedly, historical data prior to 1970 are very limited (only six records relating to “toxic chemicals” with publication dates before 1970 were identified). Of the I/D records, around 220 have publication dates between 1970 and 1989, and about 130 have publication dates of 1990 or later.

Reviewing the compilation of I/D records by parameter groups associated with “toxic chemicals” indicates the following approximate number of records: toxic metals, 180; pesticides/PCBs/herbicides, 110; trace organics, 80; bioassay/toxicity, 30; Similarly, the number of records related to “toxic chemicals” by sample type (matrix) was approximately: water, 230; sediment, 180; tissue (biological), 130; other, 50. It should be noted that the tissue (biological) sample type category includes records with biological data such as macroinfauna, as well as records with chemical contaminant analyses of a “tissue” matrix (for example, chemical analyses of fish fillets).

#### *Spatial Distribution of Data Records*

The spatial distribution of the I/D records may be reviewed by two principal search techniques, referred to as: (1) “location-on-map”, and, (2) “quad selection”. The search results depend upon the manner of record entry. Generally, for those records not containing specific station locations, the record entry included a menu selection of narrative descriptors such as “NEP Area”, “Mobile Bay”, “Dog River”, and others. However, when station locations were given such that their location within USGS 7.5-minute quadrangles could be determined, a menu selection of Quadrangle names was used. Generally, it was intended that the fields be exclusive; that is, if spatial information was specific such that “quad selection” could be utilized, then the more general “location-on-map” field was not necessary.

Spatially-oriented search results are presented in tables compiled in Appendix IV. Searching the I/D records (related to the “toxic chemicals” issue) by the “location-on-map” field indicates a number of information records categorized as applicable to the region as a whole and/or to generalized segments such as Mobile Bay. Searching the I/D records (related to the “toxic chemicals” issue) by the “quad selection” field selects those records which contain more specific spatial information. Groupings of quadrangles can be selected to be generally consistent with the MBNEP sub-areas as previously described, but exact correlations are not possible since the MBNEP sub-areas incorporate watershed boundaries which of course are not coincident with 7.5-minute quadrangle delineations (refer to Figure 4-6). Nevertheless, this search technique is useful for spatial screening of the I/D records. The search results (Appendix IV) indicate that information records exist for all designated sub-areas, with a greater number of records for Lower Mobile Harbor, Mobile Bay, and Mobile-Tensaw Delta.

In addition to the above-described spatial search techniques, exact station locations were entered for certain I/D records. For such records, latitude and longitude are entered in a separate field. Some 30 of the 360 I/D records related to the “toxic chemicals” issue have specific station latitude/longitude coordinates.

The spatial representation of Information Records may also be reviewed against those parameters which are related to the toxic chemicals issue, as displayed in tables within Appendix IV.

#### **5.3.2.4 Data Sets Related to Selected Potential Impacts or Sources**

Evaluation of the data sets relating to toxic chemicals may be best approached by focusing on specific aspects of known or potential problems related to the issue category. With reference to the introductory discussion, several impacts and sources of potential concern have been identified through the MBNEP process. Discussed below are evaluations of the “toxic chemicals” data sets as related to selected known or potential problems.

##### ***Atmospheric Deposition***

A word search of the I/D records for the phrase “atmospheric deposition” identifies only one record, that being the National Atmospheric Deposition Program (Colorado State University, 1996). The I/D record provides a link to the NADP web-site, where information on the “Mercury Deposition Network” may be obtained. This information indicates that the closest MDN stations are in Florida, Georgia, and Louisiana (proposed). Broadened searches of the I/D records do not indicate other references currently in the I/D record compilation that are specifically applicable to atmospheric deposition of toxic chemicals within the Mobile Bay NEP area.

##### ***Contaminated Sediments***

The above example illustrates a data set in which only limited information was anticipated. As an example of a data set in which much more information is expected, consider “contaminated sediments” as a known or potential source which could relate to any or all of the known or potential impacts considered under the “toxic chemicals” issue category.

As discussed in the general introduction to this sub-section, numerous I/D records related to the “toxic chemicals” issue are identified by “field” searches for the sample matrix “sediments” and for parameter groups “toxic metals”, “trace organics”, “pesticide/PCBs/herbicides”, and so forth. Closer examination of this volume of information may be facilitated by initial review of data systems and databases, followed by examination of I/D records for technical reports and summary/review publications.

As depicted within the maps in Appendix III, EPA’s “BASINS” GIS includes station location information for the National Sediment Inventory (NSI) database. A nationwide assessment of NSI data was recently submitted to Congress in January 1998 in a three-volume report entitled “The Incidence and Severity of Sediment Contamination in Surface Waters of the United States” (EPA, 1997). Volume 1 of the report presents the methodology and findings of the National Sediment Quality Survey, including a delineation of watersheds (USGS Hydrologic Units)

designated as “Areas of Probable Concern”. The approach used by EPA involves classification of sediment chemical analyses, sediment toxicity data, and fish tissue residue data from selected sampling stations (1980-1993) into three categories, or tiers, based on their “probability of adverse effects”:

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

Watersheds are classified as Areas of Probable Concern (APCs) for sediment contamination if they contain at least 10 Tier 1 stations, and at least 75 percent of all stations are either Tier 1 or Tier 2. EPA recognizes that the National Sediment Quality Survey should be considered as a screening-level exercise, and acknowledges that 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. Nevertheless, EPA believes that APCs represent the highest priority for further ecotoxicological assessments, risk assessment, temporal and spatial trend analysis, contaminant source evaluation, and management action.

The Mobile Bay watershed (HU 3160205) is classified by EPA’s National Sediment Quality Survey as an Area of Probable Concern. Volume 2 of the referenced EPA report provides data summaries for each APC watershed. For the Mobile Bay APC, EPA’s analysis included a total of 81 stations: 31 designated as Tier 1, 43 as Tier 2, and 7 as Tier 3. The stations used by EPA for their assessment may be a subset of the total NSI stations, because the NSI database may include pre-1980 data (excluded from the National Sediment Quality Survey). Also, considerably fewer than 81 station locations are depicted (for the Mobile Bay watershed hydrologic unit) on the figures displaying the NSI stations, and in the watershed station location map provided in the referenced EPA report. Presumably, station positions from various data sources and/or timeframes overlap. The data sources referenced by EPA as applicable to the Mobile Bay APC determination range in timeframe from 1981 through 1992. The sources with the greatest number of stations include USACE for 1981 (30 stations), ADEM for 1990 (22 stations), and USFWS for 1988 (11 stations). Other sources include NOAA’s Benthic Surveillance for 1984 (3 stations), NOAA’s National Status and Trends for 1984 – 1990 (7 stations), EPA’s EMAP-Louisiana Province for 1991-1992 (5 stations), EPA’s ODES for 1986-1988 (2 stations), and Florida Department Environmental Regulation for 1981 (1 station).

The data summary for the Mobile Bay watershed APC provides a listing of the chemicals responsible for station classification as Tier 1 or Tier 2. Most Tier 1 classifications appear related to the metals mercury and silver, but a limited number were also attributed to the metal arsenic, the pesticide DDT, PCBs, and certain PAHs. Tier 2 classifications were attributed to the same chemicals plus other metals, pesticides, and PAHs.

Volume 3 of the referenced EPA report provides an inventory of probable point source releases of sediment contaminants. A similar inventory of probable non-point source contributors of sediment pollutants is in preparation for subsequent biennial reports. The point source inventory involved a relative ranking of chemicals and industrial categories based on 1993 Toxic Release Inventory (TRI) and 1994 Permit Compliance System (PCS) chemical release data, and a “load score” prioritization system for watershed units. (As described in an earlier section, TRI and

PCS facility locations from EPA's BASINS GIS are depicted on maps in Appendix III). Based on the Total Load Scores at the watershed level (which ranged from 0 to 312 nationwide), EPA prioritized watersheds as follows:

Priority Group 1:	Load Score >80
Priority Group 2:	Load Score 61-80
Priority Group 3:	Load Score 41-60
Priority Group 4:	Load Score 21-40
Priority Group 5:	Load Score 1-20

Nationwide, 17 watersheds were placed in Priority Group 1, 19 watersheds in Priority Group 2, 29 watersheds in Priority Group 3, 87 watersheds in Priority Group 4, and 672 in Priority Group 5. 196 watersheds had a load score of 0, and were not assigned to a group.

Watershed hydrologic unit classifications within and surrounding the MBNEP study area were ranked as shown in the following tabulation:

**Table 5-3. EPA National Sediment Quality Survey Watershed Rankings of Probable Point Source Releases of Sediment Contaminants, MBNEP and Adjacent Areas**

<b>Watershed Name (HU#)</b>	<b>Priority Group (Load Score Range)</b>	<b>Dominant Chemical Class/ Dominant Industrial Class</b>	<b>Data Source</b>
Mobile-Tensaw (HU#03160204)	Group 2 (61-80)	Divalent Metal/ Sewerage Systems	PCS
Mobile Bay (HU#03160205)	Group 4 (21-40)	Divalent Metal/ Sewerage Systems	PCS
Perdido Ba (HU#03140107)	Group 5 (1-20)	Mercury/Sewerage Systems	PCS
Mississippi Coastal (HU#03170009)	Group 5 (1-20)	Divalent Metal/Industrial Inorganic Chemicals PAH/Plastic Materials and Synthetics	PCS TRI
Lower Alabama (HU#03150204)	Group 5 (1-20)	Other/Lumber and Wood Products	TRI
Lower Tombigbee (HU#03160203)	Group 5 (1-20)	Divalent Metal/Industrial Organic Chemicals  Other/Paper and Allied Products	PCS TRI

It is of some interest to note that although the Mobile-Tensaw watershed hydrologic unit is placed by EPA in the second priority group of the point source inventory, it was not classified by the National Sediment Quality Survey as an Area of Probable Concern. The referenced EPA report does not state whether a given watershed receives a non-APC rating because data pass the Tier 1 / Tier 2 screening system, or because there were too few sampling stations for evaluation.

Another EPA data system, the “Index of Watershed Indicators” (IWI) on the Internet provides rankings on a watershed (hydrologic unit) basis. The IWI scores fifteen indicators (“data layers”) of environmental “condition” or “vulnerability”, and provides an overall composite score for the watershed. One of the data layers is “contaminated sediments”, which is also based on 1980-1993 NSI data. For the Mobile-Tensaw watershed unit, the IWI scores “contaminated sediments” near “best”, but notes the status as “inconclusive data”. By comparison, the IWI contaminated sediments status for the Mobile Bay watershed is noted as “high degree of concern”.

Other noteworthy national-scope data sets include NOAA’s National Status and Trends Program (NS&T) and EPA’s EMAP Estuaries Program. Information on both programs is available on the Internet. Both programs include stations within the Mobile Bay estuarine area. As noted earlier, certain of the NOAA and EMAP-Estuaries data are incorporated into the NSI.

Temporal trends are monitored for numerous bays and estuaries (including Mobile Bay) as part of NOAA’s Mussel Watch program, whereas spatial trends are monitored by both the Mussel Watch and Benthic Surveillance programs. These programs monitor and evaluate trends in: (1) chemical contaminants and (2) biological responses to these contaminants. Information gathered over the years has indicated that distribution of concentrations for both sediments and mollusks are lognormal (i.e., many observations having low concentrations and only a few having high concentrations); approximately 15 percent are found to exceed the mean value plus one standard deviation. Observations in this category are termed “high” and a growing database now contains information on which metals or compounds in a given estuary are this category. The NOAA NS&T data are discussed more fully later in this section pertaining to contaminant levels in shellfish.

The EMAP-Estuaries program has issued a draft report “EMAP Estuaries: A Report on the Condition of the Estuaries of the United States in 1990-1993” which is Internet-accessible. Included in that report are Gulf of Mexico state indicator data which display “ecological health indicators” for coastal regions, and rate the indicators according to defined conventions. For sediments, EMAP-Estuaries considers sediment chemical concentrations and sediment toxicity tests. Sediment chemical concentrations are evaluated against “Effects Range Median” (ERM) and “Effects Range Low” (ERL) criteria. In general, ERM is considered to represent the contaminant concentration that will result in ecological effects 50 percent of the time based on scientific literature studies. The more protective ERL criterion is considered to represent the contaminant concentration that will result in ecological effects 10 percent of the time. Sediment toxicity bioassays reflect bioavailability of contaminants and directly demonstrate potential effects on aquatic life by bioassay toxicity testing. Toxicity is defined as greater than 15 percent mortality during exposure. The EMAP-Estuaries ranking system rates sediment toxicity as “good” when any potentially toxic materials are below levels that could cause harm to bottom life. A “poor” rating is given if: 1) greater than 50 percent of an estuary’s sediments have at least two contaminants above ERL criteria, 2) greater than 25 percent of sediments are above ERM criteria, or 3) 15 percent of its sediments demonstrate toxicity by bioassay testing.

The EMAP-Estuaries 1991-1993 data presented in the referenced draft report classifies Mobile Bay sediments as “poor”, noting that sediments exceeded ERL levels for multiple contaminants in over 87% (+/- 12%) of samples and exceeded ERM levels for 64% (+/- 14%). About 9% of

Mobile Bay sediments were classified as toxic to aquatic life by bioassay toxicity testing. The EMAP-Estuarines ratings for the 1991-1993 sediment data from the Alabama portion of Mississippi Sound indicate better conditions. The report notes that while some sediment contaminants were observed above ERL criteria, no sediments showed contaminants above ERM levels or displayed toxicity.

The EMAP-Estuarines program inspired ADEM to adopt a similar sampling strategy, which was implemented in 1993. Referred to in the past as Alabama REMAP or ADEM EMAP, the program is currently designated as ALAMAP-Coastal (ALAMAP-C). ALAMAP-C data may be obtained from ADEM's Mobile Field Office. ADEM has recently released, a summary report providing interpretation of 1993-1995 ALAMAP-C results (Carlton *et al.*, 1998).

The ALAMAP-C report interprets sediment chemistry data for 1993-1994 (summer sampling events during each year), which included 213 samples for 11 trace metals and 159 samples for 10 pesticides, including DDT and PCBs. The sampling program design considers nine specified regions of Alabama's coastal waters, based on designated water use classifications. (The program includes stations within the Perdido Bay watershed, therefore the number of stations within the MBNEP area is less than noted above.) In the absence of Federal or State sediment quality criteria, the ALAMAP-C report uses comparisons to values derived from the popular scientific literature to assist in the interpretation of sediment contaminant data. However, the report cautions that reference to any particular set of values or contaminant level must not be construed as acceptance of, or support for, the value as a Federal or State standard or criteria.

The ALAMAP-C ratings employ similar conventions to the EMAP-Estuarines, but also evaluate whether metals are "enriched" (greater than natural, background levels) and whether pesticides/PCB's were above analytical detection limits. A "good" sediment quality rating is given (for a region of estuary) if: (1) less than 10 percent of the sediments have 3 or more metals greater than ERL values, or (2) less than 10 percent of the sediments are enriched by 6 or more metals, or 3) if no detectable pesticides or PCBs were measured. A "poor" rating is given to a region if more than 25% of the sediments exceeded the guidelines. In summary, the four regions of Mobile Bay proper ranged from "good" to "poor" with respect to sediment chemistry. The Mississippi Sound region was given a "poor" sediment rating. The three regions of Mobile/Tensaw Rivers and Delta were rated as "fair" to "poor". "Metals enrichment" appeared the chief cause of the lower ratings for sediments in Mobile Bay proper and Mississippi Sound; whereas detectable levels of pesticides / PCBs appeared mostly to influence the ratings of the Mobile-Tensaw River and Delta regions. Although metals enrichment appeared evident in many regions (with copper, chromium, and lead being the parameters mostly exhibiting enrichment), the report notes that most sediments had very few metal concentrations above ERL guidelines. Arsenic, chromium, and nickel were indicated to be the predominant metals of concern when comparisons to ERL guidelines were considered. (Mercury was excluded from the data set due to analytical problems.)

Further review of the I/D record compilation technical reports and summary/review publications related to "contaminated sediments" indicates many additional information sources, both post-1990 and earlier. For illustration, selected I/D records are noted below:

- Webster, 1997. "Heavy metal trends in subsurface of Mudhole Creek and Little Bateau Bay, Mobile-Tensaw River Delta, Baldwin County Alabama."
- EPA, 1996. "Mobile River Study 1993-1994".
- U.S. Fish and Wildlife Service, 1996. "An investigation into the uptake of contaminants in largemouth bass and sediment from the lower Tombigbee and Mobile Rivers, 1992."
- Halcomb, 1993. "A survey of water quality and sediment chemistry of selected sites in the Mobile delta system."
- Halcomb, 1992. "A survey of water quality and sediment chemistry of shipyards in coastal Alabama."
- Halcomb, 1991. "A sediment chemistry baseline study of coastal Alabama." *[Note: Data from the above record is apparently incorporated in the NSI database.]*
- Isphording, 1990. "Heavy metal chemistry of Mobile Bay sediments".
- Gambrell, *et al.*, 1984. "Chemical availability of mercury, lead, and zinc in Mobile Bay sediment suspensions as affected by pH and oxidation reduction conditions."
- U.S. Army Corps of Engineers, 1984. "Report on offshore disposal site designation for two areas southwest of Mobile Bay, Alabama." *[Note: Data from the above record is apparently incorporated into the NSI database.]*
- Isphording, *et al.*, 1983. "Environmental implications of metal contamination levels in *Crassostrea virginica* from Mobile Bay, Alabama and St. Louis Bay, Mississippi."
- Isphording, 1983. "Chemistry and partitioning of heavy metals in Mobile Bay, Alabama."
- Settine, *et al.*, 1982. "Bivalves as indicators of environmental pollution: A pilot study of oysters (*Crassostrea virginica*) in Mobile Bay."
- TechCon, Inc., 1980. "Environmental monitoring program for the Mobil Oil Exploration and Producing Southeast, Inc. test well in Mobile Bay."
- Malatino, 1980. "Chemical quality of bottom sediment samples from Mobile Bay, Alabama."
- Gulf South Research Institute, 1977. "Collection and analysis of sediment samples, maintenance dredging material, navigation projects, Mobile District, Corps of Engineers."



- Lloyd, *et al.*, 1972. “Mercury concentrations in sediment samples from the Tennessee, Mobile, Warrior, and Tombigbee Rivers, Alabama, June 1971.”
- Casper, *et al.*, 1969. “Study of chlorinated pesticides in oysters and estuarine environment of the Mobile Bay area.”

The above-referenced technical reports pertaining to the contaminated sediments issue demonstrate that there exists a substantial information base which may not be fully incorporated into the “status” assessments provided by the NSI, IWI, EMAP, ALAMAP-C, and NS&T programs discussed earlier. Furthermore, sufficient available data sets if examined more rigorously may allow more definitive conclusions regarding trends of contamination levels within the estuary.

Due to the affinity of certain contaminants to fine-grained sediments, contamination distribution and transport mechanisms are closely related to sedimentation characteristics within the estuary. The sedimentology and geochemistry of Mobile Bay and other north Gulf Coast estuaries has been the subject of considerable research over the past two to three decades by Isphording and others. From the standpoint of uniqueness, Mobile Bay is the terminus of the Nation’s fourth largest river system (in terms of discharge), exceeded only by the Mississippi, Columbia, and Yukon. These other rivers, however, discharge directly offshore rather than into a restricted estuarine system. Hence, from a contamination standpoint, natural or anthropogenic contaminants that are discharged into Mobile Bay are destined to have a considerably greater residence time than those discharged into an oceanic system (average residence time of oceanic contaminants is 3,370 years). This extended residence time for Mobile Bay is assured by virtue of two other factors associated with the bay’s sediments. The first is the fact that the bay contains a higher percentage of clay-size sediment ( $< 4$  micron) than other bays in the northern Gulf of Mexico (Isphording *et al.*, 1989). The smaller the particle size, the greater the surface area of the particle, consequently, the greater the ability of the particle to adsorb organic and inorganic contaminants. The large quantity of clay-size sediment results from the fact that the delta complex at the head of the bay (the largest inland delta in all of North America) effectively traps most sand and silt-sized sediment, allowing only clay-size material to pass into the bay (except in times of high river discharge when even sand-size material may transit the delta). Secondly, the mineralogy of Mobile Bay bottom sediments is dominated by Smectite clays (principally montmorillonite). The clays are present in lesser amounts in the bays and estuaries eastward on the Florida panhandle (Pensacola Bay, Choctawhatchee Bay, St. Andrew Bay, Apalachicola Bay) where Kaolinite clays become increasingly more common. Kaolinite clays, though capable of absorbing contaminants, do so at a more attenuated rate than their montmorillonite counterparts. This is caused by the fact that they possess a much lower cation exchange capacity (c.e.c. = 8 to 10 meq/l) when compared with montmorillonite clays ( $> 100$  meq/l) and also typically have fewer site defects, which leads to fewer unbalanced charge sites for adsorption. Hence, Mobile Bay historically was characterized by the highest levels of heavy metals in bottom sediments of any bay in the northern Gulf of Mexico (Isphording, 1985). However, the passage of Hurricane Frederic in 1979 re-suspended and removed nearly 300 million tons of sediment, largely clays and organic particles. Because these are the favored sites for accumulation of contaminants, the bay underwent a natural “cleansing” that substantially reduced the level of contaminants, literally overnight (Isphording, 1994). Heavy metals levels in

the bay are again slowly increasing but, at present, the bay ranks first in the northern Gulf only in the quantity of lead found in bottom sediments.

### ***Health risks / consumption advisories, and shellfish closures related to toxic chemicals***

Data systems with information related to fish consumption advisories include EPA's BASINS (forthcoming in Version 2.0) and the Internet-accessible Index of Watershed Indicators (IWI). These systems incorporate an EPA database of "Listing of Fish and Wildlife Advisories" (LWFA), also accessible on the Internet. One fish consumption advisory in the MBNEP area is evidenced by these sources, that being the "Cold Creek Swamp" area adjacent to the Mobile River within the Mobile-Tensaw watershed (HU #03160204) due to the pollutant mercury. Information about waterbodies affected by fish consumption advisories is included in ADEM's biennial 305(b) report (ADEM, 1996), which indicates that the Cold Creek Swamp advisory was issued 5/11/92 and that about 650 acres are affected. ADEM's Fish Tissue Monitoring Program was initiated in 1991 and is a cooperative agreement with the Alabama Department of Public Health (ADPH), the agency responsible for issuing consumption advisories.

Search of the I/D Records for information related to toxic chemicals in the Mobile River and Delta yields numerous references. One noteworthy recent reference pertaining to the area is the "Mobile River Study 1993-1994" (EPA, 1996). That study was conducted to assess contamination potentially emanating from four "Superfund" National Priority List (NPL) sites along the Mobile and Lower Tombigbee Rivers, two near the Cold Creek Swamp region and two upstream of the MBNEP area near McIntosh, Alabama. One of the study findings, based on a limited human health risk assessment, indicated that the risk to the general public was marginal or within EPA criteria; however, a potential increased risk to a "subsistence fisherman" was demonstrated. The study also included a preliminary ecological risk evaluation, which indicated, in general, no potential impact to large, fish-eating wading birds as represented by the woodstork. A potential for ecological effects was evident for the belted kingfisher and those fish-eating birds having similar ecological functions and feeding regimes.

Mercury contamination of fish tissue has also been reported in Fish River near Polecat Creek (Lynn, 1997), which references ADEM fish tissue monitoring for 1995 and 1997. The referenced report indicates that a public health advisory was issued by ADPH, however, no consumption advisories related to the Fish River sampling area are found in the data systems or databases previously referenced. The Fish River area contains relatively limited industrial development, and the source or cause of the reported fish tissue mercury levels appears uncertain. Recently, a similar finding of mercury contamination in fish tissue (largemouth bass) was reported by ADEM for Fowl River and Chickasaw Creek. As with the Fish River mercury levels, the source or cause appears uncertain. ADEM, in a recent news release, notes that mercury contamination problems are not unique to Alabama, and theorizes that the source of mercury may be natural or may be the result of atmospheric deposition.

EPA's EMAP-Estuaries and NOAA's National Status and Trends (NS&T) Program (referenced previously) include fish and shellfish contaminant residues data. The EMAP-Estuaries program includes monitoring of target finfish species and shrimp for contaminant residues and examination of fish for external pathologies. An estuary is rated in "good" condition if less than 2% of fish have elevated tissue residues and pathology rate. Greater than 10% is considered

“poor”, and between 2-10% “moderate”. The previously referenced EMAP-Estuaries draft report for conditions of estuaries in 1990-1993 indicates about 2% of Alabama’s estuaries overall showed high rates of pathologies and high contaminant residues. About 3% of Mobile Bay samples reportedly showed elevated pathologies, whereas no evidence of fish contamination or pathologies was evidenced from Mississippi Sound.

NOAA’s “Mussel Watch Program” has monitored nationwide levels of contaminant residues in mollusks since 1986, and includes stations in Mobile Bay. A recent on-line report (NOAA, 1998) entitled “Chemical Contaminants in Oysters and Mussels” summarizes trends at sites that were sampled in at least six years. Contamination residues are considered “high” if the level falls within the top 15 percent of all levels for all sites, based on 1990 samples (the year when most sites were sampled). These levels are not based on toxic effects of the chemicals on the organisms or on public health consumption criteria. Appendix C of the referenced NOAA report is a listing of sites with 50% or more occurrences of “high” concentrations since 1990. Stations in Mobile Bay which indicate “high” levels include Dog River and Hollingers Island Channel (for various metals and organics), but not Cedar Point Reef. The Dog River monitoring station in Mobile Bay was, for a single observation year, identified as being characterized as one of the Urban Areas having “high” concentrations (greater than mean plus one standard deviation) over a five-year period for cadmium, copper, and zinc. Similar results were also reported for the chemicals Dieldrin, DDT, PCB’s and polyaromatic hydrocarbons. The Hollinger’s Island monitoring station fared somewhat better and data over a five-year period found only copper, zinc, and DDT rated as “high”.

Appendix A of the NOAA report summarizes trend analyses at sites sampled in six or more years. Data collected in Mobile Bay over a seven year period, for example, indicates a general decrease in quantities of DDT, Chlordane, and Dieldrin; a decrease in PCB’s was similarly observed over a nine-year period. At the Cedar Point Reef site, trends are not evident for any parameters except PCB’s, where a decreasing trend is noted. At the Hollingers Island site, decreasing trends are noted for several pesticides. This is consistent with the national trends observed as part of the Mussel Watch program. Metals, however, have shown no such decrease (with the exception of cadmium) and have remained essentially constant.

As noted above, the NS&T data (and characterizations of “high” concentration levels) is not related to shellfish public health consumption criteria. Although closure of shellfish areas are sometimes required due to results of microbiologic monitoring, no impairment of shellfish waters due to toxic chemicals has been indicated within ADEM’s latest 305(b) report (ADEM, 1996).

### ***Point sources of toxic pollutants***

Search of the I/D records related to the “toxic chemicals” issue for information related to point sources yields a considerable volume of information. Point sources are regulated under National Pollutant Discharge Elimination System (NPDES) permits. The EPA Permit Compliance System (PCS) database is the principal repository for information pertaining to point sources. The EPA “BASINS” GIS is again useful as a data system for initial review of this database as well as other databases related to toxic chemicals. As depicted in the maps in Appendix III, BASINS includes locational positions for several major EPA databases including PCS, Industrial

Facility Discharge (IFD), Toxic Release Inventory (TRI), and Superfund National Priorities List (NPL) sites. Permitted hazardous waste facilities (under RCRA) are being incorporated into BASINS for the upcoming version (2.0) now being developed.

Certain data systems and/or assessments use one or more of the above-referenced databases. As previously discussed, EPA used the PCS and TRI databases in its National Sediment Quality Survey to group watershed units by priorities with respect to sediment contamination potentially related to point source contributions. EPA incorporates a similar screening assessment within its Index of Watershed Indicators (IWI) data system available on the Internet. Within the IWI, EPA utilizes, as one indicator of “environmental vulnerability”, the PCS database to assess watershed units for “pollutant loads discharged above permitted units – toxic pollutants”. This analysis combines (for a given watershed hydrologic unit) discharges over a one-year period expressed as a percentage above or below the total discharges allowed under the NPDES permitted amount. The IWI presently characterizes the watershed hydrologic units within and surrounding the MBNEP area as follows:

**Table 5-4. EPA "Index of Watershed Indicators" Point Source/Toxic Pollutants Summary for Watersheds in MBNEP and Adjacent Areas**

<b>Watershed Name (HU#)</b>	<b>Pollutant Loads Discharged Above Permitted Limits – Toxic Pollutants</b>
Mobile – Tensaw (HU# 03160204)	Number of Dischargers*: 80 Toxic Pollutants: Up to 20% average load over permitted limits
Mobile Bay (HU# 03160205)	Number of Dischargers*: 49 Toxic Pollutants: No aggregate loads in excess of Total permit limits or no permitted discharges
Perdido Ba (HU# 03140107)	Number of Dischargers*: 8 Toxic Pollutants: Up to 20% average load over permitted limits
Mississippi Coastal (HU# 03170009)	Number of Dischargers*: 138 Toxic Pollutants: No aggregate loads in excess of total permitted limits or no permitted discharges
Lower Alabama (HU# 03150204)	Number of Dischargers*: 8 Toxic Pollutants: Up to 20% average load over permitted limits
Lower Tombigbee (HU# 03160203)	Number of Dischargers*: 23 Toxic Pollutants: No aggregate loads in excess of total permit limits or no permitted discharges.

\*Number of Dischargers includes both conventional pollutants and toxic pollutants.

A principal reference for information relating to point sources, from a “recent history” perspective is the Water Quality Management Plan for Mobile and Baldwin Counties, Alabama (SARPC, 1979) which was performed pursuant to Section 208 of the Federal Water Pollution Control Act Amendments of 1972. Another more-recent reference is a nationwide study of point source discharges for estuarine watersheds (NOAA, 1989).

ADEM’s current programs for monitoring and control of point source contributors of toxic pollutants are described within the biennial “305 (b)” report (ADEM, 1996). These programs include review of facility self-monitoring reports (chemical analyses and effluent toxicity

bioassays) and selected compliance monitoring inspections (and effluent testing) by ADEM personnel, supported by ADEM's surface water monitoring and fish tissue monitoring networks. ADEM maintains databases of fish tissue monitoring results and toxicity testing of wastewater discharges related to these programs.

Another data set which is noteworthy, as relating to point sources of toxic pollutants, includes information about Discharge Information Zone (DIZ) studies required for major NPDES permits in the coastal area. DIZ studies are conducted for the purpose of evaluating biological impacts in the vicinity of major industrial effluent discharges. The I/D record compiled for the MBNEP study area includes references for 33 DIZ study reports performed between 1989 and 1997.

### ***Non-point sources of toxic pollutants***

Information records pertaining to potential non-point sources of toxic pollutants are more limited when compared to point sources. However, given the recent emphasis towards non-point source evaluation and watershed-based evaluation and management, the information base is increasing.

Of available data systems, EPA's BASINS GIS is noteworthy in that it is intended to integrate non-point and point source contributions on a watershed basis. The data layers being incorporated into BASINS relating to non-point source (NPS) pollution include spatially-distributed data such as land use and soils.

EPA's Index of Watershed Indicators (IWI) data system includes two indicators of environmental vulnerability which are related to NPS pollutants (both conventional and toxic): (1) "urban runoff potential"; and (2) "agricultural runoff potential". The "urban runoff potential" is based on the percentage of impervious surface in a watershed; whereas the index of agricultural runoff is a composite of a nitrogen runoff potential index, a pesticide runoff potential index, and modeled sediment delivery to rivers and streams. For all watersheds in the MBNEP study area, "insufficient data to make estimates" is noted for urban runoff potential. For agricultural runoff potential, potential pesticide runoff from farm fields (1990-1995) is noted high for Mobile Bay (HU# 3160205) and low for Mobile-Tensaw (HU# 03160204).

Several references were found relating to NPS programs in Alabama and in coastal estuarine regions. ADEM's latest 305(b) report (ADEM, 1996) includes NPS assessment and listings of impaired waterbodies, including (for the MBNEP area): Theodore Industrial Canal, Chickasaw Creek, Three-Mile Creek, Upper Mobile Bay, Dog River, Fish River, and Fowl River. Considering the listed causes of NPS impairment related to toxic chemicals (pesticides, priority organics, metals), the list of NPS – impaired waterbodies included Three-Mile Creek, Upper Mobile Bay, and Fish River.

Several watershed studies have been performed by ADEM. Reports have been issued for Dog River watershed (ADEM, 1994 and ADEM, 1995), Bon Secour Watershed (ADEM, 1996), and Chickasaw Creek Watershed (ADEM, 1997). The Bayou La Batre Watershed was studied in 1997, and a similar report should be issued this year. A similar study is planned for 1998 for the Little Lagoon watershed. ADEM's program of watershed studies in the coastal area provide an overview of land-use practices and effects of development on aquatic resources, and employs qualitative as well as quantitative assessment. With respect to "toxics", quantitative data

principally include sediment chemistry for metals. The Dog River studies noted metals enrichment of sediments, and due to the lack of industrialization in the watershed, the causes were attributed to NPS pollution.

Additional recent efforts to note are the nonpoint source assessments being performed by the USDA National Resource Conservation Service (NRCS) for sub-watersheds of Mobile and Baldwin Counties. The final reports of these studies are expected this summer. The assessments will "rank" sub-watershed area areas based on land use and associated impact factors; however, quantitative data on toxic pollutant loadings is not being acquired.

Also noteworthy within the MBNEP area are the cooperative studies and management efforts in progress for the Weeks Bay Watershed Project. This project has fostered several multi-faceted studies, most of which are focused on NPS-related considerations. The information base includes NPS toxic pollution considerations, although primary focus appears mostly related to other issues.

Excepting the data sets related to contaminated sediments, as previously discussed, quantitative data relating to non-point source loadings (i.e., stormwater runoff) of toxic pollutants from within the NEP area appears limited. One exception is the data set generated by the NPDES Municipal Separate Storm Sewer System (MS4) permit application compiled by the South Alabama Regional Planning Commission (SARPC) for the Mobile-Baldwin Counties Stormwater Consortium. That effort involved flow-proportioned sampling of three storm events in 1993 at seven sites selected to represent various land uses in urban/suburban areas, and included analyses of toxic (priority pollutant) as well as conventional parameters (Thompson Engineering Testing Inc., 1993). The MS4 permit was issued in 1997 and requires continuing monitoring efforts, but toxic pollutants are not included.

### ***Upstream river inputs***

Information and data related to toxic chemicals from upstream river input to the MBNEP area may be found in certain data systems, databases, and reports. Considering data systems and databases, records available from the USGS appear to be the most comprehensive and systematic. The USGS operates water quality and discharge (flow) monitoring stations at two locations along the major tributaries which join to form the Mobile River at the upper end of the MBNEP area. These stations are located on the Tombigbee River near Coffeeville and on the Alabama River near Claiborne, and are part of the National Stream Quality Accounting Network (NASQAN). Long-term data records are available, and may be purchased on CD-ROM and/or downloaded from the Internet. From the standpoint of data related to toxic chemicals, the NASQAN records include inorganic trace elements (metals, dissolved and total) but limited data on trace organics.

Also of note, pertaining to upstream river inputs, is USGS's National Water Quality Assessment (NAWQA) study for the Mobile River Basin. The study was initiated in FY97, and intensive data collection (a 3-year effort) is scheduled to commence in FY99. The NAWQA study apparently will not extend directly into the MBNEP area, but offers an excellent opportunity to fill data gaps which are identified related to upstream river input.

### ***Hazardous waste sites and landfills***

The information base relating to hazardous waste sites, landfills, spill incidents and similar sources contains considerable information. This is not unexpected given the emphasis placed on hazardous waste control and related environmental protection in recent timeframes. As previously described, EPA's data systems and databases provide easily-accessible inventories pertaining to facilities which handle hazardous and/or toxic materials. Information pertaining to solid waste (non-hazardous) landfills is best accessed through contact with ADEM.

Mobile County has three Superfund NPL sites within the MBNEP area. Additionally, two NPL sites are located in the adjacent upstream watershed (Lower Tombigbee). Substantial information exists concerning assessment and remedial activities at these sites, as discussed in previous sections.

### ***Oil and gas exploration***

Due to the level of hydrocarbon exploration activities in Mobile Bay, Mississippi Sound, and Gulf of Mexico waters since 1979, a considerable volume of information relating to toxic chemical issues has been generated. Of note in this regard is the final generic environmental impact statement for exploration and production of hydrocarbon resources in coastal Alabama and Mississippi (U.S. Army Corps of Engineers, 1984). Principal references related to sediment and biota contamination concerns have been previously discussed. Such data sources are available from the U.S. Army Corps of Engineers, as well as other resource management, regulatory, and research organizations.

### ***Navigation projects***

Numerous environmental studies and data collection efforts related to navigation projects and port activities have been performed over the past three decades. Environmental concerns, as pertaining to the toxic chemicals issue, relate in large part to dredged material management and contaminated sediments, as previously discussed. In addition to the data sources related to contaminated sediments, the I/D records include several references to assessments and evaluations related to this issue.

#### **5.3.2.5 Data Adequacy Summary (Toxic Chemicals Issue)**

Based on review of information records and data sets pertaining to the toxic-chemicals issue, as discussed above, a considerable information base is demonstrated for many of the known or potential impacts or sources identified as priority concerns by the MBNEP. A notable exception is the lack of data (specific to the MBNEP area) related to atmospheric deposition. In view of the findings of mercury contamination in predatory fish (e.g., largemouth bass) in watersheds with no known sources of mercury (e.g., Fish River, Fowl River), the lack of atmospheric deposition data for the MBNEP area makes definitive conclusions of cause-effect relationships difficult. This situation, however, is not unique to the area and the problem is being researched on a regional and national scale. Therefore, the need for toxic chemical atmospheric deposition data specific to the MBNEP area will depend in large part on the applicability and transferability of findings from ongoing research efforts elsewhere.

Nonpoint source (NPS) pollution represents another potential source of toxic chemicals for which limited quantitative data exist specific to the MBNEP area. However, investigations related to NPS pollution from toxic chemicals (as well as conventional pollutants) have increased in recent years, particularly within the last decade. Notable studies and programs for the MBNEP area include ADEM's coastal watershed characterization studies and biennial assessments incorporated within "305b" reports, ongoing NRCS sub-watershed NPS screening/ranking studies (which are near completion), cooperative studies conducted as part of the Weeks Bay Watershed Project, and urban stormwater monitoring/assessment programs performed by local governments as part of the Mobile-Baldwin Counties Municipal Separate Storm Sewer (MS4) Stormwater Consortium. Although quantitative data are limited, these initiatives are increasing the knowledge base from a watershed characterization and problem identification perspective. Additionally, decision-making can draw upon knowledge gained from other areas when it is applicable to NPS considerations in the MBNEP area as well. For example, there are data available relating land use and development practices to NPS pollutant contributions and watershed vulnerability, such that watershed characterization and predictive modeling approaches may be applied without necessarily requiring exhaustive quantitative data acquisition within each specific area. Nevertheless, without a base level of area-specific quantitative examination, it will remain difficult to adequately assess the status and relative significance of NPS pollution concerns, much less trends over time. In this regard, the information records reviewed have not revealed comprehensive area-wide assessments which definitively address certain basic technical questions regarding NPS concerns for the MBNEP area; such as: (1) the relative significance of NPS pollutant contributions compared to point sources, (2) the relative significance of NPS (and point source) pollution contributions from local watersheds within the MBNEP area compared to contributions from upstream river inputs, (3) trends over time, and (4) projections for the future. Thus, an evaluation of the adequacy of existing data begs the question of whether the existing data have been adequately assessed. Hence, the principal challenges facing the MBNEP in this regard appear to be a need to facilitate data sharing among organizations with data acquisition responsibilities, and to effectuate the realization of a coordinated and technically-reliable long-term monitoring strategy and assessment framework.

With respect to upstream river inputs, long-term data records of major riverine discharges entering the MBNEP area are available, as are records for many pollutant parameters. Additionally, at least from an area-wide perspective, sediment input and deposition processes have been characterized sufficiently to allow a generalized understanding of the system as a whole. In these regards, upstream river inputs of flow and sediment are clearly dominant factors affecting major components of the area (i.e., Mobile Bay and Delta). However, data relating to toxic chemicals contributions from upstream river inputs are more limited, and the relative significance of same warrants further assessment. In this regard, coordination and communication by the MBNEP with the USGS NAWQA program, which is initiating a comprehensive assessment for the Mobile River Drainage Basin, appears advisable.

Considerable data on toxic chemicals contributions is available related to point sources, hazardous waste sites, landfills, and industrial facilities in general. This is not surprising considering the emphasis given to toxic chemicals issues in recent years resulting from NPDES, RCRA, CERCLA (Superfund) and other regulatory programs. The data sets available and continuing to be developed under the purview of such regulatory programs are viewed to be



generally adequate to meet MBNEP objectives and needs for development of the CCMP. However, as noted before, the relative significance (compared to other sources) of toxic chemical inputs from point source and related pollutant contributions warrants more definitive examination.

Review of information records indicate a substantial volume of data pertaining to contaminated sediments within the MBNEP area. Portions of the available data sets have been used by EPA to classify Mobile Bay as an "Area of Probable Concern" with respect to contaminated sediments. This classification was given as part of the National Sediment Quality Survey, which is recognized as a "screening level" assessment approach only, and should not be construed to confirm that sediment contamination poses actual risks to human health or aquatic resources. EPA through its EMAP program and ADEM through its ALAMAP-C program have also issued recent reports categorizing the status of contaminated sediments of the area. In these assessments, the contamination status of sediments are ranked from "poor" to "good" for the various sub-regions investigated.

The screening-level assessments may be adequate from the standpoint of identification of "contaminated sediments" as an issue of concern within the MBNEP; however, they are not considered adequate in and of themselves to fully address related issues. One shortcoming, based on review of available information records compiled for this study, is that a substantial volume of data appears to exist which has not directly been evaluated in the screening assessment characterization. More rigorous examination of the full data sets may allow more definitive conclusions regarding contamination levels, spatial distribution, and temporal trends.

More importantly, there remains scientific uncertainty (and controversy) as to the relationship of total chemical contaminant concentrations in sediment and adverse affects on aquatic life. This uncertainty continues to hinder the development and acceptance of sediment quality standards or criteria based on total chemical concentrations. Toxic chemical sediment information, while being available for many years, is mostly restricted to "total levels" and is non-specific as to partitioning behavior. Hence, even where data is available, inadequate information is provided as to the potential for impact on the biota. Data is needed throughout the entire watershed area on this aspect in order to truly assess the health of both the bay and the delta.

While a number of procedures have been developed to address the basic question of heavy metal bioavailibiltiy to the biota, Ion Site Partitioning analysis (ISP) remains the most effective way of providing such information. Elutriate tests have been shown to correlate poorly with actual biota mortalities. Similarly, while quite effective if metals are in an oxidizing environment (and sediment pore water pH is near-neutral), the Acid Volatile Sulfide (AVS) method could likely yield misleading (or totally incorrect) results when applied to sediments from a number of locations in the Mobile Bay watershed. Numerous areas are present within the bay and delta system where negative redox conditions exist. Using this method to evaluate potential toxicity for samples from these areas would be inappropriate. Hence, it is strongly suggested that ISP analyses be utilized to provide this critical data.

Sediment-phase bioassay toxicity testing and more comprehensive ecotoxilogical evaluations are more complex to conduct, and thus more expensive. Accordingly, such data are much more

limited for the MBNEP than sediment chemical concentration data. The available data sets may not prove adequate to sufficiently address concerns related to contaminated sediments in the estuary.

Chemical contaminant data for biological (tissue) matrices such as fish and oysters are available for several portions of the MBNEP area. Notable data resources include ADEM's fish tissue monitoring program and NOAA's "Mussel Watch" program which includes oyster monitoring at three locations in Mobile Bay. Also of note is a 1993-1994 EPA study of the Mobile River, which was performed to assess potential contamination from four Superfund NPL sites located along the river, two of which are in the MBNEP area and located near Cold Creek swamp. A fish consumption advisory had been previously issued in 1992 for Cold Creek swamp by ADPH based on ADEM fish tissue monitoring due to the pollutant mercury. The EPA Mobile River study indicated that the risk to the general public was marginal or within EPA criteria, but that a potential risk would exist to a "subsistence fisherman". A potential ecological risk to the belted kingfisher or similar birds was also noted. As discussed earlier, fish consumption advisories due to mercury have also been issued by ADPH (based on ADEM fish tissue monitoring) for watersheds where no known sources have been identified.

The NOAA "Mussel Watch" (oyster) monitoring stations exhibit "high" levels of certain metals and pesticides at Dog River and Hollingers Island reefs, but not at Cedar Point reef. The NOAA "high" classification is based on nationwide statistics of concentration levels, and is not derived from human health or ecological impact considerations. Trend analyses by NOAA indicate decreasing levels of certain pesticides and PCB's in Mobile Bay, with no statistically-significant trends (up or down) noted for metals.

### 5.3.3 Nutrient and/or Organic Overloading

#### 5.3.3.1 Introduction

The major nutrients, typically carbon, nitrogen and phosphorus, are key components in the functioning of aquatic and marine ecosystems. The lack of nutrients limits growth and production of primary producers (plants) but in excess they can cause very undesirable conditions such as low dissolved oxygen and excessive growth of nuisance algae and aquatic plants. The excess discharge of nutrients and the concomitant accumulation of nutrients and organics in systems is known as the process of eutrophication, which literally means “excessive feeding”.

The excessive discharge of carbon based compounds, or organic chemicals, can lead to a variety of impacts such as low dissolved oxygen, excessive organic color in water, and the build-up of highly reduced organic bottom sediments. The discharge of large quantities of these materials from point sources is usually prevented by the National Pollutant Discharge Elimination System (NPDES); however the buildup of organics still occurs through the production of organic materials in the watershed, and its production in the waterbodies themselves through the eutrophication process above.

The mineral nutrients, especially phosphorus and nitrogen have been used for more than 100 years in the fertilization of crops. When discharged in an uncontrolled manner into aquatic and marine systems, they can also stimulate excessive growth of plants, both microscopic and macrophytic, leading to similar problems as from the discharge of organic materials. A large biomass of living and/or decomposing plant material can use all the oxygen in a system resulting in impacts to water quality and aquatic life. Thus the key indicators in detecting problems from excessive nutrient loading are the measure of microscopic algal biomass, the plant pigment chlorophyll *a*, the dissolved oxygen (DO) levels in the mid and bottom waters, and levels of mineral and organic nutrients.

The molar (atom) ratio of Carbon:Nitrogen:Phosphorus in marine and aquatic systems is 106:16:1 and is known as the Redfield ratio (Kadlec and Knight, 1996). This ratio is useful in determining which nutrient is in limiting supply in these systems. The Redfield ratio for Nitrogen:Phosphorus (total) is also expressed on a weight:weight basis which for a balanced healthy phytoplankton biomass is 7.2:1. In practice, due to the uncertainty of chemical sampling and analytical methodology, and limited knowledge of the availability of organically bound nutrient, the ratio is usually expanded. For example, in a study of Tampa Bay (Blancher & Stewart, 1991), nutrient limitation by nitrogen was indicated when the weight:weight ratio of TN:TP fell below 5:1 or limited by phosphorus when the TN:TP ratio exceeded 30:1. In marine and estuarine systems nitrogen is most often the nutrient which controls plant production (so-called limiting nutrient) and thus is a key component in determining the growth of algae and plants.

### 5.3.3.2 Known or Potential Problems Related to Nutrient and/or Organic Overloading

#### *Known or Potential Impacts*

Potential known or potential impacts identified impacts from nutrient and organic overloading to marine and aquatic systems may include:

- Blooms of undesirable algae and macrophytic plants (especially macro-algae)
- ✓ Indicators: Chlorophyll a levels, macrophyte biomass, weed problems
- Reduced desirable submerged aquatic vegetation (from shading &/or competition)
- ✓ Indicator: Loss of grassbeds
- Harmful and toxic algal blooms (blue-green algae and red tide)
- ✓ Indicators: Fish kills, mammal kills, diseased fishes and other aquatic animals
- Low dissolved oxygen concentration
- ✓ Indicators: Fish Kills, jubilees, bottom life impacts
- Human health concerns (fish/shellfish consumption, algal toxins)
- ✓ Indicators: Shellfish bed closures, fish consumption advisories, beach advisories.
- Aesthetic problems
- ✓ Indicators: Dead and decaying fish and plants, odors on beaches and near coast, green water, reduced water clarity, seafood taste problems.

#### *Known or Potential Sources*

Nutrients and organics enter receiving waters from a variety of sources but most notable for estuarine systems are the following:

- Non-point source runoff
- ✓ Urban/suburban runoff
- ✓ Agricultural runoff
- ✓ Silvicultural
- ✓ Industrial Runoff
- Point Source inputs
- ✓ Industrial
- ✓ municipal (sanitary sewers, sewage plants, Combined Sewer Outfalls's)
- Upstream River Inputs
- Atmospheric deposition
- Sediment release
- Septic tanks
- Dredging
- Groundwater inputs
- Tidal exchanges
- Migrating animals
- Spills and dumping
- Seepage

### **5.3.3.3 Database Inquiries**

The MBNEP database has approximately 290 recorded entries related to nutrient loading/nutrient enrichment topics. Many of these records (225) have information related particularly to the Database Identification parameter nutrients and oxygen demand. Of the 290 records under the “Nutrient Overloading” Issue, about 45 records are classified as “data system/model/database”, 50 as “summary publications”, and 195 as “technical publications”.

Several caveats to the searches to the nutrient overloading issue must be kept in mind in reviewing these searches. The “nutrient overloading” issue also relates to the general physico-chemical parameter group including dissolved oxygen (DO) and hence the nutrient issue is flagged whenever dissolved oxygen is mentioned. This is particularly noticeable in the more older databases because DO is measured often. Thus, a close examination of many of these documents for nutrient or chlorophyll data will be unsuccessful because of DO.

Another issue relates to the analytical detection limits for many of the mineral nutrients. Caution should be used when looking at nutrient data before 1970 because of the limited techniques for determining low levels of dissolved mineral nutrient before that time.

The spatial distribution of the I/D records may be reviewed by two principal search techniques, referred to as: (1) location-on-map, and, (2) quad selection. The search results depend upon the manner of record entry. Generally, for those records not containing specific station locations, the record entry included a menu selection of narrative descriptors such as “NEP Area”, “Mobile Bay”, “Dog River”, and others. However, when station locations were given such that their location within USGS 7.5-minute quadrangles could be determined, a menu selection of Quadrangle names was utilized. Generally, it was intended that the fields be exclusive; that is, if spatial information was specific such that “quad selection” could be utilized, then the more general “location-on-map” field was not necessary.

Searching the I/D records (related to the “Nutrient Overloading” issue) by the “quad selection” field selects those records which contain more specific spatial information, whereas, the “location-on-map” field yields records with more general spatial descriptions of data applicability. The results of these searches are tabulated in Appendix IV. Similar search results are provided for parameter groupings.

Database search statistics for temporal distribution are also included in Appendix IV. The I/D records (relating to nutrient overloading) range in timeframe from 1917 to the present, indicating a long-recognized concern for this issue during contemporary and recent periods. Not unexpectedly, historical data prior to 1970 are limited and many of those identified were done so because of references to dissolved oxygen. Approximately 210 of the I/D records date between 1970 and 1998.

### **5.3.3.4 Data Resources**

The primary data resources for the nutrient overloading issue for nitrogen and phosphorus data are primarily the USEPA, USGS, and ADEM records along with several datasets reported by several academic institutions (DISL and Auburn).

Dissolved Oxygen data are taken frequently in many studies and thus a large database exists for this particular parameter. However, no comprehensive data compilation of these various sources exists.

Chlorophyll *a* data are limited to several older ADEM reports, DIZ surveys, and the more recent ALAMAP-C and DISL studies. No comprehensive dataset for all areas and over all time periods is available for this parameter.

Long-term, spatially synoptic data for nutrients and dissolved oxygen for Mobile Bay and its immediate contributing watersheds do not exist. While many studies have collected these parameters in some areas, overall synoptic data, and particularly information for nutrients, is limited. The piecemeal treatment of this parameter group as a whole, makes long-term trend evaluation difficult at best.

### 5.5.3.5 Key Reports

#### *Dissolved Oxygen*

Numerous summary and technical documents exist on the dissolved oxygen issue for the Mobile Bay NEP areas. The key reports include the various sub-watershed studies performed by ADEM, the published reports of the Dauphin Island Sea Lab, and the ALAMAP-C datasets and reports. Trend station and ALAMAP-C data exist and are accessible through the STORET system. Although limited in timeframe and sampling frequency, the ALAMAP-C report (Carlton *et al.*, 1998) is considered the best study to characterize and present the status of existing data for dissolved oxygen and synthesize these data into a meaningful format.

Historical studies by Schroeder (1975, 1979) and Schroeder *et al.* (1988, 1979) describe the dissolved oxygen characteristics of Mobile Bay and Main Pass to the Gulf of Mexico.

#### *Nutrients*

The first comprehensive data report for nutrients was the "208" Report prepared by the South Alabama Regional Planning Commission (SARPC, 1978). It contains both monitoring and modeling information that can be used as a starting point for the historical nutrient /organic enrichment data perspective.

Additional data and observations can be obtained from the following reports, studies and databases:

ADEM 305b Reports (ADEM, 1996)  
Chickasaw Creek Study (ADEM, 1997)  
Dog River Study (ADEM, 1994)  
Bon Secour Study (ADEM, 1996)  
Pennock, J. *et al.* (1995)  
Cowan, J. *et al.* (1996)  
ALAMAP-C (ADEM, 1998)  
EPA's BASINS System (1997-98)  
STORET

Complete descriptions of these data sources appear in the MBNEP Document database.

### ***Chlorophyll *a****

The most comprehensive data resources for the plant pigment chlorophyll *a* are the studies performed by Pennock (1993) and the data collected by the EMAP and ALAMAP programs. These studies recognize the importance of this water quality indicator and provide spatial and temporal data which are extremely useful in characterizing this parameter. These data can be supplemented by the earlier Coastal Area board studies which collected chlorophyll *a* at 8 baywide stations for a 14 month period (1981-82). Additional but spatially and temporally limited chlorophyll data are included in many of the Discharge Information Zone surveys performed by industry.

#### **5.3.3.6 Characterization of Nutrient Overloading Issues in the Mobile Bay NEP Subareas.**

A preliminary characterization of the nutrient overloading issue in the Mobile Bay NEP area is possible from the summary reports published by others. The following section discusses the characterization of nutrient overloading issues in the various portions of the MBNEP subareas described in those publications. Because of its timely publication, the ALAMAP-C report was used to supplement the information from the 1996 305b report covering the overlapping period (ALAMAP-C 1993-95, 305b report 1994-95).

### ***Offshore Area***

The offshore area encompasses approximately 150 sq. mi. of coastal Alabama and is currently listed as meeting its designated uses (ADEM 1996).

Limited data resources tend to hamper the overall characterization of the offshore MBNEP area for nutrients, dissolved oxygen and chlorophyll *a*. For example, ADEM, in both its Trend stations and its ALAMAP-C program does not include stations outside of the barrier islands. Several ongoing federal programs examining nutrient issues in near-coastal waters may address nutrient issues in coastal Alabama.

Of particular relevance is the South Baldwin County EIS produced by USEPA (1990) which was performed to provide planning information on the impact of wastewater on the nearshore environment near Baldwin County. It includes both nutrient information as well as algal bioassay information of the offshore region of coastal Alabama.

### ***Mississippi Sound and Dauphin Island***

The Mississippi Sound consists of 145 sq. mi. of coastal waters and is classified as Fish and Wildlife/Swimmable/Shellfish. Harvesting for at least portions of its area (ADEM 1996). The only portions listed within the 305b report which show water quality limitations from nutrients are portions of the Bayou La Batre River presumably due to septic tanks and stormwater. Formerly, seafood processing plant discharges were also limiting use classifications (i.e., exceeding standards) in some of these streams but they have largely been diverted directly to Portersville Bay.

Limited recent data are available for the Mississippi Sound and adjacent area. The most recent information is the ALAMAP-C study (Carlton *et al.*, 1998) which characterizes the Mississippi Sound area. This study has rated the Mississippi Sound area as good to fair during the period 1993-1995. The study indicated some DO limitations (14% of area  $DO < 2$ ; 38%  $DO < 4$ ) and high chlorophyll *a* levels (18% of area with high  $> 20$  ug/l). Some selected studies such as ADEM's Seafood Waste Studies (1984) and the Corps' Mississippi Sound studies (1970) have documented the nutrient levels in some portions of the system but these studies are somewhat dated.

### ***Mobile Bay***

Because of its large area and hydrologic diversity, Mobile Bay has been subdivided for various water quality investigations (ADEM, EMAP, ALAMAP-C) into 4 distinct regions. These areas are then useful for analyzing the various areas of the Bay. Each area also has a different use classification as listed in the ADEM 305b report (ADEM 1996).

Overall, for the nutrient overloading/organic enrichment issue for Mobile Bay, the estuary was rated good to fair for the period 1993-95 by ADEM (Carlton *et al.*, 1998). Low dissolved oxygen levels for a large portion of the Bay indicates this issue is of key concern. Over 55% of Mobile bay had bottom dissolved oxygen levels below 4 mg/l and 30% showed dissolved oxygen levels below 2.0 mg/l which represented poor conditions. However, it should be noted, dissolved oxygen standards were actually met, on average, in 95% of coastal waters, when the entire coastal area is considered. Occurrence of low dissolved oxygen is clearly associated with salinity stratification and higher summer temperatures in Mobile Bay, Lower Mobile River and Chickasaw Creek. This occurrence of diel hypoxia has been described at 80% of the stations in eight Northern Gulf of Mexico estuaries (Summers and Engle, 1993).

#### Region I, Harbor Area, Northwest

Region I of Mobile Bay encompasses 25 sq. mi. of estuarine waters that is listed as Fish and Wildlife Classification. The upper portion of Mobile Bay has impaired use according to the 305b report (ADEM 1996), and only partially supports its designated use, in part due to nutrients and organic enrichment. This is indicated by the low DO levels observed periodically in the estuarine area.

The most recent characterization by ADEM, in the ALAMAP-C report, indicated good nutrient levels, fair dissolved oxygen with 16% of the area with  $DO < 2.0$  mg/l and 36% with  $DO < 4.0$  mg/l.

#### Region II, Upper Bay, Northeast

Region II of Mobile Bay encompasses 88 sq. mi. of estuarine waters that is listed as Fish and Wildlife/Swimmable use classification (ADEM 1996). This area had an overall rating of fair during 1993-95 in the ALAMAP-C report with high nutrient levels (15% with high chlorophyll and 12% with high nitrate) and and rated as poor due to low bottom DO (37%  $< 2.0$  mg/l and 50%  $< 4.0$  mg/l).



### Region III. Middle and Lower Bay (Southwest)

Region III of Mobile Bay encompasses 135 sq. mi. of estuarine waters that is listed as Fish and Wildlife Classification, Swimming and Shellfish Harvesting. The region was not listed as having impaired use in the 305b report for nutrients or organic enrichment. The ALAMAP-C program rated the area as good to fair, with the lower rating due primarily because of low bottom DO throughout a large portion of this estuarine area (32% DO < 2.0 mg/l, 69% DO < 4.0 mg/l).

### Region IV. Bon Secour

Region IV of Mobile Bay encompasses 132 sq. mi. of estuarine waters that is listed as Shellfish Harvesting, Swimmable, and Fish and Wildlife Classification. It is designated in the 305b report as not having any limitations due to nutrients or organic enrichment. The ALAMAP-C report lists this area as overall good to fair during 1993-95. Moderate areas of this sub-area showed low bottom DO levels (25% with DO < 2.0 mg/l, 45% with DO < 4.0 mg/l) and high nutrients in 15% of the area which resulted in the “fair” designation.

### ***East Fowl River, Deer River and Dog River Watersheds***

#### Fowl River

The Fowl River (East and West) is classified as Fish and Wildlife/Swimmable by ADEM(1996). It is listed by ADEM (1996) as partially meeting its designated uses with nutrient and organic loading as problems, presumably from pasture and stormwater runoff.

The Fowl River area has extremely limited information regarding the nutrients, chlorophyll and dissolved oxygen within the river itself. The data used for the 305b report listing is indicated as from 1986.

#### Deer River/Theodore Canal

The Deer River area is classified as Fish and Wildlife use classification and is designated in the 305b report as meeting its designated use. The Theodore Industrial Canal shows a partial impairment from organic enrichment that ADEM listed as due to channelization and natural sources. Dissolved oxygen problems have been periodically noted within the canal itself. Trend station data exist on the Theodore Industrial Canal along with data collected by industry as part of the DIZ monitoring program in Alabama coastal areas.

#### Dog River

The Dog River watershed located in Mobile County, encompasses about 90 square miles. It includes the drainage from six sub-basins all of which are navigable for some portions of their length. The lower tidally influenced portions of this river from its mouth at Mobile Bay are classified as Fish and Wildlife/Swimmable (ADEM 1994). The remaining upper portions are classified as Fish and Wildlife (ADEM 1994).

The Dog River watershed was the subject of a study conducted by ADEM during 1993 which included some intensive surveys of various stations within the watershed. These data were used to supplement the existing ADEM trend station located near Luscher Park in Mobile County.

Indications from the ADEM trend station and from the intensive sub-basin studies show that elevated nutrient levels chronically exist within at least the incoming streams and the upper portion of the tidally influenced portions, especially during high stormwater flow (ADEM 1994).

### ***Lower Mobile River - Chickasaw Creek - Threemile Creek***

The Lower Mobile River, Chickasaw Creek, and Threemile Creek areas Alabama represent the lower portions of a large watershed with many diverse land uses which include industrial, urban, agricultural and silvicultural categories. The channelized portions of these streams are the major maritime port and shipping center for the Port of Mobile and thus have intensive commercial activities including ship and barge traffic, material loading and unloading and associated dredging activities. The land uses immediately adjacent to these lower portions include very heavy industrial and high density urban development, adding potential impacts to this highly utilized lower riverine system.

The Lower Mobile River, Chickasaw Creek, and Threemile Creek areas are classified as Agricultural and Industrial (A&I). However, because of recent litigation, the USEPA has recently published in the Federal Register (FR/63:43-10799 5 March 1998) a proposed rule to upgrade and classify these stream segments as Fish and Wildlife.

The Lower Mobile River currently has some infrequent exceedences of the A&I DO standard (less than 3.0 mg/l DO) during the "low flow" time of the year (September) but generally is currently fully meeting its designated use according to the 1996 305b report (ADEM 1996). The lower Chickasaw Creek and Three Mile Creek currently are only partially meeting designated A&I use, due in part to low DO levels observed during periods of low flow and salinity stratification caused by a salt wedge encroachment in the channel from Mobile Bay. A listed contributing cause for these segments (Chickasaw and Three Mile) not meeting their designated use is organic enrichment/DO.

This issue is currently under intense study by ADEM to support its use designation and determine the ultimate source of loadings contributing to the observed impaired use.

### ***Mobile-Tensaw Delta***

The Mobile-Tensaw River Delta areas encompass about 280 sq. mi. and are classified as Fish and Wildlife with portions (Tensaw River) classified as Swimmable. Portions of the Tensaw River do not fully meet their use designations, in part due to nutrient and organic enrichment (ADEM 1996). Several water quality trend stations are maintained by ADEM within this area for monitoring conditions.

The recent ALAMAP-C report (ADEM 1998) Lists the Mobile-Tensaw Delta and the Tensaw River as being classified overall as fair with regard to nutrients, with some areas showing low DO and high chlorophyll *a*.

### ***Three-Mile Creek and Chickasaw Creek Watersheds***

The Three Mile Creek is classified as Agricultural & Industrial, but Chickasaw Creek above the lower segment is classified as Fish and Wildlife/Swimmable. These areas only partially meet current use designation, in part due to nutrient and dissolved oxygen limitations (ADEM 1996). The affected portions of these watersheds are generally in the lower stream segments in the watershed where the impacts from urban and agricultural runoff are expressed in high nutrients and low DO, especially during periods of high runoff (also see Lower Chickasaw Creek discussion above). High nutrient levels are periodically observed and are associated with stormwater runoff events in this area. Septic tanks in the basin may also be contributing factors in the increased nutrient levels observed.

Trend stations for monitoring water quality parameters including nutrients are maintained by ADEM and are reported in STORET.

### ***Bayou Sara, Cold Creek and Cedar Creek Watersheds***

Few data exist for the Bayou Sara, Cold Creek and Cedar Creek watersheds from a nutrient and organic overloading perspective. Trend stations are lacking for most of this area.

### ***North Baldwin County Watersheds***

The North Baldwin County watersheds have very limited data with regards to nutrient data. No station data were identified nor trend station information were found in the database for nutrients. The 305b report does not list any stream segments in this area as not meeting their designated uses as Fish and Wildlife because of nutrient or organic enrichment issues.

### ***Eastern Shore Watersheds***

The Eastern Shore watersheds also show limited information. Water use for the area is designated as Fish and Wildlife and swimmable in Fly Creek. A few special studies by ADEM, SARPC and USGS provide limited information on nutrient and organic enrichment information along this growing area.

### ***Weeks Bay Watershed***

The Weeks Bay watershed has been intensively studied in part as a result of the National Estuarine Research Reserve program for Weeks Bay. The area has uses classified as Fish and Wildlife, Swimmable and Shellfish Harvesting, and Weeks Bay has been given the special designation of "Outstanding Natural Resource Water".

The 305b report lists the Fish River as not meeting its designated use due to nutrients and organic overloading. In particular, urban (suburban) development and agricultural loadings are contributors to the reasons this river does not meet its designated use.

### ***Bon Secour River Watershed and Ft. Morgan Peninsula***

The Bon Secour watershed was the subject of a recent report (ADEM 1996) which provided some sampling and studies directly related to nutrients and organic loading from this subarea. Water use classifications for portions of the watershed include Swimming, Fish and Wildlife, and Shellfish Harvesting. The subarea has no major industrial or municipal wastewater discharges but shows some impacts from non-point sources. The elevated levels of nutrients in some tributary streams show high nutrient inputs presumably from agricultural or septic tank fields influences.

#### **5.3.3.7 Sources of Nutrients and Organic Materials**

Sources of nutrients and organic materials to estuarine systems come from a variety of sources, both natural and anthropogenic. Nutrient and organic enrichment threatens many of our coastal systems. Compilations of these sources can give insight into various management strategies on how to reduce loadings to areas that are currently impacted and how to prevent additional areas from future impacts through landuse and facility planning efforts of local and state governments.

A search of the database for documents and data to address the sources of nutrient overloading for the Mobile Bay NEP area are presented below.

#### ***Non-point source runoff***

Non-point source runoff enters Mobile Bay from the following major contributors

- Urban/suburban stormwater runoff
- Agricultural runoff
- Silvicultural runoff
- Industrial stormwater runoff

A search of the database for “non-point” and “nutrient” produced about 50 data records in the MBNEP document database. An examination of these records reveals the following noteworthy data sets:

The SARPC "208" study (1978) includes valuable information of nonpoint sources as well as point sources, but is mainly applicable from a historical perspective. No rigorous comparison of present-day source contributions (compared to the 1970's) was identified by the Information Record search.

A system for estimates of non-point source data and analyses includes the BASINS GIS system developed for USEPA which contains not only information on land use and runoff data, but a NPS model system derived from EPA's HSPF program. However, evaluations using this system have not been applied within the MBNEP area.

Thompson Engineering (1993) reported on non-point runoff for several landuse types in Mobile County for the stormwater characterization study. This analytical characterization was performed for the Mobile-Baldwin Counties Stormwater Consortium, for which SARPC

coordinated the efforts of local governments for Municipal Separate Storm Sewer (MS4) permit application. The local governments and consortium are continuing to develop further information and management plans as part of the MS4 permit requirements.

### ***Point Source inputs***

Major point source discharges in the MBNEP area which may be significant to the Nutrient Overloading Issue include:

- Industrial
- Municipal (sanitary sewers, sewage plants, CSO's)

Point source discharge data are available through the PCS and IFD systems and STORET. These data are available through the BASINS system and online data sources from EPA. From an historical perspective, SARPC's "208" studies (1978) provide the most comprehensive area-wide assessment of point source contributions. However, comprehensive comparison evaluation with present conditions has not been performed.

Additional compilation of point source data for the MBNEP areas has been accomplished by USGS and NOAA. These reports provide estimates of point source loading from the EPA PCS database.

### ***Upstream River Inputs***

Upstream river inputs from beyond the MBNEP area have been compiled by NOAA and USGS in several studies. Of particular note are the NCPDI database of NOAA's strategic assessment branch and the NASQAN stations of the USGS. The USGS, through its ongoing NAWQA study, plans to develop more comprehensive estimates of basin-wide loadings for the Mobile River system.

### ***Atmospheric deposition***

Atmospheric deposition data for nutrients is available through the NADP program operated by the USEPA. This program is an ongoing monitoring network and associated database that is accessible through the Internet.

No data for local atmospheric depositional data exist, however, regional data of a general nature are available for order-of-magnitude estimates for a preliminary nutrient budget.

### ***Sediment release***

Sediment release of nutrients, notably nitrogen and phosphorus, have been determined for several points within Mobile Bay in a very comprehensive study covering this topic (Cowen, et al., 1996; Cowen 1995).

### ***Septic tanks***

A search of the database for Septic Tanks and Nutrient produced 4 records. This included a report on various wastewater practices in Baldwin County (CH2M-Hill, 1996) and two EPA studies about septic systems on Dauphin Island and Gulf Shores. Obviously, quantitative data relating to septic tanks and nutrient issues are very limited.

### ***Potentially Minor Contributions to nutrient loadings***

Potentially minor contributions to the nutrient/organic enrichment inputs include the following categories:

- Dredging
- Ground water inputs
- Tidal exchanges
- Migrating animals
- Spills and dumping
- Seepage

While these inputs usually represent minor contributions to the overall loading budgets for nutrients and BOD, in some instances, such as during a spill incident, they may be important factors. A search of the database for “spill and nutrients” produced 3 records in the existing database.

### **5.3.3.8 Preliminary Nutrient Loading Budget**

To demonstrate how the available information in the MBNEP database can be used to assemble the above information, a preliminary nutrient budget has been prepared for the parameters, biochemical oxygen demand (BOD), total nitrogen (TN) and total phosphorus (TP) from the existing literature and databases. This is also useful to identify data gaps where information may be lacking. In particular, it can identify where additional studies and effort of the Mobile Bay NEP may need to be directed.

Using the records identified above, data were compiled to prepare overall preliminary average annual loading budgets for the identified parameters, as summarized in Table 5-5.

**Table 5-5. Preliminary Mass Loadings Estimates for Biochemical Oxygen Demand (BOD), Total Nitrogen (TN) and Total Phosphorus (TP) for the Mobile Bay Estuary.**

<b>Loading Source</b>	<b>Total Nitrogen (tonnes)</b>	<b>%</b>	<b>Total Phosphorus (tonnes)</b>	<b>%</b>	<b>Biochemical Oxygen Demand (tonnes)</b>	<b>%</b>	<b>Data Source</b>
Atmospheric	1,277	2	99	2	0	0	This Study
Upstream Tributary	45,182	87	5,554	86	66,409	72	TN,TP USGS, 1996; BOD*
Point Sources	2,459	5	596	9	16,102	17	NOAA, 1993
Non-Point Sources	2,940	6	240	4	9,800	11	TN,TP (Pennock, 1995); BOD *
Internal						0	not assessed
<b>TOTALS</b>	<b>51,858</b>	<b>100</b>	<b>6,489</b>	<b>100</b>	<b>92,311</b>	<b>100</b>	

\* BOD loads from upstream and non-point sources estimated for this study

### 5.3.3.9 Data Adequacy Summary (Nutrient Overloading Issue)

Adequate data exist to provide rough estimates for many types of comparisons of nutrient overloading issues within Mobile Bay and for the MBNEP area as a whole. Through the EMAP, ADEM trend stations and the ALAMAP-C programs, data for generalized indications of these parameters seem sufficient. Lacking are long term, that is without significant data gaps, monthly datasets for parameters such as Chlorophyll a and the various specific nutrient parameters such as nitrate, nitrite, ammonia and Total Kjeldahl Nitrogen (TKN). Such information will be necessary to adequately calibrate and verify water quality models for the MBNEP system. Several studies have been proposed to collect this information such as the renewal and continuation of the USGS data collection efforts performed by the Dauphin Island Sea Lab (Pennock, 1994). Additional data collection efforts should focus on filling additional data gaps, if the monthly data collection efforts are resumed.

Status and trends of dissolved oxygen within the Mobile Bay system could be synthesized by combining a series of “snapshots” taken from existing studies such as the historical work of Schroeder and the ALAMAP efforts, and combined into a comprehensive analysis of dissolved oxygen. Numerous studies have demonstrated the dissolved oxygen deficits within Mobile Bay and in its tributary streams (e.g., Lower Mobile River, Dog River, Chickasaw Creek). A recent study (SAIC 1998) generally describes the factors responsible for the low dissolved oxygen phenomena and attempts to derive a dissolved oxygen criteria for Mobile Bay and Lower Mobile River. To synthesize this information into a comprehensive “status and trends” would require calibration and verification of a model capable of adequately simulating dissolved oxygen for the period when the 208 study was performed (1976-80), and then performing the procedure again for a more recent period (1994-96) with more recent data.

A similar process for simulating nutrient and chlorophyll *a* status and trends could be undertaken using again land use and ambient data collected during the 208 studies and compared to a synthesis of data from more recent datasets (ALAMAP-C and Pennock's data, for example). Using these as a beginning point, a model capable of simulating nutrient and phytoplankton (chlorophyll *a*) for 1976-80 period and again for more recent data sets would be instructive.



### 5.3.4 Physical and/or Hydrologic Modification

#### 5.3.4.1 Introduction

By definition, estuaries require freshwater inflow. Alteration of the natural flow regimes in the tributaries can have significant effects on the water quality and health distribution of living resources in the receiving estuaries. Estuarine organisms are adapted to the salinity gradient that is established in an estuary. This gradient provides refuge from predators and parasites that are not adapted to a lower salinity. The overall impacts of changing the salinity gradient on species inhabiting estuaries depends on the system and the individual species tolerances. Species composition and abundance will shift in any given area as salinities rise, with some species benefiting and others being negatively affected.

In addition to changing the salinity regime in receiving waters, channels and overdraft of coastal aquifers can cause localized saltwater intrusion. Decreasing water flows allows the tide to push saltwater further upstream, into freshwater habitats. Most freshwater plants and animals are not tolerant of salty water. Also critical is the quality of the freshwater flowing into receiving estuaries. Agriculture, forestry, and the increase of paved surfaces due to development can increase stormwater runoff. Stormwater runoff can contribute pollution in the form of toxic substances, excess nutrients, suspended sediment, and debris to receiving estuaries. Freshwater flows may also affect red tide occurrences, although red tide cycles are poorly understood.

#### 5.3.4.2 Identified or Potential Problems

Based on discussions of the MBNEP Water Quality Workgroup and review of issues identified by EPA in other NEP areas, key problems to be considered as related to physical and hydrologic modifications have been enumerated as follows:

##### *Impacts (known or potential):*

- Effects on health and abundance of aquatic species due to altered water flow patterns and/or salinity gradients (including saltwater intrusion into streams and rivers).
- Changes in water quality due to water flow pattern alterations.
- Changes in water quality due to physical modifications of shoreline areas.
- Changes in water quality of tributaries and receiving waters due to hydrologic modifications within watersheds (for example increased stormwater runoff due to development, flood control/drainage improvements).
- Saltwater intrusion of drinking water supplies due to groundwater withdrawal [Note: See separate section on groundwater impacts].

##### *Sources of Modifications (known or potential):*

- Navigation channels and Dredged Material Disposal Areas (DMDAs)
- Bridges and causeways
- Shoreline development (canals, bulkheads, etc.)

- Increased impervious surfaces due to local urban/suburban watershed development (stormwater runoff)
- Local watershed flood control and drainage modifications.
- Groundwater withdrawals [Note: See separate section on groundwater]

#### **5.3.4.3 Information Record Database Inquiries**

There are currently approximately 470 documents in the Water Quality Information Record Database catalogued as being related to the hydrologic modification issue. Two parameter groups which are directly related to this issue are “hydrodynamic” and “meteorological”. Many of these records have data or information related particularly to these parameters. Of these documents relating to the physical and/or hydrologic modification issue, about 95 are classified as “summary publications”, 335 as “technical publications”, and 16 as “data system/models/databases”. Similar results can be found from more specific searches, such as those in tables compiled in Appendix IV.

The large number of records suggests that a considerable amount of information exist related to this issue. However, because most information sources are likely to have at least some data pertaining to water flow or similar parameters, many of the records thus categorized probably contain only limited data comprehensively related to the issue.

#### ***Spatial Distribution of Data Records***

Two principle search techniques were used to determine the spatial distribution of documents in the Information Record Database: location-on-map and quad selection. For records not containing specific station locations, the location-on-map selection was chosen. This group contained generalized areas such as “NEP Area”, “Mobile Bay”, “Baldwin County”, and others. However, when station locations were specific enough so that a USGS 7.5-minute quadrangle could be determined, a menu selection of quadrangle names was utilized. Another option for spatial documentation was an entry table for documents containing specific latitude/longitude.

Information database searches were made for the physical and/or hydrologic modification issue and related parameters by “location-on-map” and by “quad selection” option. Documents classified as technical publications comprised the majority of data records for these two searches. The results of these searches are enumerated in the tables in Appendix IV.

#### ***Temporal Distribution of Information Records***

Temporal distribution of information records is also presented in tabular form in Appendix IV, which compares the “temporal limits” field of record entries in 5-year intervals. This chronological summary applies to the time periods of data discussed in the reference source, and not the publication date. Although certain records contain information related to historical perspectives, the chronological summaries indicate (not unexpectedly) that the majority of information records are relevant to more recent time periods.

#### 5.3.4.4 Data Resources

Primary information resources for data related to the physical and hydrologic modification issue include the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers, Mobile District (USACE-Mobile), the National Oceanic and Atmospheric Administration (NOAA), and the Dauphin Island Sea Lab (DISL).

The USGS maintains the most comprehensive data set of flow (discharge) data for major rivers and selected minor tributaries. The USGS Internet data system (NWIS) for discharge records is highly functional and “user-friendly”. Long-term records are available for the major river systems draining into the MBNEP area: the Tombigbee River at Coffeeville and the Alabama River at Claiborne. Also, there are several USGS gaging station records and/or special studies applicable to local regions.

NOAA maintains selected tide and current data systems of interest to the MBNEP area, information about which can be accessed through their Internet site. Also, the USACE-Mobile has performed and/or cooperated with hydraulic data acquisition programs applicable to the MBNEP area for a long time period. Several tide and river gage stations are maintained in the area, for which information may be accessed through their Internet site and/or by contacting the Mobile District. Additionally, because of the Corps’ role in navigation and related interests, USACE-Mobile has conducted a number of studies and evaluations pertaining to channel construction and maintenance, and dredged material disposal. These have involved several modeling efforts (physical and numerical) in connection with navigation projects.

Researchers at DISL have performed and published many studies pertaining to circulation, salinity, and related hydrodynamic features of Mobile Bay. For example, query of the Information Record Database related to the hydrological modification issue for “Dauphin Island Sea Lab” yields about 80 records. Their efforts over the past quarter century have considerably advanced the base of knowledge pertaining to the dynamics of the estuary.

#### 5.3.4.5 Data Sets Related to Selected Potential Impacts or Sources of Modifications

With reference to the known or potential key problems considered relevant to the physical and hydrological modification issue, as discussed in the introduction to this section, evaluation of data resources are further grouped (for discussion purposes) into three broader categories: (1) altered flow patterns/salinity, (2) watershed alterations, and (3) shoreline modifications. The following summarizes applicable data sets pertaining to these categories.

##### *Altered Flow Patterns/Salinity*

Information records, which pertain to circulation patterns, salinity gradients, and related hydrodynamic features within Mobile Bay are abundant. A key word search (pertaining to the issue category of “physical and hydrological modifications”) for “salinity” identifies some 280 documents. Adding the term “circulation” still leaves about 180 records. Most of these are technical publications, with fewer records in the categories of “datasystems/models/databases” and “summary publications”.

These information records range in publication dates from 1954 to 1998. For illustration, selected examples of these records include:

- Austin, G. B., Jr., 1954. "On the circulation and tidal flushing of Mobile Bay, Alabama "
- McPhearson, R. M., Jr., 1970. "The hydrography of Mobile Bay and Mississippi Sound, Alabama"
- Schroeder, W. W., 1975. "Meteorological and oceanographic observations made during Hurricane Carmen (September, 1974) at Dauphin Island, Alabama"
- Eleuterius, C. K., 1976. "Mississippi Sound salinity distribution and indicated flow patterns"
- Schroeder, W. W., 1979. "Dispersion and impact of Mobile River system waters in Mobile Bay, Alabama"
- Schroeder, W. W. and Lysinger, W. R., 1979. "Hydrography and circulation of Mobile Bay"
- Kjerfve, B. and Sneed, J.E., 1984. "Analysis and synthesis of oceanographic conditions in the Mississippi Sound offshore region, final report, Vol. 1"
- National Oceanic and Atmospheric Administration, 1985. "National Estuarine Inventory, data atlas-Volume 1: Physical and hydrologic characteristics"
- Schroeder, W.W., S.P. Dinnel, W.J. Wiseman, Jr. and W.J. Merrell, Jr., 1987. "Circulation patterns inferred from movement of detached bouys in the eastern Gulf of Mexico"
- Orlando, P. S. Jr., and Klein, C. J., III, 1989. "Characterization of salinity and temperature for Mobile Bay"
- Orlando, S.P., Jr., Rozas, L. P., Ward, H. and Klein, C. J., III, 1993. "Salinity characteristics of Gulf of Mexico Estuaries"
- National Oceanic and Atmospheric Administration/ Gulf of Mexico Program Freshwater Inflow Committee, 1995. "Workshop on Freshwater Inflow to Gulf of Mexico Estuaries"

Additionally, there have been several modeling efforts in the MBNEP area. A key word search for "model" finds about 70 documents. Several of the modeling references were performed in connection with navigation projects such as the Theodore Ship Channel, Mobile Ship Channel deepening, and Mississippi Sound studies. A water quality as well as hydrodynamic model was used in the SARPC "208" water quality management plan developed in the late 1970's and early

1980's. Of the bay-wide modeling efforts, the majority of efforts were performed in the 1970's and 1980's. More recent efforts have been performed in segments such as Weeks Bay. None of the previous major hydrodynamic models developed for Mobile Bay have been maintained and updated for present-day utility. However, their data sets may prove very useful for future hydrodynamic modeling as envisioned by the MBNEP.

### ***Watershed Alterations***

If the Information Record Database (related to the “physical and hydrological modification” issue) is searched for key words such as “watershed”, “non-point source”, “urban”, and so forth, fewer records are identified. For example, query by the issue: “hydrological modification” and key word: “watershed” yields about 30 information records. Notable among these are the ADEM watershed studies (Dog River, Chickasaw Creek, Bon Secour River) and various studies connected with the Weeks Bay Watershed Project. The ADEM watershed studies provide characterizations of the effects of land use practices and development on aquatic resources, but quantitative data (e.g., increased acreage of impervious surfaces, miles of channelized stream flow, etc.) is limited. The work being sponsored by the Weeks Bay Watershed Project is more comprehensive, and may provide a useful “example” (as well as transferable data) for other watersheds as well. Also of note are the ongoing stormwater management programs of the governments participating in the Mobile-Baldwin Counties Stormwater Consortium. These programs are being developed in response to Municipal Separate Storm Sewer (MS4) permit requirements, and are generating additional data relating to watershed alterations as well as other issues.

### ***Shoreline Modification***

Query of the Information Record database (related to “physical and hydrological modification”) for the keyword: “shoreline” points to approximately 30 records. Much of the work appears to relate to coastal shoreline changes and trends, and perhaps effects on habitat. The amount of information relating to water quality impacts caused by shoreline modifications (such as bulkheads) appears limited.

#### **5.3.4.6 Data Adequacy Summary (Physical and/or Hydrological Modification Issue)**

With respect to data adequacy pertaining to altered flow patterns and/or salinity, the information records which have been reviewed include many prior research studies and modeling projects characterizing various hydrologic, circulation, and/or salinity patterns within portions of the MBNEP estuarine area, particularly for Mobile Bay proper. Additionally, historic and ongoing data acquisition programs which measure major (and some minor) riverine discharges entering the area, and tidal stages at selected locations, provide long-term records relating to principal hydrodynamic factors affecting the system. This body of information demonstrates a knowledge base which may be viewed as adequate for an understanding of general flow and salinity patterns of the estuary; however, which may not necessarily be sufficient for critical evaluation of future activities and for informed decision-making by management agencies. The MBNEP and participating agencies with responsibilities and interests in water quality management have

recognized, as a high priority, the need to initiate an updated water quality modeling effort for the MBNEP area. (Although hydrodynamic and water quality models have been applied in the past, none have been maintained for present day utility). The available data sets may prove very useful for future hydrodynamic modeling efforts envisioned by the MBNEP; however, their overall adequacy will be dependent upon the specific requirements of the model(s) selected and the specific areas and detail of coverage.

With respect to data adequacy pertaining to watershed alterations, the information records which have been reviewed indicate the limitations of quantitative data which have been acquired or comprehensively evaluated for the MBNEP area (for example, data on increased impervious surfaces or channelized stream segments within delineated watersheds). However, the available data sources reflect an increased emphasis on watershed-based evaluations and data acquisition programs, particularly within the last decade. Notable among the available data resources are several "local" watershed studies performed by ADEM, special studies and evaluations performed in connection with the Weeks Bay Watershed Project, and ongoing programs of the Mobile-Baldwin Counties Stormwater Consortium governments. For many areas, this information base provides at least qualitative characterizations of the effects of watershed alterations on water quality and aquatic resources. However, the lack of quantitative data limits the ability to make meaningful comparisons of such alterations over time.

Insofar as potential water quality impacts caused by shoreline modifications, available data sets for the MBNEP area are lacking. Information records do indicate a body of work related to shoreline changes and trends, and these data resources (which are expected to be more comprehensively evaluated in habitat loss characterization) may prove useful for corollary examination of possible effects on water quality.

### 5.3.5 Erosion and Sedimentation

#### 5.3.5.1 Introduction

Erosion is a naturally occurring geomorphic process that can be greatly accelerated by anthropogenic processes including agriculture, construction, silviculture, and urban development. Soil erosion is often an important contributor to non-point source pollution and can have significant impacts on water quality.

Climatic conditions of the central Gulf Coast region produce the highest rainfall erosive factors in the United States. Erosion problems are further compounded by the fine-grained and/or unconsolidated nature of the soil and slopes of rolling hills and coastal ravines which makes the MBNEP area highly susceptible to erosion and sedimentation concerns. Uncontrolled or poorly managed stormwater runoff, improper construction techniques, and topographic modification greatly add to the potential of problems within the area. Sediments may be transported into bodies of water altering flow patterns in addition to causing turbidity and water quality problems. Concerns associated with soil erosion range from structural uncertainty for developments to habitat loss. Urban developments increase the amount of imperviousness within watersheds, which increases the volume and velocities of stormwater runoff resulting in increased erosion of stream banks and bottoms. Hard stabilization of streams and coastal shorelines can disrupt hydrology causing increased runoff velocities and less absorption of wave energy, either of which can increase erosion or alter natural deposition processes.

Sediment discharge rates in runoff from construction sites are typically 10 to 20 times that from agricultural lands and more than 1000 times that from undisturbed soils (USEPA, 1992). The MBNEP contains some of the most rapidly developing areas in the state of Alabama. Throughout any given year, there are continuously ongoing construction activities that produce denuded soil surfaces exposed to precipitation. Without appropriate control measures many of these construction sites can be highly susceptible to erosion. Subsequently, erosion from construction activities potentially produces large quantities of sediment that places embayments, wetlands and tributary streams in the vicinity of construction activities at risk of being filled by the sediment transported from eroding construction sites. As depicted in Figure 5-1, turbidity plumes within the Mobile Bay extend from the mouths of major rivers and the most notably from reported construction activities situated in the D'Olive Bay watershed (Isphording, *et al.*, 1984).

The presence of water in the mainly unconsolidated soils contributes greatly to mass wasting. This is the ability of materials to move downslope, eroding the land surface. Most large-scale bulk movement of mass wasting is natural, though human activities may promote or trigger these occurrences. Three primary contributing factors are:

- 1) the steepness and instability of slopes,
- 2) the nature of slope materials, and
- 3) the amount of water in the soil material.



**Figure 5-1. National Aeronautic and Space Administration photograph of the Mobile Bay area taken by SKYLAB in January of 1974. A prominent sediment plume appears to extend from D'Olive Bay southward into the bay. The D'Olive Bay watershed had been impacted by construction activities that had denuded soils highly susceptible to erosion.**

Mass movement of soils has been observed in the MBNEP study area as creep, debris flow, and slumping. Creep is generally a very slow movement difficult to measure over short periods of time. It can be observed locally in deformed bulkheads, retaining walls, and cracked bridges, and roads, as well as poorly constructed geotechnical surfaces. Debris flows are earth flows that



travel faster than adjoining soil materials and are typically associated with stratum containing fine-grained materials. These can be seen after heavy rainfalls where supersaturated areas move down slope carrying un-retained materials such as hillsides that have been stripped of vegetation, hillsides receiving too much runoff, or embankments not properly retained. Slumping is a slow slide of unconsolidated materials that travel as a unit. Typically this occurs in the MBNEP area during or after heavy rains as a result of large volumes of water saturating areas under heavy overlying structural or ground weights. Recent problems have occurred with hillsides giving way blocking highways with debris, roads or bridges being washed out, and actual building structural failure. Materials typically are transported into nearby tributaries, marshes, bays, and bayous. Large quantities of water also erode unconsolidated materials and eventually lead to nearby embankment collapse.

Soil erosion can significantly impact the water quality of tributary streams, rivers and tidal embayments. Soil erosion and the subsequent transported sediments can increase both the suspended solids in the water column and dissolved constituents. Mineral nutrients that typically have a low solubility, such as phosphorus, can be transported into the estuarine environments adsorbed to soil particles. Pinyerd, *et al.* (1993) found that total phosphorus concentrations in the urban stormwater runoff of Mobile and Baldwin Counties (Thompson Engineering, 1993) was related to the concentration of total suspended solids. Sediment deposition can have an adverse physical impact on the benthic community in numerous ways that range from “suffocation” to destruction of wetland habitats. Turbidity caused by suspended solids can reduce photosynthesis, which reduces the dissolved oxygen in the water column and the production of food within the estuarine system.

Waterfront developments that include shoreline clearing practices and construction of bulkheads can cause erosion that adversely impacts water quality. Riparian vegetation plays an important role in reducing turbidity by trapping sediment. Clearing shores of either riparian vegetation along the banks or submerged aquatic vegetation de-stabilizes the soils and sediments held in place by roots. Wave energy that causes the suspension of sediments in the water column is absorbed by vegetation. However, bulkheads reflect waves with little energy deposition causing the bottoms near the bulkhead to be eroded significantly. When anthropological activities increase wave erosion, the water column can become significantly loaded with both mineral and organic constituents. Organic materials derived from muck sediments that commonly form in tidal marshes can be suspended in the water column and significantly increase biochemical oxygen demand. In addition to the loading of the water column with nutrients and carbon compounds that increase biochemical oxygen demand, sediments and soils absorb toxins that can be released into the environment once suspended in the water column by various erosion mechanisms.

#### **5.3.5.2 Known or Potential Problems Related to Erosion and Sedimentation**

Known or potential impacts related to the erosion and sedimentation issues have been listed by the MBNEP Water Quality Workgroup as follows:

- Increased local sedimentation in tributaries and tidal rivers, creeks, bays and embayments,
- Increased widespread sedimentation within Mobile Bay,
- Degraded water quality of tributaries and tidal rivers, creeks, bayous, and embayments (e.g., turbidity and contaminants whose migration is related to sediment transport)
- Degraded widespread water quality of Mobile Bay (turbidity, nutrients, contaminants, etc.)

Erosion and sedimentation are natural processes that can be greatly accelerated by human activities. Known or potential sources of excessive or accelerated erosion and sedimentation that have been identified as concerns within the MBNEP area include:

- Urban and suburban runoff (resulting from increased and high-velocity runoff volumes from impervious surfaces to unstable drainageways, resulting in stream bank and bottom erosion)
- Construction site runoff
- Agricultural runoff (erosion of agricultural land)
- Silviculture runoff (deforestation and forestry practices)
- Waterfront development (e.g., bulkheads, groins, and shoreline clearing)
- Rural runoff including unpaved roads
- Upstream river inputs
- Resuspension of sediment due to human activities (e. g. dredging, shrimping) or by natural forces (wave action, floods)

#### **5.3.5.3 Database Inquiries**

There are approximately 260 Information Records compiled within this study that were characterized as related to erosion and sedimentation. Of these approximately 15 were categorized as “Data system/Model/Database”, about 60 were “Summary Review Publications”, and 180 were “Technical Publications”.

Erosion and sedimentation Information Records may be reviewed by for both spatial and temporal distribution. The spatial distribution of the Information Records may be reviewed by two principal search techniques, referred to as (1) location-on-map, and, (2) quad selection. The search results depend upon the manner of record entry. Generally, for those records not containing specific station locations, the record entry included a menu selection of narrative descriptors such as “NEP Area,” “Mobile Bay,” “Dog River,” and others. However, when station locations were given such that their location within USGS 7.5-minute quadrangles could

be determined, a menu selection of Quadrangle names was utilized. Searches in erosion and sedimentation utilizing one or both spatial variations are shown in tables (Appendix IV). Temporal limits of Information Records contained related to the Erosion and Sedimentation issue range from the 1850's to the present. Approximately 80 records contain Information Records obtained prior to 1950. There are approximately 70 records for data with temporal limits of 1950 to 1969. As might be expected from the recent increase in concerns related to the erosion and sedimentation issues, the majority of data and information related to erosion and sedimentation have been collected between 1970 and the present, with approximately 230 records compiled in that temporal range. Searches for information records pertaining to the "erosion and sedimentation" and related "parameter groups" can be performed using the database. Searching this issue by "parameter group" field indicates that the parameter groups with the greatest number of records were associated with those typically utilized to characterize the physical characteristics of soil or sediments and non-point source pollutants. Erosion and sedimentation concerns are typically considered non-point source pollution problems. Non-point source pollutant parameter groups typically include "Routine Physio-Chemical" and "Nutrients and Oxygen Demand." The tabulation of the temporal distribution of Information Records for "Routine Physio-Chemical", "Nutrients and Oxygen Demand," and "Sedimentological" parameters is presented in tables in Appendix IV.

Further search of the data sets relating to erosion and sedimentation may be best approached by focusing on specific aspects of known or potential problems related to the issue category. Several impacts and sources of potential concern have been identified through the MBNEP process. Discussed below are evaluations of the "Erosion and Sedimentation" data sets as related to selected known or potential problems. Using a combination of issue categories of "erosion and sedimentation" and "physical and/or hydrological modification," keyword research of this combined grouping provided the following tabulation:

<u>Keyword</u>	<u>Number of Records</u>
Fishing OR Shrimping	85
Beach	68
Hurricane OR storm	65
Dredging	40
Hurricane	23
Agriculture	24
Flood	23
Construction	19
Silviculture OR Forestry	9
Climate	9
Urban OR Urban development	6
Roads	5
Exploration AND (oil or gas)	4
Dune	4
Bulkhead	3
Tributary	3
Tributary AND sedimentation rate	3

Wave	3
Rainfall	3
Sedimentation rate	2
Erosion rate	2
Waterfront AND development	1

#### 5.3.5.4 Key Reports

Although the Water Quality Management Plan Mobile and Baldwin Counties (often referred to as the 208 Report) prepared by the South Alabama Regional Planning Commission (SARPC, 1978) largely addressed point sources, it was the first comprehensive data report to address non-point source water quality issues such as erosion and sedimentation. It serves as a "starting point" containing both monitoring and modeling information. This report can be best used from an historical perspective of available water quality data related to erosion and sedimentation concerns.

Additional data and/or qualitative observations can be obtained from the following key reports, studies and databases:

EPA's BASINS System (EPA, 1997)  
 Soil Survey of Baldwin County (SCS, 1964)  
 Soil Survey of Mobile County (SCS, 1980)  
 Management Plan for the Weeks Bay Watershed (Lynn, 1997)  
 State 305b Report (ADEM, 1996)  
 Chickasaw Creek Study (ADEM, 1997)  
 Dog River Study (ADEM, 1994)  
 Bon Secour Study (ADEM, 1996)  
 Isphording *et al.* (1984)  
 Basnyant *et al.* (1996)

Complete descriptions of these reports and data sources are listed in the MBNEP Information Record Database. Selected descriptions of Information Records that provided major sources of erosion and sedimentation data as related to water quality are summarized in the following discussion.

#### ***EPA's BASINS System***

Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) is a multiple environmental analysis system for performing water quality and watershed studies. Version 2.0 of BASINS will have GIS layers for soil type and topography that will make it useful for assessing erosion potential and subsequent sediment transport into tributaries and embayments. Future modelers of erosion and subsequent sediment transport mechanisms may find BASINS a useful data system.

### ***Soil Surveys of Baldwin and Mobile Counties***

The classification and mapping of superficial soils by soil series is presented in the Soil Surveys of Baldwin County (SCS, 1964) and Mobile County (SCS, 1980). Some understanding of how soils are classified is useful to the environmental planner because attributes, which differentiate soil types, also control soil erodibility and stormwater hydrology. The erosion hazard for each mapping unit or soil series is tabulated in the Baldwin and Mobile County Soil Surveys. In addition, the USDA/Natural Resource Conservation Service (NRCS) [formerly the Soil Conservation Service (SCS)] has developed procedures based on soil series hydrologic group, land use characteristics and regional climatic factors for calculation of stormwater runoff volumes. These procedures are presented in the Technical Release 55 publications (USDA, 1975 and 1986) and are becoming widely used in urban stormwater planning and non-point source pollution abatement by engineers and planners. The hydrologic group data of soil series is presented in the Soil Survey of Mobile County and are also available through the USDA and NRCS for the soil series throughout the MBNEP.

Soil series classifications are based on “typifying” characteristics observed within the soil profile. These profile characteristics are developed from “pedogenesis”. Through space and time, pedogenic processes have occurred and formed distinct layers, or horizons, within the upper portions of parent material or geological formations. In addition to parent material and time, the environment in which these soils formed largely determines the characteristic soil horizons of a soil series. The soil series are classified by the arrangement of soil horizons, color, texture, structure, chemical reaction, and mineralogical properties. In a mineral soil profile these soil horizons are typically designated A, B or C. The A-horizon is topsoil and the C-horizon is the parent material. The B horizon forms as the soil matures and is a zone of accumulation of materials that have either leached from the A-horizon or formed in place from minerals within “soil solutions”. Due to the number of factors controlling pedogenesis, soil scientists have developed a complex system to classify soils. Pedogenic development of soil horizons is controlled by the interrelated function of soil and water that is dependent on plants, animals, microorganisms, inorganic processes, the slope of the land, composition, and physical condition of the soil. Soil surveys generally provide information and data pertaining to specific locations to a depth of five to six feet below ground surface, which typically include a significant portion of the solum or the extent of pedogenetic processes have occurred in mature soils.

Pedogenesis, the horizon formation process in mineral soils, is a weathering process such that in the humid temperate climate found in the MBNEP, soils of upland areas that form on flat to moderate slopes are conducive environments for the formation of distinct A, B, and C soil horizons. Mineral soils can remain in a characteristic “youthful” state if these soils:

- 1) Are situated on steep slopes,
- 2) Are often re-worked by erosive activities (as occur in beaches and dune environments),

- 3) Have poor internal drainage as may be associated with an elevated water table,
- 4) Often receive new sediment as is the case for terraces along riverbanks.

Soils classification documents reviewed for the MBNEP area, are complicated by a change in the classification systems. The Baldwin County survey took place while the classification system was under revision. Thus, the old series terminology was used for Baldwin County. The Mobile County Soil Survey presents a soil classification utilizing the modern and more universal or worldwide classification system orders. Two types of parent materials form the solums of the MBNEP area soils:

- 1) Mineral sediments of geological formations and,
- 2) Organic matter accumulations that occur on the bottom of marshes and swamps.

The primary pedogenic process in mineral soils is eluviation, the weathering and leaching of the upper layers followed by the accumulation of materials and formation of clay minerals in the subsoil horizons. The mineral soils in the MBNEP are typically sandy loams and the underlying parent materials are deposits of Holocene to Miocene age.

Organic soils contain partially decomposed plant materials. Unlike mineral soil formation, which primarily occurs from eluviation of parent materials, organic soils form in depositional environments or by the geomorphic process of sedimentation. Organic soils primarily exist in tidal marshes and wetland areas.

If an area-wide MBNEP mapping of soil characteristic based on series were to be performed, a uniform soil series classification system might require some effort. Information is available through the state office of the USDA/ Natural Resource Conservation Service which translates (where applicable) the soil series names provided in the Soil Survey of Baldwin County into the current classification system as was used in developing the Soil Survey of Mobile County.

### **ADEM 305(b) Reports and Coastal Watershed Assessments**

ADEM's biennial 305(b) report (1996) includes NPS assessment and listings of impaired waterbodies, which relates in general to erosion and sedimentation issues. Data within the report is restricted to general summaries and therefore of limited utility in examining specific problems of sub-watershed areas. However, several coastal watershed studies have been performed and provide more complete information of interest to the subject. In Mobile County, these include the Dog River watershed (ADEM, 1994 and ADEM, 1996) and the Chickasaw Creek watershed (ADEM, 1997). An additional study report on the Bayou La Batre watershed is in progress. In Baldwin County, ADEM has performed a similar study on Bon Secour watershed (ADEM, 1996) and is scheduled to study Little Lagoon this year. ADEM's watershed studies provide an overview of land-use practices and effects of development on aquatic resources, and include descriptive (qualitative) information pertaining to erosion and sedimentation as well as other non-point sources. Nevertheless, these studies include only limited quantitative data directly related to the issue.

Except for the soil survey data discussed above, limited quantitative data related to erosion and sedimentation was found for Mobile County watersheds. Two watershed based efforts of note have been identified in Baldwin County. Studies have been performed in the D'Olive Bay and Weeks Bay watersheds of Baldwin County that provide quantitative data related to the erosion and sedimentation issue.

### ***D'Olive Bay Watershed***

Isphording, *et al.*, (1984) investigated the impact of large-scale development projects on the rate of sedimentation in D'Olive Bay. This study developed methods for obtaining reliable parameters that allowed for differentiation, in sediment cores, deposition of natural versus anthropogenic phenomena. Construction of suburban developments greatly increased in the 1960's and accelerated soil erosion within the D'Olive Bay watershed. Until the late 1960's the D'Olive Bay reportedly had a depth of approximately four feet. Isphording's work indicated a deposition rate of approximately 0.1 foot per year within D'Olive Bay. As such, D'Olive Bay was at risk for being filled with sediments derived from human activities within a relatively short period of time.

### ***Weeks Bay Watershed***

The Weeks Bay watershed has been intensively studied in part as a result of the National Estuarine Reserve Program for Weeks Bay. The Draft Management Plan for the Weeks Bay Watershed (Lynn, 1997) summarized non-point source pollution problems caused by stormwater runoff erosion and wave erosion. In addition to identifying problems associated with various land uses in the watershed, the plan provides alternatives for consideration by management agencies. The plan summarized the potential impacts of turbidity on submerged aquatic vegetation and other adverse impacts that result from uncontrolled erosion. The plan provides turbidity data describing areas within the watershed where high turbidity has been identified by the Geological Survey of Alabama and by citizen volunteer water quality monitors. According to Lynn (1997), new residential construction poses the greatest threat to the watershed.

The relationship between landscape and land use characteristics within the Fish River watershed was compared with non-point source parameter inputs in a study performed by the Auburn University School of Forestry (Basnyat, *et al.*, 1996). Soil erodability characteristics, based on soil series information presented in the Baldwin County Soil Survey, were used in GIS layers as part of the characterization of the watershed landscape attributes. In addition, more than 350 water samples were collected in the Fish River watershed at approximately 25 sites. Reported sample parameters included fecal coliform, aluminum, calcium, iron, potassium, magnesium, nitrate, phosphate, sulfate, total organic carbon, total suspended solids, and others. The study relates the:

- 1) Stream and river concentrations of chemical inorganic parameters to the mineralogical composition of watershed soils and,
- 2) Soil erosion as contributing factor controlling the concentrations of these parameters in the waters of the Fish River.

Stream discharge rates and loadings are provided for selected parameters. Using GIS to provide contributing area analysis, multiple regression models were developed that can be used by environmental planners to address issues of watershed management. These regression equations, which include terms for contributing land use characteristics, indicate there are highly probable relationships between total suspended solids concentration, nitrate concentration, and the land use characteristic within a contributing area.

Similar to the findings of Basnyat, *et al.*, (1996) and Lynn (1997), the ADEM Water Quality Report to Congress (305b Report) indicates impairment to the water quality of Fish River Fish caused by erosion. In particular, urban (suburban) development and agricultural loadings are noted as contributors to the river's impacted water quality.

#### **5.3.5.6 Data Adequacy Summary (Erosion and Sedimentation Issue)**

Considerable qualitative information related to erosion and sedimentation as a potential impairment to water quality exist. Some data is available documenting beach erosion and shoreline changes. However, little quantitative data relating erosion rates in upland areas to the quantity sediment transported into tributaries and embayments was determined to exist for the MBNEP area based on the literature and data sources reviewed.

Erosion and sedimentation impact data could be improved by obtaining more quantitative information related to erosion and sediment transport phenomena. It is generally assumed that if soil erosion is controlled, then sedimentation will also be controlled. However, it is impossible to eliminate all erosion. Effective management of erosion and sedimentation within the MBNEP will require estimates of acceptable sedimentation rates. Information pertaining to acceptable sedimentation rates and loads of suspended solids in the water column may become available from research performed for the "habitat loss assessments". Once an acceptable level of sedimentation is established, calculations of soil loss under various land management programs can be made. This could include characterization of soil loss that results from anthropogenic activities including construction, farming and silviculture by linking the various human activities to the type of soils, topography and conservation practices. The final step should involve the development of "sediment delivery ratios" for eroded material to bodies of water at risk.



## 5.3.6 Groundwater

### 5.3.6.1 Introduction

While groundwater is not identified as a separate issue per se in the MBNEP process, the effects of the before mentioned issues also apply to groundwater resources. Because of the uniqueness of groundwater related data sets, individual discussion of this information seemed appropriate. In this section, the physical use and possible contamination of groundwater will be discussed. This section is not intended to review or evaluate the potential pollutant contribution groundwater input makes to the estuarine system, since such potential inputs are considered as non-point sources in respective issue category discussions.

Water quality is typically measured by the solutes and gases dissolved in water as well as the matter suspended in or floating on the water. Water quality is a consequence of the natural physical and chemical state of the water as well as alterations that are the consequence of human activities. The natural quality of groundwater can vary between locations as with surface water. When establishing the quality of groundwater, several factors are involved which are similar to the evaluation of surface waters. Quality may be affected by infiltration, naturally existing conditions, and alterations due to well pumping activities.

### 5.3.6.2 Known or Potential Problems Related to Groundwater Quality

#### *Pathogens, Toxic Chemicals and Nutrients*

The presence of pathogens, toxic chemicals, or nutrients in groundwater may be viewed in terms of a shallow and/or unconfined aquifer versus a deep and/or confined aquifer. In shallow and/or unconfined aquifers, contamination may occur as a result of infiltration of pollutants at the area of recharge through the subsurface. Overlying units act as a filter for many potential contaminants. This filter may be compromised by the alteration or elimination of other supporting factors, such as if the depth to the water table is shallow, and/or if the concentration of the material(s) is too high. Contaminants noticeable to the human senses at the surface may not be apparent in the groundwater. Deep and/or confined aquifers may naturally contain components present during the formation of the aquifer. For deep wells, contamination may take a much longer period of time (years in many cases) and can be the result of infiltration or hydraulic connections with shallower aquifers that are contaminated. Contamination of confined aquifers may occur through the well bore. The processes of drilling, securing, and maintaining a well improperly may introduce foreign materials into the system and compromise the quality of the water. Once contaminated, groundwater is difficult and costly to clean.

The chemical or biological contaminants that contribute to groundwater degradation may come from a variety of sources. These can include land application of agricultural materials (e.g., fertilizers, pesticides); animal wastes; septic-tank disposal systems; sewage-treatment lagoons; land application of organic waste; municipal landfills; toxic- and hazardous-waste landfills; leaking underground storage tanks; faulty underground injection wells, pits, ponds, and lagoons used for storage; treatment and disposal of various liquid compounds; and chemical and petroleum product spills (Fetter, 1994).

### ***Physical and/or Hydrologic Modification and Erosion and Sedimentation***

The amount and use of groundwater also contributes to its quality. Under natural conditions, most aquifers are in a state of equilibrium. Withdrawal of water from the aquifer may be natural or anthropogenic. How groundwater responds is dependent on a host of complex relationships. In general, an aquifer will respond by the amount of recharge it receives, the proportion of water withdrawn to water recharged, water table gradient, and other factors. Withdrawal of water can cause a variety of physical problems that can affect the water quality. Where certain materials are present naturally or normally at safe levels, withdrawal can cause these materials to become concentrated to the point of unsafe levels. Withdrawal near saline waters can cause saltwater encroachment. The redirection of saline waters into the freshwater makes the water virtually unusable in most situations. Overuse of shallow aquifers may redirect recharge such that infiltration is higher, thereby creating a higher potential for surface to subsurface contamination. Overpumping from a well in one part of an aquifer may redirect groundwater flow such that another well is compromised. Groundwater discharge to base stream flow may also be reduced.

Erosion and sedimentation are issues more applicable to surface water quality. However, the physical nature of aquifer strata can affect groundwater quality. Thickness and layering of units as well as particle size, shape, and composition affect permeability and porosity. Permeability controls the ability of an aquifer to transmit contaminants by water and vapors, and its ability to capture and store water.

#### **5.3.6.3 Hydrogeologic Summary**

The geology and hydrology of the MBNEP area has been discussed in Section 4.2. The study area is located within the Eastern Gulf Coastal Plain. Most of Mobile and Baldwin Counties consist of uplands underlain by terrigenous sediments. Terrace deposits occur along major streams such as the Mobile and Tensaw. Cropping units in coastal lowlands and along tributaries are characteristically terrigenous deposits late Pleistocene to Holocene in age.

#### ***Local Aquifer System***

The Gulf Coastal Lowlands aquifer system constitutes the uppermost hydrogeologic unit in the Coastal Plain of Alabama. The upper part is composed of Miocene to Holocene siliciclastic strata (Davis, 1987). Miocene deposits of the Gulf Coastal Lowlands aquifer system are a prolific source of groundwater and are the principal source for public supplies for many municipalities in Baldwin and Mobile Counties. Wells are generally shallow, 100 to 400 feet, and yield as much as 500 gal/min (Davis, 1987) from upper sand beds within the Miocene. The Pliocene Citronelle Formation is a discontinuous water-table aquifer with spatially varying water levels. Recharge is directly from rainfall and water moves relatively rapidly vertically as well as laterally. This water supplies base flow to local streams as well as the underlying, hydraulically connected, Miocene system (Davis, 1987). Recharge areas for the major aquifers include the entire study area and some Miocene outcrops to the north. Regional groundwater flow is to the south, down dip. Groundwater discharges are primarily to streams, water bodies, and wells.

Near the coast, water in the deeper sand beds is saline. Heavy pumping in the coastal areas of Baldwin and Mobile Counties has caused vertical and lateral movement of saline water toward the freshwater sands (Davis, 1987). While aquifers within the MBNEP area are hydraulically connected, aquifers between the two counties are influenced by the Mobile Bay. Similarly, Dauphin Island and Gulf Shores, Alabama are influenced by the Gulf of Mexico.

### ***Soils***

The soils throughout most of the study area are highly permeable and allow rapid infiltration of surface water. Consequently, ground water in the study area is considered susceptible to surface contamination (Mooty, 1988). Soils in Baldwin County comprise a combination of very fine to sandy loams to wet clayey and/or loamy alluvial land. Soils in Mobile County are mainly sandy loams or loamy sands with a small percentage of muck. These soil definitions were made to a maximum of 6 feet and do not reflect the underlying parent material.

#### **5.3.6.4 Database Inquiries**

Searching the Information Record Database (IRD) for groundwater related documents is not separately categorized by issue. As the MBNEP has not listed groundwater as a separate entity with identified issues and parameters, those selections were not available in the database. From the Information Records collected, approximately 130 contained reference to groundwater spelled either “groundwater”, “ground water”, or “ground-water”. Of these, about 20 were “data systems/models/databases”, “20” “summary publications” and the rest were “technical reports”. The “parameter other” section contains groundwater related terms to include: cuttings, groundwater levels, logs, permeability, stratigraphy, water balance, water level, potentiometric surfaces, hydrogeologic unit and well depth. The “sample matrix other” selection includes groundwater. Groundwater searches spatially by sub-area are presented in Appendix IV.

Information that directly relates to groundwater quality is difficult to quantify. It is available in a myriad of locations, recorded in different ways, and not readily available in an organized electronic format. Information available to assess the conditions of groundwater are in the following forms: well tests, water analysis, pump tests, geophysical logs, drill cuttings, chemical analyses, monitor data, water levels, flow, pumping, depths, corings, yield, aquifer source, saltwater encroachment, contamination, mineralization, depressions, and septic/soil suitability.

Data that directly relates to groundwater quality or alteration was searched in IRD. Six documents pertaining to saltwater encroachment were identified and cumulatively 20 documents containing “chlorides, nitrates, or sulfates” were found. Some of these searches may be referencing the same documents.

Information on groundwater has been collected since the 1800’s in various formats. The Geological Survey of Alabama and U.S. Geological Survey have kept well records since close to the turn of the century. While different forms of data exist prior to 1970, few summary or technical works were identified. Contributions greatly increase in the seventies and the decades of the 80’s and 90’s have near equal amounts of work with some works referencing earlier archived materials. This search information is reflected in Appendix IV.

### 5.3.6.5 Data Resources and Key Reports

Groundwater, used by public watersystems, is strictly monitored through a variety of programs. While sections 5.1 and 5.2 focused on primary electronic and watershed collection data, they did not emphasize resources pertinent to specific groundwater topics. Extensive information is available electronically and in physical files through various local, state, and federal entities.

Information available at the federal level may be found through the U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey (USGS). As previously discussed, STORET is EPA's principal electronic database storage mechanism and it may contain groundwater information obtained from other federal, state, and local authorities. EPA also mandates the Wellhead Protection Program established to protect public water systems. Available through the Internet, in EPA's "EnviroFacts Warehouse," is compliance information on safe drinking water for every well supplying public water to 25 people or more annually. Technical publication packages are available through EPA concerning the following groundwater related topics: ensuring safe drinking water, pesticide usage and disposal, and risk assessment. Also previously discussed is the WATSTOR database held by the USGS. Standard monitoring data as well as research and special endeavors by the USGS are kept electronically. USGS produces yearly water resource publications that highlight gaging station data as well as selected groundwater sources throughout the state. In addition to these yearly works, selected areas are studied. Of note, the recent Baldwin County assessment (Pearman, *et al.* 1996) is the most comprehensive and up-to-date work available. Other studies on Mobile County and Dauphin Island are dated and need renewed evaluations.

The State of Alabama also collects groundwater data. The Alabama Department of Environmental Management (ADEM) has groundwater information in several areas. The Wellhead Protection Program is designed to comply with the federal mandate for safe drinking water. Information accessibility is through the ADEM Montgomery office by site specific file search. Those municipalities that must comply with the program can be found on the Internet. The purpose of the Water Supply program is to regulate public water systems to assure Alabamians safe drinking water. The program determines if the system is in compliance and ADEM works with the system to make appropriate adjustments if necessary. Reports submitted for systems in compliance are archived in physical files while an electronic database is in development for non-compliance information. The Leaking Underground Storage Tank (LUST) program identifies sites that have reported petroleum releases and their remediation status. This information can be obtained via ADEM's bulletin board. ADEM produces a biennial Report to Congress or "305b" report. This report mainly discusses surface water but a section is devoted to groundwater. Each report addresses a particular region within the state and the most recent publication did not discuss the MBNEP area. Also of significance was the recent work "Ground water monitoring for pesticides in Alabama: a compilation of studies 1989-1993," the purpose of which was to investigate the presence of pesticides in private/residential and/or irrigation wells with regards to agricultural practices. There are numerous non-superfund sites with contaminated groundwater. Some are small areas surrounding USTs and some are larger. ADEM can produce GIS maps of some limited site areas.

The Geological Survey of Alabama (GSA) supports the Wellhead Protection Program by working with communities who request their expertise in complying with the program. GSA has extensive files (as early as 1900) on groundwater levels in both counties and is working to make these available in an electronic format. Groundwater well files containing driller's reports, well schedules, pump tests, and water analysis are archived for both counties back to the 1940's. Also under development is an extensive geochemical database that will cover biological and soil parameters in addition to surface and ground waters. GSA performs a number of contracts for state agencies and municipalities while doing their own research. Their accumulated data and analyses are reported in various publications released on a continual basis. Of note are "Selected Wells and Springs" (Gillett, *et al.* 1987), "Water Use in Alabama" (Baker and Mooty, 1987), and the "Geohydrology and Susceptibility of Major Aquifers to Surface Contamination in Alabama; Area 13" (Mooty, 1988). This report is conducted in a series of geohydrologic studies to delineate the major aquifers in Alabama and their susceptibility to surface contamination. Gillett's work was the second in a series of six regional ground water data inventories in Alabama. Its purpose is to provide a compendium of data for large wells and springs for an eight-county area in southwestern Alabama for use in the development of additional Geological Survey of Alabama (GSA) and U. S. Geological Survey (USGS) reports. The annual reports, "Water in Alabama" and "Ground Water Levels in Alabama" contain monitoring data on water quality and groundwater levels in both counties.

Information available from the Geological Survey of Alabama or U.S. Geological Survey generally includes all pertinent available geographic and hydrogeologic information for a site and indicates availability of other data not published, such as geophysical logs, drill-cuttings data, results of chemical analyses, and monitor data. Although data for a large number of sites have been published in several reports through cooperative efforts of the GSA and USGS, they also have been included as tables along with additional information, to provide an assemblage of important regional data. Maps and tables will be periodically updated as future data are received. Water-level data in the tables generally include the initial and most recent static water-level measurements available for each site. For those sites used as observation wells, additional water-level data are included to provide an indication of water-level trends. Most initial measurements are those reported by the contractor upon completion of the well. Most other measurements were made by personnel of the GSA or USGS. Much data are taken from contractor's final reports and the accuracy cannot be verified.

The Alabama Department of Economic and Community Affairs (ADECA) compiles all the uses of water for the area. Additional information may be obtained from individual municipalities and private businesses who use groundwater as their public water supply. By strict guidelines, these entities are required to do frequent and regular monitoring, the results of which are submitted to ADEM for compliance. These paper documents are generally archived in physical files.

Additionally, groundwater protection regulatory programs dealing with solid waste landfills, hazardous waste (RCRA), and Superfund (CERCLA) have generated volumes of site-specific information. Information and data pertaining to such sites is generally available through report and file search at applicable agencies (namely, ADEM and EPA).

### **5.3.6.6 Discussion of Groundwater Data and Characteristics in MBNEP Sub-Areas.**

The understanding of groundwater can generally be viewed on a regional basis. The following discussion summarizes groundwater use and characteristics by county. Where applicable, information is also provided for individual sub-areas.

#### **MOBILE COUNTY**

Mobile County surface geology is predominately alluvial low terrace and coastal deposits along the western shore and well into the delta. Along the topographic high dividing the watershed between Mobile Bay and Escatawpa is the Citronelle Formation in the southern portion of the county and the Miocene Series in the northern portion of the county and groundwater flows east or west accordingly. Aquifer recharge for the alluvial coastal areas is in the immediate county topographic high area through means of rainfall and the Mobile River or Mobile Bay. The Citronelle Formation is recharged along the topographic highs. The Miocene Series is recharged in the northern portion of the county where it is cropping. All aquifers receive recharge where they are down dip of infiltration areas. The cities of Mobile and Prichard utilize surface water for their public drinking water supplies. The remainder of public water systems use groundwater. Also, many private individuals and businesses use groundwater.

Early Mobile City water use began in 1840 with a water service franchise. The waterworks location was on Three Mile Creek and supplied water to the city until 1898. In 1886, the Bienville Water Supply Company constructed a pumping station on Clear Creek and the two systems operated independently of one another. Both stations were obtained by the Mobile water-supply system and, from 1907 forward, the city operated the water works (Peterson, 1947). Currently, the system is managed by the Mobile Area Water and Sewer Service, an independent entity which derives its drinking water supply from Big Creek Lake, which is outside the MBNEP area.

Water use for the city was initially associated with domestic and industrial purposes. Prior to 1900 groundwater was used for breweries and in the manufacturing of ice. In approximately 1937 air conditioners began to be installed and groundwater was pumped for that use. Maximum pumpage of these shallow wells occurred until about 1942 when saltwater encroachment affected shallow aquifers. Ground water use shifted to deeper aquifers where contamination was not observed.

Saltwater is used for catfish and aquaculture farming but is not useful in industrial or agricultural purposes. The mineral content of the water corrodes and clogs industrial equipment. The minerals also contaminate fertile soils and inhibit crop growth.

Over development of the downtown area was cited by Peterson as a central issue in 1947. Shallow aquifer withdrawal, coupled with the construction of the Bankhead tunnel, lowered the water table several feet below sea level. Restoration of the aquifers was suggested through further reduction of pumpage to allow sufficient recharge and potentially by induced recharge.

Mobile County completed work on "Geohydrology and Susceptibility of Major Aquifers to Surface Contamination in Alabama: Area 13" in conjunction with Baldwin County conducted by the USGS in cooperation with GSA (Mooty, 1988). This study reported a large cone of depression around the Prichard-Mobile area mostly as a result of industrial use (Mooty, 1988). Northern Mobile County also exhibits cones of depression associated with local industries on the Mobile River. One concern may be the potential for saltwater encroachment through tidal reaches up the river.

Coastal areas are susceptible to saltwater contamination by storm water surge raising the sea level above the fresh aquifer water table. Saltwater contamination may also be induced due to over pumping in coastal areas. Areas along the Mobile River potentially could be contaminated by chemical industries in the area (Mooty, 1988).

The entire Mobile County area is susceptible to contamination from the surface owing to the permeability of the underlying sediment and parent materials. Increased susceptibility also exists in areas of large cones of depression. These cones create increased hydraulic gradients by which contaminants are drawn toward the pumping center. Areas with high agricultural use and little slope create potential for contamination. Soils are highly permeable with little surface runoff accounting for a high degree of infiltration. Pesticides may be the primary concern in these situations (Mooty, 1988).

Contamination is of particular concern in low lying areas when soil limitations for septic tanks are compared with the Coastal Zone Management 10-foot contour (Figure 5-2). Viewing these figures one can see that Bayou La Batre, areas of Fowl River and Dog River, areas in the cities of Mobile, Prichard, Chickasaw, Saraland, Satsuma, and low-lying communities along the Mobile River all show severe soil limitations with risk for groundwater contamination. Pathogens and nutrients can quickly reach the shallow water table.

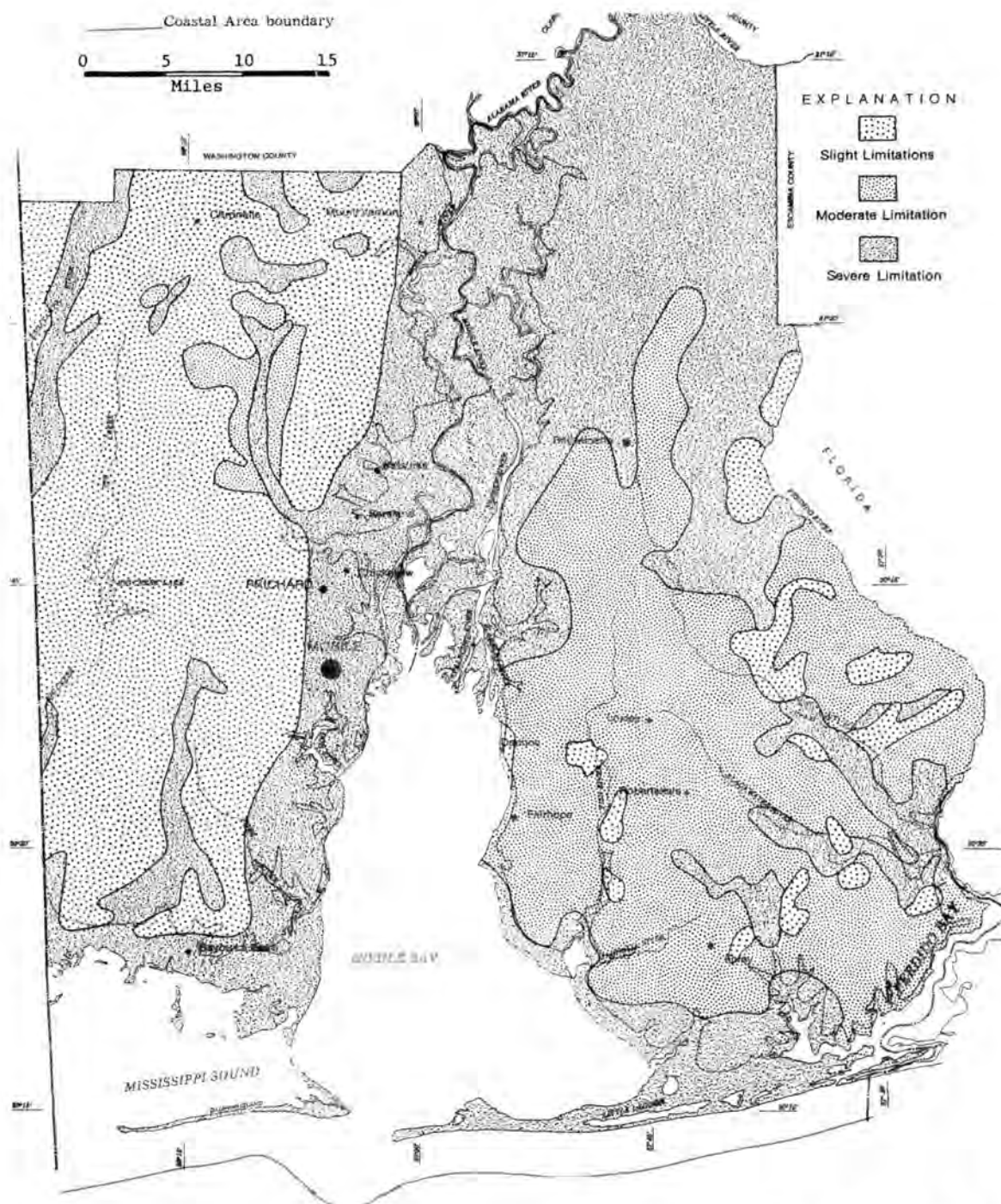
### ***Offshore***

Wells on barrier islands off the coast are capable of yielding an estimated 40-mgd per well. However, because of the danger of salt-water intrusion, only about half of these quantities are exploitable (Moser, 1978).

### ***Mississippi Sound and Dauphin Island***

The Dauphin Island area, comprising 6.3 square miles, is positioned at the confluence of the waters of Mobile Bay, Mississippi Sound, and the Gulf of Mexico in Mobile County, Alabama. The Bay and Gulf waters are boundaries for the fresh groundwater zone on Dauphin Island.

The freshwater zone of the area is confined to the upper 100 feet of a surficial unit, which consists of alluvial, low terrace, and coastal deposits. The zone consists of water-saturated, primarily fine-to coarse-grained sands with a computed volume of 5.65 billion cubic feet and a storage capacity of 15.6 billion gallons of water. The theoretical maximum yield of water to wells from the zone is 10.6 billion gallons. The zone is primarily in the form of an elliptical lens oriented east-west along Dauphin Island, which is approximately 15 miles long and has various widths and depths. The lens has an irregular surface and its symmetry is affected by seasonal



Sources: Alabama Coastal Area Board, 1980 and  
South Alabama Regional Planning Commission, 1977



Preliminary Characterization of Water  
Quality of the MBNEP Study Area

Thompson Engineering

TAI ENVIRONMENTAL  
SERVICES, INC.



Figure 5-2

Soil Limitations for Septic Tank  
Absorption Field Use



evapotranspiration losses, variations in rainfall, and the presence of salt water. The storage capacity of the lens of the fresh groundwater zone is small, roughly twice the annual rainfall.

The small size of the fresh-water zone and the sensitivity of the zone to environmental changes, are important factors to consider in formulating a plan to manage this resource. Presently, salt-water encroachment is a potential concern with increasing development. Septic-tank pollution is no longer a concern as the island is now completely served by a sewerage system. The effects of urbanization are currently limited but are expected to increase. Water quality problems include high iron, manganese, chloride and dissolved solids contents, and color and turbidity (Chandler and Moore, 1982).

Saltwater encroachment is indicated in the area by an increasing chloride content in water produced by a public deep-well system. The wells in the Dauphin Island system tap an interval of Miocene siliciclastics (sand and gravel beds) which are 200 to 300 feet below land surface and semi-confined by clay layers. It has been long recognized that only by considering all pertinent aspects can a program be developed that will adequately protect and preserve the fresh groundwater zone of the Dauphin Island area (Chandler and Moore, 1982). Because the public water supply is sourced solely from groundwater, the Dauphin Island municipality must comply with the Wellhead Protection Program. In ten years of reporting, Dauphin Island has not reported any major contamination. In December of 1992, sampling tested positive for fecal coliform. No further positive samples have been reported to date.

Within the mainland Mississippi Sound watershed, including Bayou La Batre, coastal areas are poorly drained marsh. No groundwater information is available for the Mississippi Sound area as defined in this report, though surface water information can be found. In the West Fowl River area, the Fowl River Marina is under the Wellhead Protection Program. The Fowl River Marina tested positive for fecal coliform in May of 1997. No major contamination or other health threats have been recorded in the past ten years. The Bayou La Batre area (South Alabama Regional Planning Commission, 1978) has poorly drained soils on broad flats and very gentle slopes. These soils have seasonally high water tables. Wetness is the main limitation for some uses. This municipality is in compliance with the Wellhead Protection Program. As discussed earlier, much of these areas lie below the 10-foot contour and are shown to contain soils with severe limitations for on-site sewage disposal (septic tanks).

While surface waters in the Grand Bay area drain westward, groundwater is sourced from the same aquifers. The regional hydraulic gradient is not clearly understood and local contamination is possible in the southwestern MBNEP area. However, the Grand Bay Water Works Board has reported no problems in the past ten years. There is no readily available information regarding groundwater resources for Little River sub-watershed.

### ***Bayou Sara, Cold Creek, and Cedar Creek Watersheds***

Three "Superfund" National Priority List (NPL) sites are currently under remediation and monitoring in Mobile County, and are located within the "Bayou Sara, Cold Creek, and Cedar Creek Watershed" sub-area.

Redwing Carriers, Inc. in Saraland, Alabama has reported volatile organic compounds (VOC's) in the soil. The city of Saraland Water Department has three 100-foot wells which are located less than 2 miles from the one-acre site. The aquifer underlying the site may be contaminated, thus threatening the nearby public water supply (EPA, 1990). Contaminated soils have been removed from the area as well as any "ooze" rising to the surface. Local residents have been relocated.

The former Stauffer Chemical Company locations comprise the other two NPL sites, and are referred to as the Axis and Cold Creek swamp locations. Both are approximately 20 miles north of the city of Mobile. The groundwater in the vicinity of both locations has been found to contain VOC's. Mercury has been found in Cold Creek Swamp sediments and fish tissues. Carbon tetrachloride and carbon disulfide seeping from plant disposal ponds has reportedly infiltrated the aquifer. The contamination has migrated across the property line of an adjacent industrial property, and has been detected in two wells. Because the aquifer in this region is pumped extensively, the migration of the contamination over a much larger area, and to other nearby wells, is possible. Therefore, considerable efforts have been performed to delineate the contamination, and estimate potential direction and rate of migration. Stauffer Chemical and successor companies have developed an extensive remediation effort which involves modifying the existing groundwater system; extraction wells; intercept wells; and monitoring activities (EPA, 1990). The responsible parties and regulatory agencies are continuing to pro-actively address these concerns.

## **BALDWIN COUNTY**

The freshwater bearing sediments of Baldwin County are composed of interbedded gravel, sand, silt and clay to a depth of approximately 800 feet. The sand and gravel units are the primary sources of water (Robinson *et al*, 1996). The southern portion of the county is underlain by Pliocene sediments (Citronelle Formation). A thin veneer of Miocene Series deposits crop out along the topographic high associated with the north eastern shore. Alluvial coastal materials line the water's edge. The Mobile Clay is the distinguishing marker bed within the southern area of the county. To the north, the Mobile Clay has not been identified. High terrace deposits are exposed along the northern Tensaw Delta boundary. Middle to upper Miocene materials are assumed to be the exposed units though no detailed surface geology has been performed in the northern part of the county. Topography in much of rural Baldwin County is flat with rolling hills. This minimizes runoff and allows for more infiltration. As with Mobile County, recharge is within the county. Topographic highs naturally create gradients which are down dip toward tributaries and depressions.

Groundwater is the sole source of public water supply in Baldwin County. It is also heavily utilized for self supplied domestic, agricultural, and recreational purposes. Private well depths are average 100 feet deep and public systems average 100 to 300 feet deep although a few wells approach 1,000 feet. The USGS (Robinson *et al*, 1996) estimated withdrawal to be 41 million gallons per day.

The 1996 USGS report estimated groundwater levels from a high of 259 feet above sea level to near sea level. The highs were near the Baldwin County/Escambia County border outside the MBNEP area. The lows were noted in areas near the Gulf Coast. A pronounced low occurred in the Spanish Fort area. The USGS tested ten wells from confined aquifers in Baldwin County,

but did not perform multiple well tests. Therefore the estimation of transmissivity can only be placed in moderate confidence. Transmissivity was found to be greatest in the southeastern part of the county, and least in the western part of the county near Mobile Bay.

The USGS reported a generally good groundwater quality (Robinson *et al*, 1996). Many self-supplied homeowners use the water with no treatment. Groundwater quality problems reported for Baldwin County include iron, sulfur, turbidity, color, dissolved solids, chloride, and pH(acidity). Groundwater was found to be acidic in the inland and southern parts of the county. Water drawn near the Mobile River was found to have a dissolved-solid content exceeding 1,000 mg/L, a chloride content of 500 mg/L, and a sulfurous odor. In coastal areas, hydrogen sulfide and methane occur. Iron and sulfur problems were reported in Spanish Fort.

The Alabama Coastal Area Board (1980) in “Inventory of Alabama’s Coastal Resources and Uses” listed soil types and their limitations with respect to septic tank effluent absorption. Given the shallow nature of most wells in Baldwin County, this issue is of extreme importance. The degree of slope and percolation rates were used to develop slight, moderate, or severe limitations for septic tank use. Other factors that were considered included water table levels, wetness, flooding hazard, and impervious materials. Figure 5-2 shows the areal extent of these limitations for Baldwin County. Approximately half the land coverage in Baldwin County has severe limitations and most of the remaining area shows moderate concern.

### ***Eastern Shore Watersheds***

The City of Spanish Fort has reported problems with drawdown and mineral content. New wells have been drilled; however, they have the same problems. The City of Daphne has also reported mineral content problems.

### ***Bon Secour River Watershed and Ft. Morgan Peninsula***

The barrier island sand deposits of the Fort Morgan Peninsula were the source of domestic supply wells (Alabama Coastal Area Board, 1980). Fresh groundwater zones are relatively thin and are bounded by Mobile Bay and the Gulf of Mexico, creating curved boundaries. The Gulf Shores area has experienced saltwater intrusion (Alabama Coastal Area Board, 1980) as indicated by increased levels of chlorides. It was predicted that this problem would worsen as development continued. The construction of canals and dewatering sites was predicted to compound the problem.

#### **5.3.6.7 Data Adequacy Summary (Groundwater)**

Generally, an abundant amount of information is available for groundwater, although it exists in a variety of forms. Comprehensive compilation of the information would be cumbersome, yet valuable trends may be established. Ongoing work to compile and coordinate data acquisition conducted by the GSA, USGS, and ADEM warrants support.

When searching the database for hydrogeologic units, the basic subsurface stratigraphy can be found in numerous documents. However, research efforts by local geologists and work done by geotechnical contractors has been incorporated only at a minimum into the existing state or federal literature. Detailed mapping of geologic materials to depths of 300-400 feet would better define contamination potential of aquifers from landfills and septic systems, and other potential

sources, allow evaluation for workability of septic systems, and better estimate local aquifer distribution.

For groundwater supply wells, monitoring occurs in three ways: 1) to meet public water supply regulatory programs, 2) at the initial stage of drilling and securing the well, 3) at selected monitoring sites on a limited basis. If regular monitoring of all wells were established, and that information incorporated into an electronic database, establishing natural baselines, following trends, and predicting future conditions would be facilitated.

Public water supplies are monitored on a regular basis for any well supplying water to more than 25 people. Only data that is shown in non-compliance will be available in the near future in an electronic format. Other information collected is in various forms. The establishment of a database, which covers all groundwater information, would aid in more comprehensive evaluation. While proper contaminant levels may be maintained, trends within normal limits cannot be established nor can potential increases be readily predicted.

Except when a new private well is constructed, individual water well systems are not routinely monitored. Data related to potential contamination of private water wells appears very limited.

Septic tank information is available but is difficult to use. No comprehensive information concerning septic releases and groundwater quality exists. While the soils, depth to water table, and vicinity of surface water are utilized in the approval of septic tank construction, the number of septic tanks within an area is not correlated. Thus, there is no way to readily assess the area's ability to accommodate the amount of septic effluent it receives. It is suspected that a high number of communities may exist below the 10-foot contour, may contain highly permeable and wet soils, and yet are heavily concentrated in the number of septic tanks.

While the health departments may have records of every on-site sewage disposal system installed, they do not have accurate maps depicting locations. Nor is there correlation between the concentration of septic tanks by area with regards to groundwater levels, 10-foot contour, and soil limitations. The entire study area coincides with the recharge area for the major aquifers used in for the area public water supplies. The soils throughout most of the study area are highly permeable and allow rapid infiltration of surface water. Consequently, the study area is considered susceptible to surface contamination.

The surface soils may be understood but the underlying parent material is not taken into consideration for septic fields. The poor understanding of local changes within the stratigraphy may contribute the contamination of groundwater. Hence, contamination potential versus workability need better definition of limitations.

Private and irrigation wells in agricultural areas are not regularly tested, therefore data concerning potential contamination by pesticides or fertilizers may not be adequate to fully assess related concerns.

Groundwater levels are recorded and are being put into an electronic format at GSA. Development in both counties may be affecting localized recharge to shallow aquifers. This may affect the base flow of smaller tributaries. The quality of water may also be affected as the recharge water is subject to increasing pollution potential from nonpoint sources due to

impermeable surfaces. No comprehensive information is currently being collected to assess the overall impacts from such sources.

Water withdrawal and saltwater intrusion have a limited amount of information available. In particular information for the Dauphin Island area is dated and warrants additional work with the increase in population. Mobile County information, especially along the west side of Mobile Bay and adjacent to Mississippi Sound, is limited and warrants updated studies. Even though Baldwin County has had more recent studies, rapid development pressures along its coastal regions support the need for continued evaluation and assessment.

General recommendations for groundwater related data acquisition in the area are:

- ❑ Comprehensive compilation of data related to septic tank usage: locations, density, soil types, groundwater elevations, etc.
- ❑ Correlation of existing geophysical work to develop a more comprehensive guide to the stratigraphy of the area
- ❑ Compilation in electronic format of all reported data from drinking water systems, as opposed to only when systems are not in compliance
- ❑ Monitoring of private wells on a regular and periodic basis to assess contamination of individual supplies
- ❑ Regionalized modeling of hydrogeologic conditions in both counties, to include the hydraulic effects of Mobile Bay, the Delta, and sub-watershed influences.

By using the existing information on soils, on-site sewage disposal, land use, water levels, aquifer mineralization, and actual aquifers used, current conditions and predictability models can be established. Such modeling capability would greatly enhance the ability to assess impacts of development and support a regional approach towards groundwater management planning for both growing counties.

## 6.0 DATA GAPS AND RECOMMENDATIONS FOR ADDITIONAL DATA ACQUISITION

Based on the literature review and evaluation presented above, several areas have been identified where very limited data are available, and/or where present data do not allow sufficient assessment to address priority issues identified by technical and citizen advisors to the Mobile Bay National Estuary Program. The data gaps identify areas where additional information collection will enable researchers and managers to better define the issues, and hopefully to find solutions, to water quality problems in the MBNEP study area.

### 6.1 Data Gaps

One of the primary objectives of this project was to identify data gaps, in order to direct where the MBNEP might best allocate its funding resources to address priority water quality issues. Table 6-1 summarizes the major data and information gaps identified by this effort. They represent an overall evaluation of the Information Record database compiled for this study and the best professional judgement of the project researchers. Further discussion of these data gaps is presented in the following subsections.

**Table 6-1. Primary data gaps identified in the ongoing data acquisition programs, ranked for each of the major MBNEP issue categories.**

ISSUE	Responsible Source	Data Gap	Priority
<b>Pathogens</b>			
	Local	Insufficient assessment and dissemination of information on septic tank soil limitations, and areas of impacts on surface waters or groundwaters	High
	State	Insufficient bacterial indicator monitoring of “swimmable” areas	High
	Federal/State	Shellfish areas monitoring may warrant expansion	Medium
<b>Toxic Chemicals</b>			
	State/Local	No comprehensive assessment of non-point sources from local watersheds	High
	Federal/State	Ecological and human risk assessment related to Sediment Contamination	High
	Federal/State	Upstream input of toxics from non-point sources	Medium
	Federal/State	Atmospheric input of toxics unknown	Medium

**Table 6-1. (con't) Primary data gaps identified in the ongoing data acquisition programs, ranked for each of the major MBNEP issue categories.**

<b>ISSUE</b>	<b>Responsible Source</b>	<b>Data Gap</b>	<b>Priority</b>
<b>Nutrient Overloading</b>			
	State/Local	No comprehensive assessment of non-point source loadings from local watersheds	High
	Federal/State	No comprehensive assessment of upstream land use and downstream impacts	High
	Federal/State	Insufficient frequency of EMAP/ALAMAP monitoring	Medium
	Federal/State	Atmospheric deposition of nutrient inputs	Low
<b>Erosion &amp; Sedimentation</b>			
	State/Local	No comprehensive assessment of non-point sources	High
	State/Local	Soil erodibility assessment	High
	State/Local	Modeling of erosion and sediment transport	Medium
<b>Hydrologic Modification</b>			
	State/Local	No comprehensive assessment of effects of watershed hydrologic modifications (e.g., impervious surfaces)	Medium
	State/Local	Assessments of coastal saltwater intrusion (groundwater) are dated and/or not comprehensive	Medium
	State/Local	Lack of knowledge of effects on water quality by shoreline modifications	Medium

### 6.1.1 Data Gaps Identified for the Pathogens Issue

The primary data gap for pathogens is the lack of an overall and comprehensive monitoring program to assess swimming/water contact and recreational areas for exposure to pathogens. This monitoring could be for several primary indicators of fecal and other bacterial pollution. It is suggested that a review of new monitoring techniques be performed, and possible use be considered of more cost-effective methods such as Polymerase Chain Reaction (PCR) methods that can detect the presence of specific pathogens/indicators at reasonable costs.

Better compilation and dissemination of information related to septic tank limitations appear warranted. Limited quantitative data exist which definitively assess impacts of septic tanks on surface waters or groundwaters. Septic tank information is available but is difficult to use. While the soils, depth to water table, and proximity to surface water are utilized in the approval of septic tank construction, the number of septic tanks within an area is not correlated to these factors. Thus, it is difficult to assess the area's ability to accommodate the amount of material it receives. Many residences with septic tanks may exist below the 10-foot contour area with highly permeable, wet soils, and a high water table.

### **6.1.2 Data Gaps Identified for the Toxic Chemicals Issue**

Review of information on toxic chemicals indicates several areas where information is lacking. These include upstream inputs of toxic chemicals, mostly pertaining to pesticide residues. Information on point source inputs is believed to be available, but rigorous assessment of such information with respect to relative contributions from non-point sources is lacking. A thorough analysis of the Discharge Monitoring Reports for toxic chemicals reported under NPDES might be useful in this regard.

A thorough assessment of non-point sources of toxic chemicals has not been performed for the watersheds adjacent to Mobile Bay. While data have been collected and analyzed for sediments in receiving waters, no comprehensive analysis of non-point runoff has been performed. This would include both assessments of atmospheric sources and comprehensive watershed evaluation of runoff characteristics relative to toxic chemicals.

EPA, through its National Sediment Quality Survey, has designated the Mobile Bay hydrologic unit as an “Area of Probable Concern” with respect to contaminated sediments. ADEM, in its ALAMAP-C report for the 1993-1994 time period, has characterized certain locations as having moderate-to-poor sediment quality. The EPA National Sediment Quality Survey data set appear dated and limited in comparison to information sources identified in this study. Furthermore, studies which address the bio-availability of sediment contaminants and sediment toxicity data for the MBNEP area are limited. Therefore, much uncertainty remains in our understanding of potential human health or ecological risks, if any, due to contaminated sediments.

### **6.1.3 Data Gaps Identified for the Nutrient Overloading Issue**

The preliminary nutrient budget exercise and discussion of data adequacy provided in a previous section have illustrated data gaps. The most notable gap appears to be in the area of atmospheric deposition, where virtually no local data exist. However, given the apparent dominance of the upstream riverine inputs for the system, the collection of atmospheric data would have a relatively low priority for the MBNEP area.

In the area of non-point source information, where abundant data exist on land use and on discharge characteristics of local watersheds, no comprehensive evaluation compiling the information is available. Thus, as with toxic chemicals, while sufficient raw data exist, a lack of analysis has resulted in a gap in derived information that would be useful in several management arenas.

Data and trends derived from comprehensive modeling efforts are lacking for the MBNEP area. Management efforts could be better focused if available information were synthesized into meaningful trend data for Mobile Bay and its subsystems.



#### **6.1.4 Data Gaps Identified for the Erosion & Sedimentation Issue**

While much information on the nature of soils, land use and erosion issue is available; there is no summary document or synthesis of this information that would be useful in determining where in the MBNEP area the major erosion and sedimentation problems occur. An assessment of the MBNEP area soil erodability, if conducted, could be displayed on maps that can be understood by the general public. Areas susceptible to erosion could be indicated, and thereby managed, so that erosion and subsequent sedimentation are controlled. This should include shoreline erosion susceptibility along Mobile Bay and areas immediately adjacent to rivers (e.g., Dog River, Fish River, etc.) and other bays and inlets. These are sites of active residential and commercial development and directly contribute sediment to the bay.

Obtaining more quantitative information that could be used in studying the detachment – transport – deposition process of erosion and sedimentation in the MBNEP area warrants consideration. Such quantitative data could be used in estimating the impacts of erosion and sedimentation on tributaries and embayments at risk for various land management schemes.

A further task, related to this issue, would be the acquisition of sedimentation data within the bay and the delta. To date, no systematic study has been carried out that provides sediment trap data for this area. The Corps of Engineers has collected some scattered information but what is needed is quasi-synoptic information on sediment deposition at a number of sites throughout the study area.

#### **6.1.5 Data Gaps Identified for the Hydrologic Modification Issue**

While impacts due to watershed hydrologic modifications (e.g., increased impervious surfaces) are generally well recognized, a comprehensive assessment of the impacts of such alterations for local watersheds appears lacking.

Evaluation of Information Records for the hydrologic modification issue reveals that little information exists regarding water quality impacts due to shoreline modification.

Patterns and causes of saltwater intrusion of coastal groundwaters have a limited amount of information available and may not be adequately defined. There has been little work done (especially along the west side of Mobile Bay and adjacent to Mississippi Sound) to assess the degree to which salt water encroachment has taken place both in the surficial aquifer and the shallow confined aquifer. Increasing coastal populations (permanent and transient) may lead to increased concerns. Information for the Dauphin Island area is dated. Data from south Baldwin County are more recent, but attention still needs to be given to address this ever growing area.

## **6.2 Recommendations for Additional Data Acquisition**

Based on the results of the data gap identification exercise, several future data acquisition efforts can be recommended at the present time. The ranking and prioritization of these issues should be a primary task given to the MBNEP Water Quality Workgroup.

High priority is recommended for a more comprehensive monitoring plan for microbial contamination of the swimming and water contact/recreational areas. A more complete assessment and dissemination of information on septic tank problem areas, and impacts on surface waters and groundwaters are likewise recommended. The suggested bacteriological monitoring could be extended to shellfish waters as a possible adjunct to existing and adequate microbial sampling currently undertaken by the Alabama Department of Public Health.

A comprehensive study of the sediment contamination issue within Mobile Bay should be undertaken, especially in light of the level of concern expressed by the EPA in their National Sediment Quality Survey. Initially, a thorough review of existing data for the MBNEP areas is suggested. Professionals should perform such evaluation with expertise in sediment chemistry as well as ecological and human/health toxicology. While such review is needed to guide any further data acquisition, additional sediment toxicity evaluations and/or risk assessments appear warranted at this time.

Another top priority item should be to synthesize non-point source impacts. This should be undertaken to better estimate non-point source loads from the various local coastal watersheds draining into Mobile Bay and provide comparisons with contributions from point sources, upstream river input, and atmospheric deposition. Ongoing efforts of the municipalities implementing urban stormwater (MS4) permits should be closely reviewed and opportunities to jointly accomplish mutual objectives explored. Evaluations which compare present loadings with historical conditions are also needed to better define trends over time. The evaluation of pollutant loadings could be particularly useful for the Lower Chickasaw Creek – Lower Mobile River area where water use classification/use attainability controversy currently exists. This study would be useful for local and state agencies in developing Total Maximum Daily Load (TMDL) calculations for this and other areas.

Local measurements of atmospheric deposition of nutrients and toxic chemicals would better define the input of these materials on a local basis. A study is warranted to at least establish baseline characteristics of this potentially important source.

Also, a priority should be the development of a comprehensive Nutrient Loading Analysis/Nutrient Budget for the entire Mobile Bay system. Finally, there is a need for Water Quality Predictive modeling, to further refine existing data and identify additional data gaps for the Mobile Bay system.

Followup studies relating to saltwater intrusion of coastal aquifers appear warranted to support the water management efforts in these developing areas.

There is a need for a fully-coordinated regional technical monitoring and research plan to better define the cause-effect relationships relative to priority issues, optimize ongoing efforts to assess status and trends of important water quality indicators, and facilitate sharing of the knowledge gained. The recently proposed comprehensive monitoring strategy is viewed to provide an excellent “building block” for such, but would be most effective if coupled with a watershed concept on a regional basis to also focus on pollutant contributions affecting the system.

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**APPENDIX I**

**ORGANIZATION CONTACT LIST**

Contact Name	Phone	Address	City	St/Prov	ZIP/Postal
AKZO Nobel Chemicals, Inc.					
Alabama Coastal Foundation					
Alabama Department of Agriculture and Industries					
Alabama Department of Conservation and Natural Resources (ACDNR)-Game & Fish Division					
Alabama Department of Conservation and Natural Resources (ADCNR)-Marine Resources Division					
Alabama Department of Economic and Community Affairs (ADECA)					
Alabama Department of Environmental Management (ADEM)					
Alabama Department of Public Health (ADPH)					
Alabama Department of Transportation (ADOT)					
Alabama Forestry Commission					
Alabama Power Company					
Alabama State Docks					
Alabama State Oil and Gas Board					
Alabama Water Resources Research Institute					
Armstrong World Industries					
Atlantic Land Corporation					
Auburn University Environmental Institute					
Auburn University Marine Extension and Research Center					
Auburn University / College of Agriculture					
Auburn University / College of Engineering					
Auburn University / College of Mathematics and Science					
Auburn University / Cooperative Extension Service					
Auburn University / School of Forestry					
Baldwin County Commission - Planning and Zoning Department					
Baldwin County Public Health Department					
Bishop State					
Boise Cascade					
Ciba					
City of Mobile					
Courtaulds Fibers, Inc.					
Cytex Industries					
Dauphin Island Sea Lab					
Degussa Corporation					
Dupont DeNemours & Co.					
Elf Atochem North America					
EnviroChem Labs					
Geological Survey of Alabama					
Gulf Coast Research Laboratory					
Gulf of Mexico Program					
Hoechst Celanese Corporation					
Holnam, Inc.					
Huls America					



Contact Name	Phone	Address	City	St/Prov	ZIP/Postal
Hutchings & Associates					
International Paper, Mobile Mill					
Kerr McGee Chemical Corporation					
Kimberly-Clark Corporation					
Mississippi - Alabama Sea Grant Consortium					
Mobile Area Water and Sewer System					
Mobile County Environmental Services Department					
Mobile County Health Department					
National Oceanic and Atmospheric Administration (NOAA)-National Marine Fisheries Services					
NOAA - NODC					
NOAA - Ocean Research Conservation Agency					
Occidental Chemical Corporation					
Olin Corporation					
Savannah Laboratories & Environmental Services					
Shell Chemical Corporation					
South Alabama Regional Planning Commission					
Southeast Digital Mapping					
The Forum					
Troy State University					
Tuskegee University					
University of Alabama					
University of Mobile					
University of South Alabama					
UOP					
U. S. Army Corps of Engineers - Mobile District					
U. S. Coast Guard					
U. S. D. A. / Agricultural Research Service					
U. S. D. A. / Natural Resources Conservation Service					
U. S. Environmental Protection Agency (USEPA)- Region IV					
U. S. Fish and Wildlife Service					
U. S. Food and Drug Administration - Gulf Coast Seafood Laboratory					
U. S. Geological Survey, Alabama District Office					
Vittor and Associates					
Volkert & Associates					
Weeks Bay National Estuarine Research Reserve					
Woolpert Consultants					
Zeneca					

**APPENDIX II**

**INFORMATION RECORD DATABASE ENTRY FORMS,  
INFORMATION RECORD EXAMPLES,  
AND DATABASE QUERY VIEW EXAMPLES**

## **SAMPLE INFORMATION RECORD DATABASE ENTRY FORMS**

### **Mobile Bay NEP Water Quality Characterization Baseline Information / Data Records**

Information / Data (I/D) Records are created and maintained within the "NEP Document Library" of the LOTUS NOTES database. To create an I/D Record, click "CREATE", then "Document". Then, from the scroll-down arrow below the heading, choose the type of I/D Record.

The "Document Library" recognizes four types of records: Summary/Review Publication; Technical Publication; Database/Raw Data; and Data System/Model. The general distinctions are as follows:

**Summary/Review Publication** - This type of I/D Record includes articles or reports which present or discuss water quality related information (and may include summaries of data), but does not contain full data sets. Generally, a Summary/Review Publication will reference a Technical Report or Database where the complete data is presented.

**Technical Publication** - This type of I/D Record includes reports which contain full data sets (i.e. "original" data).

**Database/Raw Data** - This type of I/D Record includes databases (such as EPA's STORET system) where actual data may be compiled and accessed. Such databases may include data from multiple sources, but typically do not provide interpretative discussion of the data, or systems with which to use the data. This type of I/D Record also includes unpublished "raw" data that may not be available through an established database.

**Data System/Model** - This type of I/D Record may include multiple database records, but also provides a means for using such data (e.g. EPA's "BASINS" program).

The information/Data Record framework provides for similar entry fields (some of which are not applicable to certain types), as provided in the attachments.

MBNEP970137(10/13/97)

Number: 101397092602AM

**Mobile Bay NEP Water Quality Characterization Baseline  
Information / Data Record****Summary/Review Publication**

**Citation:** Entire citation of Article or Publication; enter 1 data record for entire compilation and 1 data record for each appropriate article or chapter within the compilation.

**Title:** Sample: Title of Summary / Review Publication

**Author(s):** Enter author(s) of paper OR Enter author(s) of entire compilation OR Enter author(s) of each applicable chapter or paper within compilation.

**Sponsoring Agency:** Enter sponsoring agency of entire compilation OR sponsoring agency for specific chapter or paper (i.e. who supported this research)

**Purpose:** Enter 1 or 2 sentences summarizing the purpose of the paper or compilation

**Publication Date:** Date of publication (NOT necessarily the date of a symposium or meeting)

**Source Availability:** Enter location / organization where this Summary / Review Publication can be acquired or accessed (i.e. Dauphin Island Sea Lab, Univ. of South Alabama, ADEM). Be specific - if possible provide contact names, address, etc.

**Data Comments/Limitations:** Comments from the author on the data (if available) and / or general comments as may be pertinent.

**Relationship to Other Data:** Other publications or datasets which directly relate to this publication (i.e. citations given in the reference list). It is intended that such other related data will also have an Information / Data Record.

**Map Quad / Spatial Limits (enter 1 of 3 options):**

- ☐ Delta
- ☐ Mobile Bay
- ☐ NEP area
- ☐ Dog River
- ☐ Fowl River
- ☐ Weeks Bay
- ☐ BonSecour Bay
- ☐ Mississippi Sound
- ☐ Offshore
- ☐ Other

**Latitude and Longitude:**

Station	Decimal Latitude	Decimal Longitude	UTMs X	UTMs Y
	0	0	0	0

**Temporal Limits:** Time period over which the data was collected. Enter each year individually and separate with a ", " or ";". For example 1993 - 1997 would be entered 1993, 1994, 1995, 1996, 1997. An additional example is: Jan. 1995 - Nov. 1995.

---

**Abstract:**

Attach an abstract here. If the Summary / Review Publication does not have an official abstract enter a short description of the Summary / Review Publication.

**Keywords:** Add in keywords if they are not present in the abstract or if the abstract was scanned in.

---

**Issues Category(s):** Physical and/or Hydrologic Modifications  
Nutrient Overloading  
Erosion and Sedimentation  
Pathogens  
Toxic Chemicals

---

**Document Status:** Incomplete  
Complete  
QAQC Complete

**Status Comments:** This field is primarily for the person entering the data record and can be used to make notes regarding additional information to be entered etc.

**Data Entry Author:** Data record author's name - This field is primarily for the people entering data on the TET computer - i.e. the data record is associated with a name rather than "TET".

---

**DATA RECORD INFORMATION**

**Last Modification Date:** 10/13/97 09:26 AM      **Author:** Susan Sklenar/TAI  
**Modification #** 19                              **By :** Susan Sklenar/TAI

---

Number: 101497110231AM

**Mobile Bay NEP Water Quality Characterization Baseline  
Information / Data Record****Technical Publication****Citation:** Enter entire citation for the Technical Publication**Title:** Sample: Title of Technical Publication**Author(s):** Enter author(s) of Technical Publication**Sponsoring Agency:** Enter sponsoring agency for the Technical Publication (i.e.who supported this research)**Purpose:** Enter 1 or 2 sentences summarizing the purpose of the Technical Publication**Publication Date:** Enter publication date**Source Availability:** Enter location / organization where this Technical Publication can be acquired or accessed (i.e. Dauphin Island Sea Lab, Univ. of South Alabama, ADEM). Be specific - if possible provide contact names, address, internet address, database(s) access location, etc.**Data Comments/Limitations:** Comments from the author on the data (if available) and / or general comments as may be pertinent.**Relationship to Other Data:** Other publications or datasets which directly relate to this Technical Publication (i.e. citations given in the reference list). It is intended that such other related data will also have an Information / Data Record.

**Maintainence Status:** Complete  
In Progress  
On-going / Monitoring  
Planned for Future  
Other

**Map Quad / Spatial Limits (enter 1 of 3 options):**

- ☐ Delta
- ☐ Mobile Bay
- ☐ NEP area
- ☐ Dog River
- ☐ Fowl River
- ☐ Weeks Bay
- ☐ BonSecour Bay
- ☐ Mississippi Sound
- ☐ Offshore
- ☐ Other

Fruitdale  
Vinegar Bend  
Seaboard  
McIntosh  
Gin House Island  
Carlton  
Chrysler  
Uriah West  
Rounsaville  
Deer Park  
Sims Chapel  
Calvert  
Bilbo Island  
Tensaw  
Blacksher  
McCullough  
Brown Town  
Citronelle West  
Citronelle East  
Mount Vernon  
Stiggins Lake  
Vaughn  
Perdido  
Freemanville  
Earlville  
Georgetown  
Churchula  
Creola  
The Basin  
Bay Minette North  
Dyas  
Walnut Hill  
Howell  
Semmes  
Kushla  
Chickasaw  
Hurricane  
Bay Minette South  
Dogwood Creek  
Enon  
Hurley  
Tanner Williams  
Spring Hill  
Mobile  
Bridgehead



Stapleton  
 Steelwood Lake  
 Gateswood  
 Big Point  
 Theodore  
 Hollingers Island  
 Daphne  
 Silver Hill  
 Robertsdale  
 Elsanor  
 Kreole  
 Grand Bay  
 Coden  
 Bellefontaine  
 Point Clear  
 Magnolia Springs  
 Foley  
 Elberta  
 Grand Bay SW  
 Isles Aux Herbes  
 Heron Bay  
 Little Dauphin Is  
 Little Point Clear  
 Bon Secour Bay  
 Gulf Shores  
 Orange Beach  
 Petit Bois Island  
 Petit Bois Pass  
 Fort Morgan NW  
 Fort Morgan  
 Saint Andrews Bay  
 Pine Beach  
 Gulf Shores Extend  
 Orange Beach Extend

**Latitude and Longitude:**

Station	Decimal Latitude	Decimal Longitude	UTMs X	UTMs Y
A	30.528055555556	31.562222222222	0	0
B	31.545	32.561944444444		
C	32.561944444444	33.561666666667		
D	33.578888888889	34.561388888889		

**Temporal Limits:** Time period over which the data was collected. Enter each year individually and separate with a ", " or ";" For example 1993 - 1997 would be entered 1993, 1994, 1995, 1996, 1997. An additional example is: Jan. 1995 - Nov. 1995.

**Sampling Frequency:** Were the samples predominantly collected hourly, daily, weekly, monthly or annually?

**Number of Sites:** Number of sites sampled

**Number of Samples:** Number of samples collected PER site or location PER sampling event.

**Sample Matrix:** Water  
Wastewater  
Sediment  
Tissue (biological)  
Other

---

**Abstract:**

Attach an abstract here. If the publication does not have an official abstract enter a short description of the Technical Publication.

**Keywords:** Add in keywords if they are not present in the abstract or if the abstract was scanned in.

---

**Parameter Group:** HYDRODYNAMIC (Flow\_Current\_Tidal\_Circulation\_Bathymetry)  
METEROROLOGICAL (Precipitation\_Wind\_Humidity\_Solar  
Radiation\_Evaporation)  
SEDIMENTOLOGICAL (Sediment Loadings\_Accumulation\_Textural  
Classifications\_Grain Size\_Sediment Deposition)  
ROUTINE PHYSIO-CHEMICAL  
(Temperature\_Salinity\_Conductivity\_pH\_Alkalinity\_Hardness\_Acidity\_Col  
or\_Density\_TDS\_TSS\_DO\_Secchi Disk\_Turbidity\_Transmissivity)  
NUTRIENTS AND OXYGEN DEMAND (Nitrogen\_  
Phosphorous\_Silicates\_Carbon (organic)\_BOD\_COD)  
INORGANICS (excluding toxic metals) (major ions\_other non-metals)  
TOXIC METALS ("Priority Pollutant" list\_Metals\_Heavy Metals\_EP  
Toxicity\_AVS)  
ORGANIC CONTAMINATION INDICATORS (Oil and grease\_TPH)  
TRACE ORGANICS (Volatiles and Semi-volatiles (incl\_PAHs))  
PESTICIDES / PCBs / HERBICIDES  
MICROBIOLOGIC INDICATORS (coliforms\_fecal streptococci)  
PATHOGENS  
BIOASSAY / TOXICITY (acute\_chronic\_sediment)  
OTHER

**Issues Category(s):** Physical and/or Hydrologic Modifications  
Nutrient Overloading  
Erosion and Sedimentation  
Pathogens

## Toxic Chemicals

---

**Document Status:** Incomplete

Complete

QAQC Complete

**Status Comments:** This field is primarily for the person entering the data record and can be used to make notes regarding additional information to be entered etc.**Data Entry Author:** Data record author's name - This field is primarily for the people entering data on the TET computer - i.e. the data record is associated with a name rather than "TET".

---

**DATA RECORD INFORMATION****Last Modification Date:** 10/14/97 11:02 AM  
**Modification #** 14**Author:** Susan Sklenar/TAI  
**By :** Susan Sklenar/TAI

---

Number: 101497101937AM

**Mobile Bay NEP Water Quality Characterization Baseline  
Information / Data Record****Database/Raw Data****Citation:** Enter entire citation for the Database / Raw Data - if data is unpublished skip this field**Title:** Sample: Database / Raw Data**Author(s):** Enter author(s) of Database / Raw Data**Sponsoring Agency:** Enter sponsoring agency for the Database / Raw Data (i.e. who supported this research)**Purpose:** Enter 1 or 2 sentences summarizing the purpose of the Database / Raw Data**Publication Date:** Enter publication date**Source Availability:** Enter location / organization where this Database / Raw Data can be acquired or accessed (i.e. Dauphin Island Sea Lab, Univ. of South Alabama, ADEM). Be specific - if possible provide contact names, address, internet address, database(s) access location, etc.**Data Comments/Limitations:** Comments from the author on the data (if available) and / or general comments as may be pertinent.**Relationship to Other Data:** Other publications or datasets which directly relate to this database / raw data (i.e. citations given in the reference list). It is intended that such other related data will also have an Information / Data Record.**Maintainence Status:** Complete  
In Progress  
On-going / Monitoring  
Planned for Future  
Other**Data Environment:** Source Media, Hardware, Operating System, Software, Format and Size of File**Access / Use Constraints:** Restrictions and legal prerequisites for accessing and / or using the data set (i.e. proprietary data)**Security:** Handling restrictions imposed on the data set because of national security, privacy or other reasons.

**Map Quad / Spatial Limits (enter 1 of 3 options):**

- ☐ Delta
- ☐ Mobile Bay
- ☐ NEP area
- ☐ Dog River
- ☐ Fowl River
- ☐ Weeks Bay
- ☐ BonSecour Bay
- ☐ Mississippi Sound
- ☐ Offshore
- ☐ Other

**Latitude and Longitude:**

Station	Decimal Latitude	Decimal Longitude	UTMs X	UTMs Y
	0	0	0	0

**Temporal Limits:** Time period over which the data was collected. Enter each year individually and separate with a ", " or ";". For example 1993 - 1997 would be entered 1993, 1994, 1995, 1996, 1997. An additional example is: Jan. 1995 - Nov. 1995.

**Sampling Frequency:** Were the samples predominantly collected hourly, daily, weekly, monthly or annually?

**Number of Sites:** Number of sites sampled

**Number of Samples:** Number of samples collected PER site or location PER sampling event.

**Sample Matrix:** Water  
Wastewater  
Sediment  
Tissue (biological)  
Other

---

**Abstract:**

Attach an abstract here. If the Database / Raw Data does not have an official abstract enter a short description of the summary/review publication.

**Keywords:** Add in keywords if they are not present in the abstract or if the abstract was scanned in.

**Parameter Group:** HYDRODYNAMIC (Flow\_Current\_Tidal\_Circulation\_Bathymetry)  
METEROROLOGICAL (Precipitation\_Wind\_Humidity\_Solar  
Radiation\_Evaporation)  
SEDIMENTOLOGICAL (Sediment Loadings\_Accumulation\_Textural  
Classifications\_Grain Size\_Sediment Deposition)  
ROUTINE PHYSIO-CHEMICAL  
(Temperature\_Salinity\_Conductivity\_pH\_Alkalinity\_Hardness\_Acidity\_Col  
or\_Density\_TDS\_TSS\_DO\_Secchi Disk\_Turbidity\_Transmissivity)  
NUTRIENTS AND OXYGEN DEMAND (Nitrogen\_  
Phosphorous\_Silicates\_Carbon (organic)\_BOD\_COD)  
INORGANICS (excluding toxic metals) (major ions\_other non-metals)  
TOXIC METALS ("Priority Pollutant" list\_Metals\_Heavy Metals\_EP  
Toxicity\_AVS)  
ORGANIC CONTAMINATION INDICATORS (Oil and grease\_TPH)  
TRACE ORGANICS (Volatiles and Semi-volatiles (incl\_PAHs))  
PESTICIDES / PCBs / HERBICIDES  
MICROBIOLOGIC INDICATORS (coliforms\_fecal streptococci)  
PATHOGENS  
BIOASSAY / TOXICITY (acute\_chronic\_sediment)  
OTHER

**Issues Category(s):** Physical and/or Hydrologic Modifications  
Nutrient Overloading  
Erosion and Sedimentation  
Pathogens  
Toxic Chemicals

**Document Status:** Incomplete  
Complete  
QAQC Complete

**Status Comments:** This field is primarily for the person entering the data record and can be used to make notes regarding additional information to be entered etc.

**Data Entry Author:** Data record author's name - This field is primarily for the people entering data on the TET computer - i.e. the data record is associated with a name rather than "TET".

---

**DATA RECORD INFORMATION**

**Last Modification Date:** 10/14/97 10:19 AM      **Author:** Susan Sklenar/TAI  
**Modification #** 17      **By:** Susan Sklenar/TAI

---

Number: 101497094152AM

**Mobile Bay NEP Water Quality Characterization Baseline  
Information / Data Record****Data System/Model****Citation:** Enter entire citation for the Data System / Model**Title:** Sample: Title of Data System / Model**Author(s):** Enter author(s) of Data System / Model**Sponsoring Agency:** Enter sponsoring agency for the Data System / Model (i.e. who supported this research / Data System / Model)**Purpose:** Enter 1 or 2 sentences summarizing the purpose of the Data System / Model**Publication Date:** Enter publication date**Source Availability:** Enter location / organization where this Data System / Model can be acquired or accessed (i.e. Dauphin Island Sea Lab, Univ. of South Alabama, ADEM). Be specific - if possible provide contact names, address, internet address, database(s) access location, etc.**Data Comments/Limitations:** Comments from the author on the data (if available) and / or general comments as may be pertinent.**Relationship to Other Data:** Other publications or datasets which directly relate to this Data System / Model (i.e. citations given in the reference list). It is intended that such other related data will also have an Information / Data Record.**Maintainence Status:** Complete  
In Progress  
On-going / Monitoring  
Planned for Future  
Other**Data Environment:** Source Media, Hardware, Operating System, Software, Format and Size of File**Access / Use Constraints:** Restrictions and legal prerequisites for accessing and / or using the data set (i.e. proprietary data)**Security:** Handling restrictions imposed on the data set because of national security, privacy or other reasons.

**Map Quad / Spatial Limits (enter 1 of 3 options):**

- ☐ Delta
- ☐ Mobile Bay
- ☐ NEP area
- ☐ Dog River
- ☐ Fowl River
- ☐ Weeks Bay
- ☐ BonSecour Bay
- ☐ Mississippi Sound
- ☐ Offshore
- ☐ Other

**Latitude and Longitude:**

Station	Decimal Latitude	Decimal Longitude	UTMs X	UTMs Y
	0	0	0	0

**Temporal Limits:** Time period over which the data was collected. Enter each year individually and separate with a ", " or ";". For example 1993 - 1997 would be entered 1993, 1994, 1995, 1996, 1997. An additional example is: Jan. 1995 - Nov. 1995.

**Sampling Frequency:** Were the samples predominantly collected hourly, daily, weekly, monthly or annually?

**Number of Sites:** Number of sites sampled

**Number of Samples:** Number of samples collected PER site or location PER sampling event.

**Sample Matrix:** Water  
Wastewater  
Sediment  
Tissue (biological)  
Other

---

**Abstract:**

Attach an abstract here. If the publication does not have an official abstract enter a short description of the Data System / Model.

**Keywords:** Add in keywords if they are not present in the abstract or if the abstract was scanned in.



**Parameter Group:** HYDRODYNAMIC (Flow\_Current\_Tidal\_Circulation\_Bathymetry)  
METEROROLOGICAL (Precipitation\_Wind\_Humidity\_Solar  
Radiation\_Evaporation)  
SEDIMENTOLOGICAL (Sediment Loadings\_Accumulation\_Textural  
Classifications\_Grain Size\_Sediment Deposition)  
ROUTINE PHYSIO-CHEMICAL  
(Temperature\_Salinity\_Conductivity\_pH\_Alkalinity\_Hardness\_Acidity\_Col  
or\_Density\_TDS\_TSS\_DO\_Secchi Disk\_Turbidity\_Transmissivity)  
NUTRIENTS AND OXYGEN DEMAND (Nitrogen\_  
Phosphorous\_Silicates\_Carbon (organic)\_BOD\_COD)  
INORGANICS (excluding toxic metals) (major ions\_other non-metals)  
TOXIC METALS ("Priority Pollutant" list\_Metals\_Heavy Metals\_EP  
Toxicity\_AVS)  
ORGANIC CONTAMINATION INDICATORS (Oil and grease\_TPH)  
TRACE ORGANICS (Volatiles and Semi-volatiles (incl\_PAHs))  
PESTICIDES / PCBs / HERBICIDES  
MICROBIOLOGIC INDICATORS (coliforms\_fecal streptococci)  
PATHOGENS  
BIOASSAY / TOXICITY (acute\_chronic\_sediment)  
OTHER

**Issues Category(s):** Physical and/or Hydrologic Modifications  
Nutrient Overloading  
Erosion and Sedimentation  
Pathogens  
Toxic Chemicals

**Document Status:** Incomplete  
Complete  
QAQC Complete

**Status Comments:** This field is primarily for the person entering the data record and can be used to make notes regarding additional information to be entered etc.

**Data Entry Author:** Data record author's name - This field is primarily for the people entering data on the TET computer - i.e. the data record is associated with a name rather than "TET".

---

#### DATA RECORD INFORMATION

**Last Modification Date:** 10/14/97 09:41 AM      **Author:** Susan Sklenar/TAI  
**Modification #** 22      **By :** Susan Sklenar/TAI

---

### **APPENDIX III**

#### **MAPS OF MBNEP SUB-AREAS DISPLAYING SELECTED BASINS DATA POINTS AND TABULATIONS SUMMARIZING SELECTED CHARACTERISTICS RELATED TO WATER QUALITY**



- ◆ National Priority List (NPL) Sites
- ★ Permit Compliance System (PCS) Locations
- ▲ Industrial Facility Discharge (IFD) Locations
- Toxic Release Inventory (TRI) 1992 Locations
- Offshore Sub-area
- Mobile Bay Sub-area



7 0 7 Miles

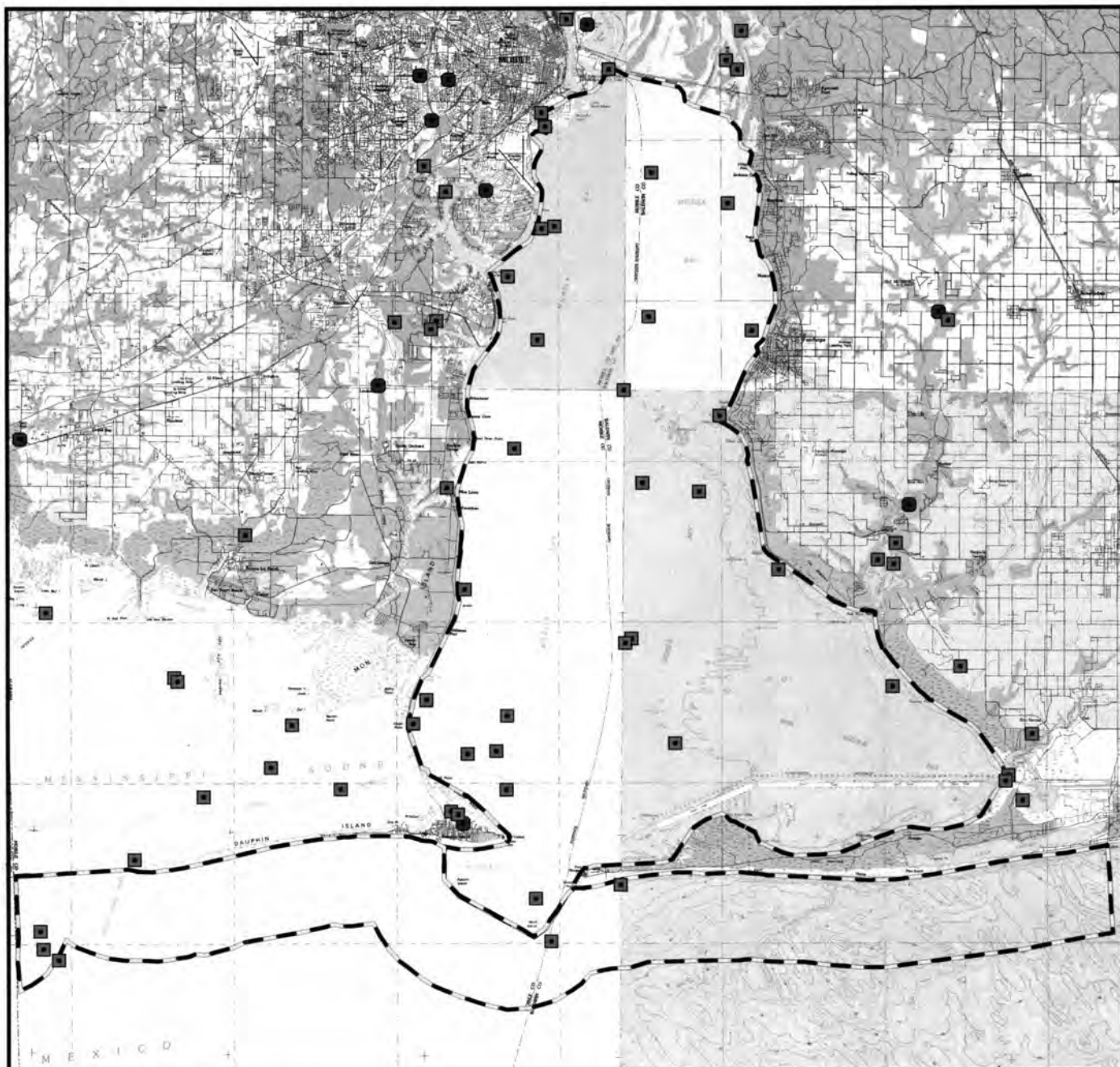
SCALE: ( 1 : 360,000)



**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI ENVIRONMENTAL**  
**SCIENCES, INC.** 

**Offshore Sub-area and Mobile Bay Sub-area  
Showing Point Source Data Locations from  
EPA's BASINS GIS**



- National Sediment Inventory (NSI) Stations
- USGS Gage Stations
- Drinking Water Supply Locations
- Offshore Sub-Area
- Mobile Bay Sub-Area



7 0 7 Miles

SCALE: ( 1 : 360,000)



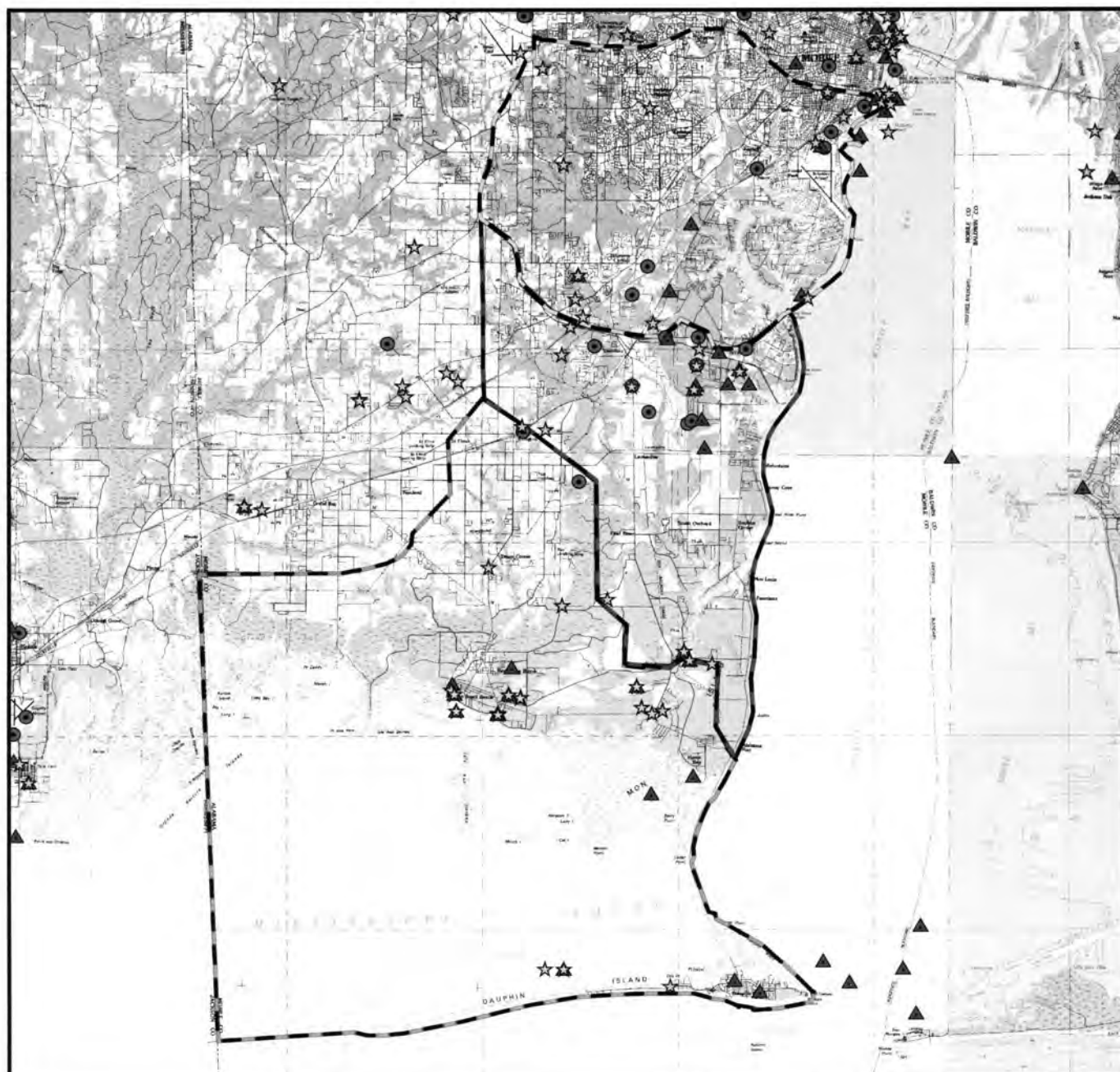
**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI ENVIRONMENTAL**  
**SCIENCES, INC.** 

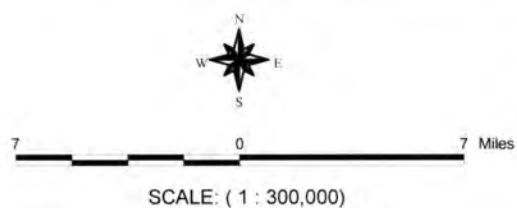
**Offshore Sub-area and Mobile Bay Sub-area  
Showing Monitoring Data Locations from  
EPA's BASINS GIS**

OFFSHORE	
Water Use Classifications	Fish & Wildlife, Swimming, and Shellfish Harvesting
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status NPS Impairment Assessment	Full N.A.
Uses/Activities	Recreation, Fisheries (commercial and recreational), Navigation, Hydrocarbon Development (Natural Gas)
Coastal Zone Jurisdiction	Yes
Urban Stormwater (MS4) Jurisdiction	No
Municipal Jurisdictions	Mobile and Baldwin Counties
Public Wastewater Sewerage	N.A.
Point Source Considerations	Limited (associated with hydrocarbon development)
Non-Point Source Considerations	Water quality conditions, particularly west of the mouth of Mobile Bay, may show considerable influence from the net outward flow from Main Pass
Remarks	The Mobile Ship Channel, a deep-draft navigation project, transects the sub-area north-south from deep water in the Gulf of Mexico to Mobile Bay. A permitted ocean disposal area for dredged material is located south of Dauphin Island near the 3-mile limit (MBNEP boundary)

MOBILE BAY	
Water Use Classifications	Fish & Wildlife (throughout); Swimming and Shellfish Harvesting (see Figure 4-3)
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status  NPS Impairment Assessment	Partial; 113 sq. mi. permanently and 267 sq. mi. periodically impaired by pathogens (attributed to municipal point sources, urban runoff)  Upper Mobile Bay (32,000 acres) impaired by pesticides, priority organics, metals, nutrients (attributed to cropland, industrial and natural runoff)
Uses/Activities	Recreation, Fisheries (commercial and recreational), Navigation, Hydrocarbon Development (natural gas) in lower bay
Coastal Zone Jurisdiction	Yes
Urban stormwater (MS4) Jurisdiction	No (Yes, for bordering areas along northern segments of both shores)
Municipal Jurisdictions	Mobile County and Baldwin County; cities of Mobile, Daphne, Fairhope along northern shores
Public Water Supply	N.A.
Public Wastewater Sewerage	N.A.
Point Source Considerations	Municipal point sources from Mobile, Daphne, and Fairhope. Primary concentration of industrial point sources at northwest portion of the bay (Mobile Harbor) and along western shore.
Non-Point Source Considerations	Upstream river input from Mobile River Drainage Basin greatly influences Mobile Bay proper; Urban stormwater from City of Mobile and developing areas along western and eastern shores, and surrounding watersheds; Runoff from more rural watersheds generally input to Mobile Bay from southern regions and may be influenced by agricultural practices, septic tanks, and increased development
Remarks	Deep-draft navigation projects include Mobile Ship Channel transecting north-south and Theodore Ship Channel from the Mobile Ship Channel to the western shore at Deer River. Gaillard Island, a man-made island for dredged material disposal from Theodore Ship Channel, has become an important habitat and rookery for birds, including the brown pelican. Shallow-draft navigation channels include the Gulf Intracoastal Waterway (GIWW) transecting east-west across the lower bay, and entrance channels to marina/docking facilities such as Dog River and Fly Creek



- ◆ National Priority List (NPL) Sites
- ☆ Permit Compliance System (PCS) Locations
- ▲ Industrial Facility Discharge (IFD) Locations
- Toxic Release Inventory (TRI) 1992 Locations
- ~~~~~ Dog River Watershed Sub-area
- ~~~~~ East Fowl River & Deer River Watersheds Sub-area
- ~~~~~ Mississippi Sound & Dauphin Island Sub-area

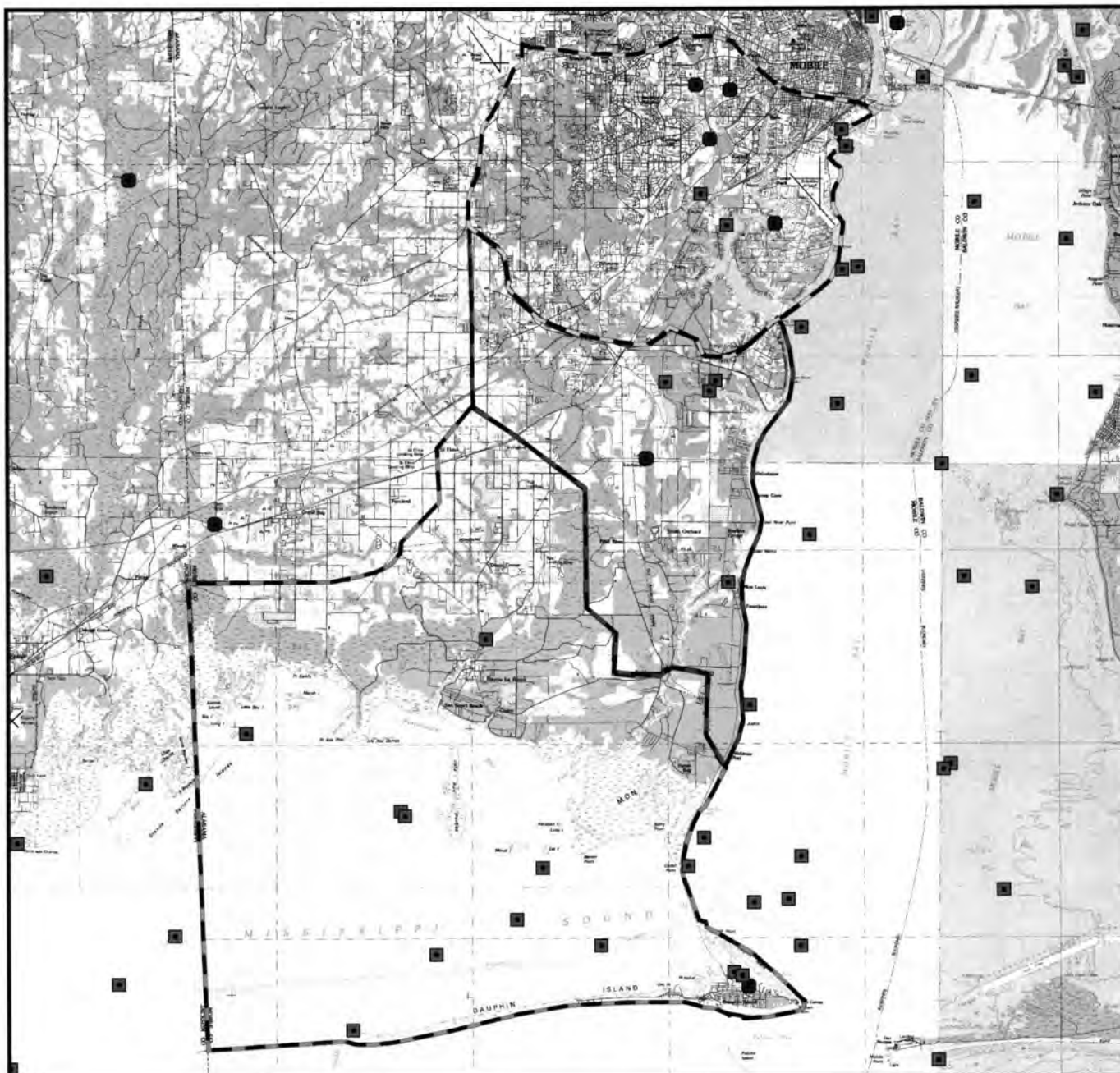


**Preliminary Characterization of Water Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI ENVIRONMENTAL SCIENCES, INC.** 

**Mississippi Sound & Dauphin Island Sub-area,  
 East Fowl River & Deer River Watersheds  
 Sub-area, and Dog River Watershed Sub-area  
 Showing Point Source Data Locations from  
 EPA's BASINS GIS**





- National Sediment Inventory (NSI) Stations
- USGS Gage Stations
- Drinking Water Supply Locations
- ══ Dog River Watershed Sub-area
- ══ East Fowl River & Deer River Watersheds Sub-area
- ══ Mississippi Sound & Dauphin Island Sub-area



7 0 7 Miles

SCALE: ( 1 : 300,000)



**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI ENVIRONMENTAL**  
**SCIENCES, INC.** 

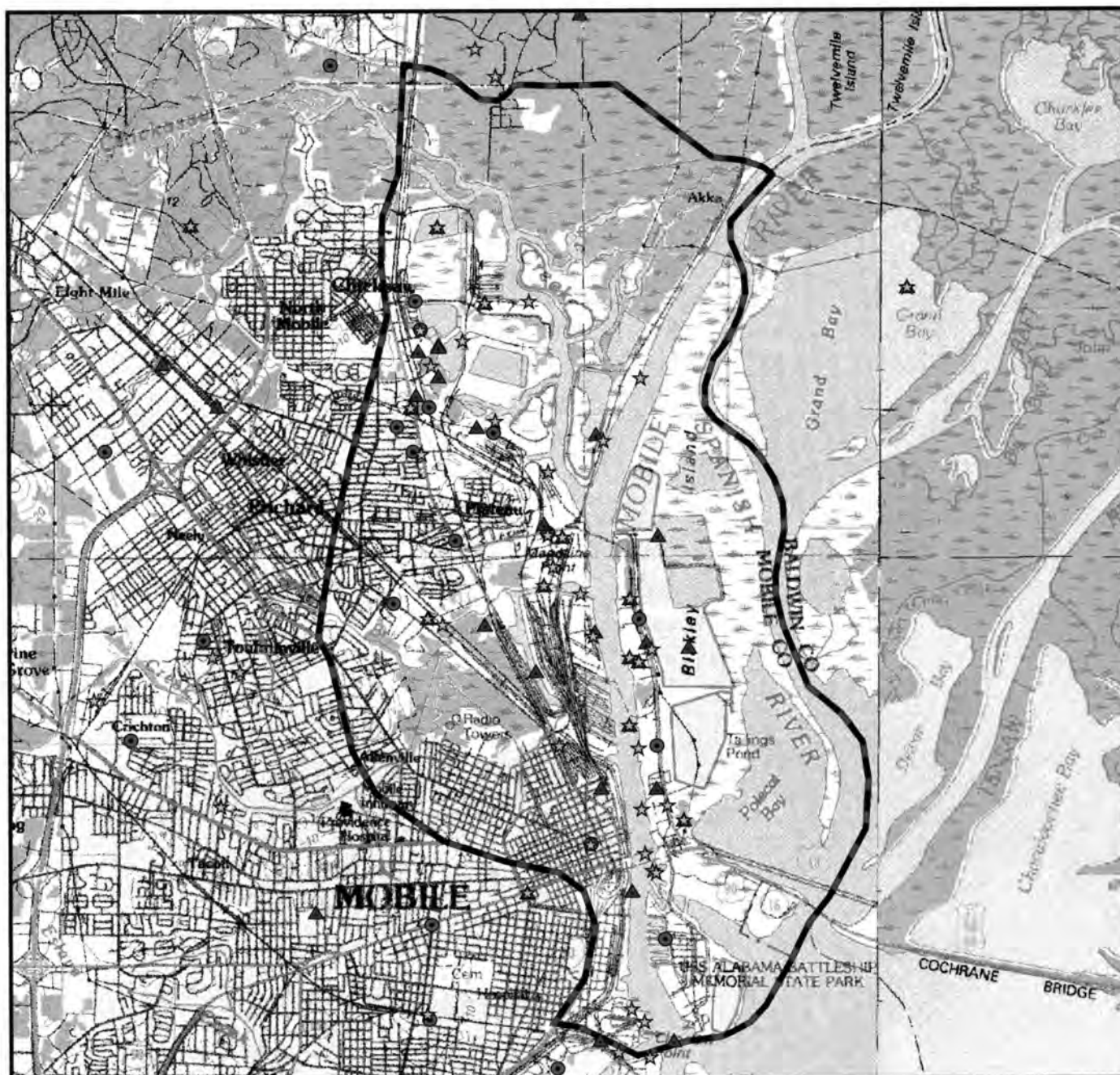
**Mississippi Sound & Dauphin Island Sub-area,  
East Fowl River & Deer River Watersheds  
Sub-area and Dog River Watersheds Sub-area  
Showing Monitoring Data Locations from  
EPA's BASINS GIS**



<b>MISSISSIPPI SOUND AND DAUPHIN ISLAND</b>	
Water Use Classifications	Fish & Wildlife (throughout); Swimming and Shellfish Harvesting (see Figure 4-3)
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status  NPS Impairment Assessment	Mississippi Sound – partial; 143 sq. mi. periodically impaired by pathogens; Bayou La Batre – non; 4 miles due to nutrients, pH, organic enrichment/D.O., oil and grease (attributed to surface runoff) No Assessed Areas
Uses/Activities	Mississippi Sound – Recreation, Fisheries (commercial and recreational), Navigation, Hydrocarbon Development (natural gas). Dauphin Island – Tourism, Recreation, Marinas and Dockage (commercial and private vessels). South Mobile County Mainland – Mostly rural / agricultural; Extensive saltmarsh and savannah border Mississippi Sound; Seafood landing/processing and shipbuilding industries (Bayou La Batre and Coden); Hydrocarbon production and distribution facilities are continuing to be sited in the area.
Coastal Zone Jurisdiction	Mississippi Sound – Yes Dauphin Island – Yes South Mobile County Mainland – large proportion below 10-ft. contour
Urban stormwater (MS4) Jurisdiction	No
Municipal Jurisdictions	Mobile County, cities of Dauphin Island and Bayou La Batre
Public Water Supply	Dauphin Island, Bayou La Batre, Alabama Port, St. Elmo/Irvington
Public Wastewater Sewerag	Dauphin Island, Bayou La Batre
Point Source Considerations	Municipal point source discharges to Mississippi Sound include Dauphin Island (Aloe Bay) and Bayou La Batre (Portersville Bay); Industrial Point Sources are limited, associated with seafood processing, ship building, and hydrocarbon production. Bayou La Batre has long been recognized for localized water quality degradation. Point source improvements have included removal of direct seafood discharges to the bayou.
Non-Point Source Considerations	Mississippi Sound conditions are greatly influenced by flow from Mobile Bay; septic tank problems may occur due to soil limitations; agricultural runoff; pipeline and industrial facility construction
Remarks	Shallow-draft navigation channels include GIWW transecting east-west through Mississippi Sound, and entrance channels to Dauphin Island and Bayou La Batre/Coden. The Bayou La Batre channel has recently been deepened.

<b>EAST FOWL RIVER AND DEER RIVER WATERSHEDS</b>	
Water Use Classifications	Fish & Wildlife (throughout); Swimming (East Fowl River)
Use Impairment Identified (ADEM, 1996 305(b) report: Use Support Status NPS Impairment Assessment	East Fowl River – partial (10 miles) due to organic enrichment/D.O. Fowl River (8 miles) impaired by nutrients, siltation (attributed to pasture, stormwater). Theodore Industrial Canal (1 mile) impaired by organic enrichment/D.O. (attributed to channelization, natural)
Uses/Activities	Fowl River – Recreation, Fisheries (recreational), Marina/Dockage (commercial and private vessels). Most of watershed is rural/agricultural and low density residential, but is exhibiting increased development. Deer River: developed for Theodore Ship Channel; surrounding area is utilized as industrial park.
Coastal Zone Jurisdiction	Limited proportion of watershed is below 10-ft. contour (mainly along shorelines)
Urban Stormwater (MS4) Jurisdiction	Limited
Municipal Jurisdictions	Mobile County
Public Water Supply	Some parts of northern portion of sub-area have public water (e.g. Theodore community, Theodore Industrial area). Also provided near Alabama Port and environs.
Public Wastewater Sewerage	Some parts of northern portion of sub-area are served by public sewer system.
Point Source Considerations	Northern portion of sub-area mostly associated with Theodore Industrial Area.
Non-Point Source Considerations	Septic tank problems due to soil limitations; agricultural runoff; industrial and commercial development
Remarks	

<b>DOG RIVER WATERSHED</b>	
Water Use Classifications	Fish & Wildlife (throughout); Swimming (part of Dog River, see figure 4-3)
Use Impairment Identified (ADEM,1996 305(b) report): Use Support Status  NPS Impairment Assessment	Dog River – non (4 miles) due to nutrients, pH, organic enrichment/D.O. (attributed to land development, surface runoff, septic tanks) Dog River (4 miles) – nutrients, organic enrichment/D.O. (attributed to urban runoff)
Uses/Activities	Dog River – Recreation, Fisheries (recreational), Marina & Dockage (commercial and private vessels). Watershed has moderate to high density commercial and residential urbanization, with new development occurring mostly in western portions.
Coastal Zone Jurisdiction	Limited proportion of watershed is below 10-ft. contour (mainly along shorelines)
Urban Stormwater (MS4) Jurisdiction	Yes
Municipal Jurisdictions	City of Mobile, Mobile County
Public Water Supply	Most of area is served by public water, but private wells are used in some portions
Public Wastewater Sewerage	Most of area is served by public sewer, but septic tanks are used in some portions
Point Source Considerations	Limited
Non-Point Source Considerations	Urban stormwater runoff and watershed drainage modifications, construction / development, sewer system malfunctions; septic tank failures due to soil limitations
Remarks	ADEM,1996 305(b) report notes Swimming Area Closures (one-time events) of Perch Creek, Bolton Branch, Moore Creek-Montlimar Creek due to fecal coliform.



- ◆ National Priority List (NPL) Sites
- ☆ Permit Compliance System (PCS) Locations
- ▲ Industrial Facility Discharge (IFD) Locations
- Toxic Release Inventory (TRI) 1992 Locations
- Lower Mobile River (Mobile Harbor) Sub-area



7 0 7 Miles

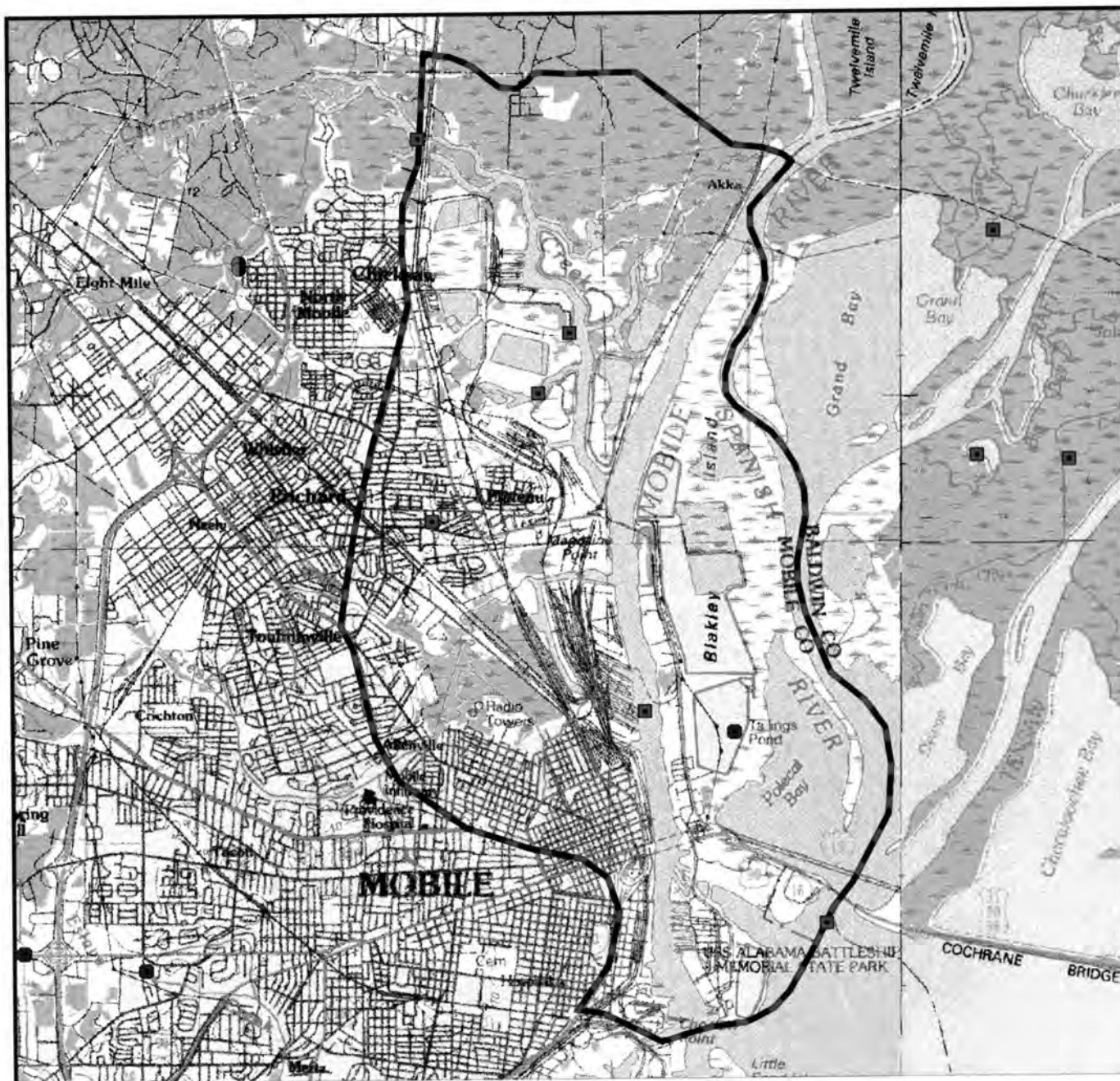
SCALE: ( 1 : 85,000)



**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
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SCIENCES, INC. 

**Lower Mobile River (Mobile Harbor), Lower  
Three-Mile Creek, & Lower Chickasaw Creek Sub-area  
Showing Point Source Data Locations from  
EPA's BASINS GIS**



- National Sediment Inventory (NSI) Stations
- USGS Gage Stations
- Drinking Water Supply Locations
- Lower Mobile River (Mobile Harbor) Sub-area



7 0 7 Miles

SCALE: ( 1 : 85,000 )



**Preliminary Characterization of Water Quality of the MBNEP Study Area**

**Thompson Engineering**

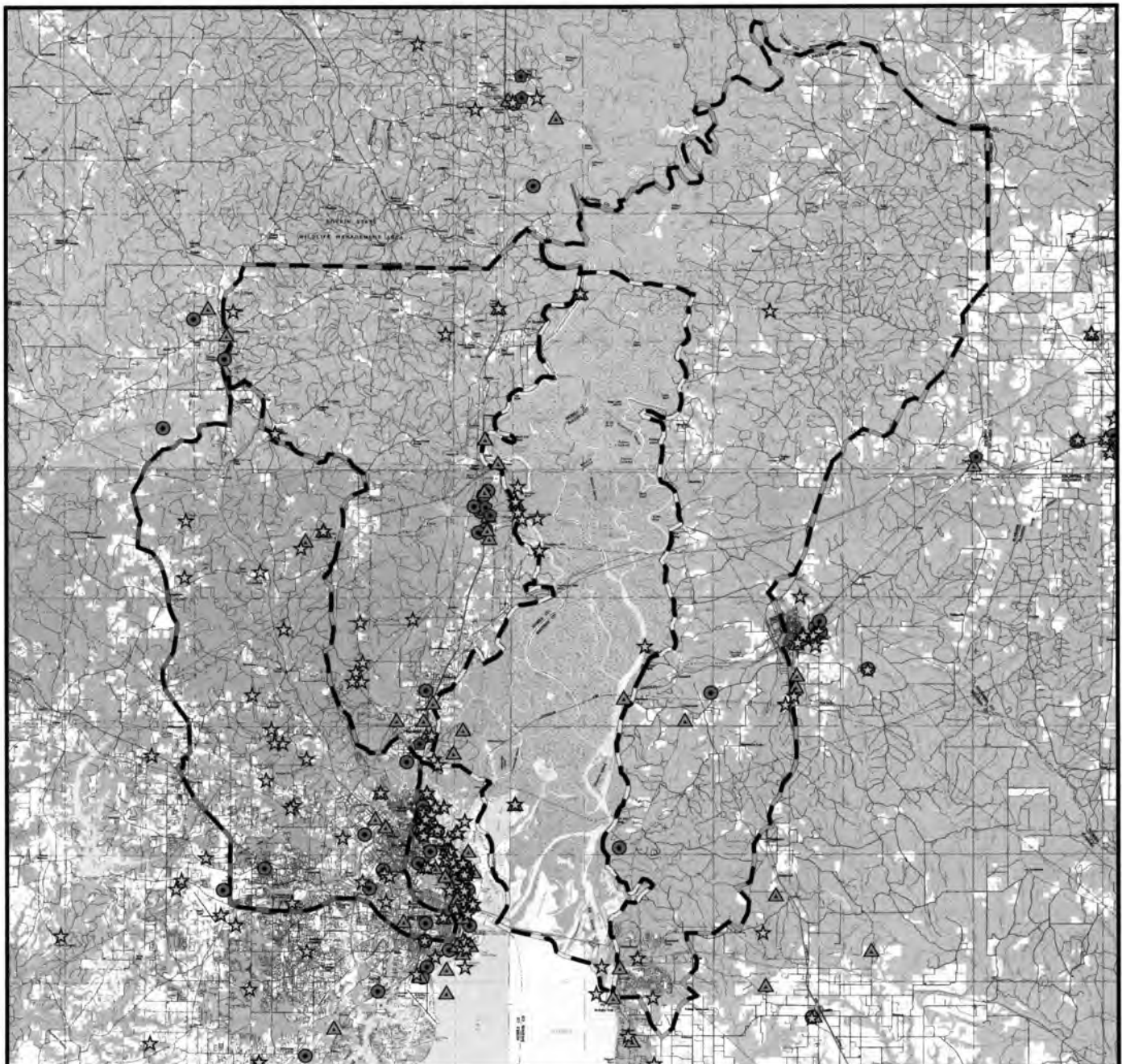
**TAI ENVIRONMENTAL SCIENCES, INC.**



**Lower Mobile River (Mobile Harbor), Lower Three-Mile Creek, & Lower Chickasaw Creek Sub-area Showing Monitoring Data Locations from EPA's BASINS GIS**

<b>LOWER MOBILE RIVER (MOBILE HARBOR), LOWER THREE-MILE CREEK, AND LOWER CHICKASAW CREEK</b>	
Water Use Classifications	Agricultural & Industrial
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status  NPS Impairment Assessment	Chickasaw Creek – non (4 miles) due to nutrients, pH, siltation, organic enrichment/D.O. (attributed to highway /road / bridge construction and urban runoff storm sewers). Hog Bayou – partial (3 miles) due to pH, organic enrichment / D.O. (attributed to industrial point sources and natural). Three-Mile Creek – non (17.4 miles) due to nutrients, pH, organic enrichment / D.O. (attributed to municipal point source, storm sewers, irrigated crop production, aquaculture). Chickasaw Creek (15 miles) impaired by nutrients, siltation (attributed to agriculture, construction, urban runoff); Three-Mile Creek (6 miles) – impaired by priority organics and metals, nutrients, organic enrichment, pathogens, oil and grease (attributed to urban runoff and spills)
Uses/Activities	Navigation and Shipping (Port of Mobile); Shipbuilding, Bulk Commodities Storage and Trans-shipment; Heavy Industry (pulp and paper, chemicals, petroleum refining); Commercial (downtown region of City of Mobile); Residential
Coastal Zone Jurisdiction	Yes, a large proportion of area is below 10-ft. contour
Urban Stormwater (MS4) Jurisdiction	Yes
Municipal Jurisdictions	Cities of Mobile, Prichard, Chickasaw
Public Water Supply	Yes
Public Wastewater Sewerage	Yes
Point Source Considerations	Long-term concentration of point source discharges, mostly industrial. This sub-area has been focus of water quality management studies and upgrades, and significant point source reductions have been implemented in recent years.
Non-Point Source Considerations	Urban and Industrial Stormwater Runoff
Remarks	EPA has recently announced a requirement to upgrade water use classification to Fish & Wildlife. However, ADEM questions whether the upgraded use is attainable. Water quality conditions are influenced not only by past and present point and non-point discharges, but also by physical modifications such as channel deepening.





- ◆ National Priority List (NPL) Sites
- ☆ Permit Compliance System (PCS) Locations
- ▲ Industrial Facilities Discharge (IFD) Locations
- Toxic Release Inventory (TRI) 1992 Locations
- Mobile-Tensaw Delta Sub-area
- Bayou Sara, Cold Creek & Cedar Creek Watersheds Sub-area
- Three-Mile Creek & Chickasaw Creek Watersheds Sub-area
- North Baldwin County Watershed Sub-area



7 0 7 Miles

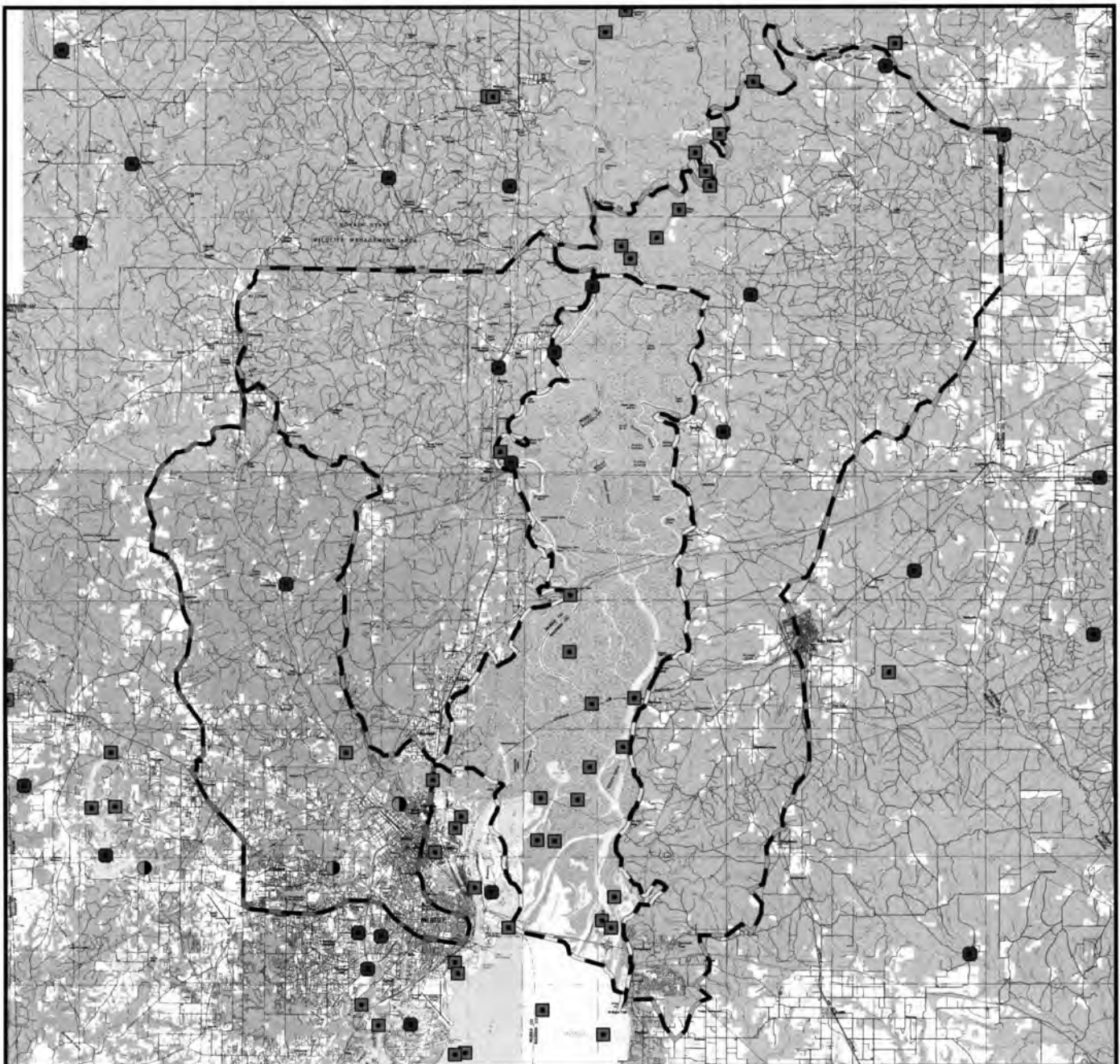
SCALE: ( 1 : 450,000)



**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI ENVIRONMENTAL  
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**Three-Mile Creek & Chickasaw Creek Watershed Sub-area,  
Bayou Sara, Cold Creek & Cedar Creek Watershed Sub-area,  
North Baldwin County Watershed Sub-area and  
Mobile-Tensaw Delta Sub-area  
Showing Point Source Data Locations from  
EPA's BASINS GIS**



- National Sediment Inventory (NSI) Stations
- USGS Gage Stations
- Drinking Water Supply Locations
- Mobile-Tensaw Delta Sub-area
- Bayou Sara, Cold Creek & Cedar Creek Watersheds Sub-area
- Three-Mile Creek & Chickasaw Creek Watersheds Sub-area
- North Baldwin County Watersheds Sub-area



7 0 7 Miles

SCALE: ( 1 : 450,000)



**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

**Thompson Engineering**   
**TAI ENVIRONMENTAL  
SCIENCES, INC.** 

**Three-Mile Creek & Chickasaw Creek Watershed Sub-area,  
Bayou Sara, Cold Creek & Cedar Creek Watershed Sub-area,  
North Baldwin County Watershed Sub-area and  
Mobile-Tensaw Delta Sub-area  
Showing Monitoring Data Locations from  
EPA's BASINS GIS**

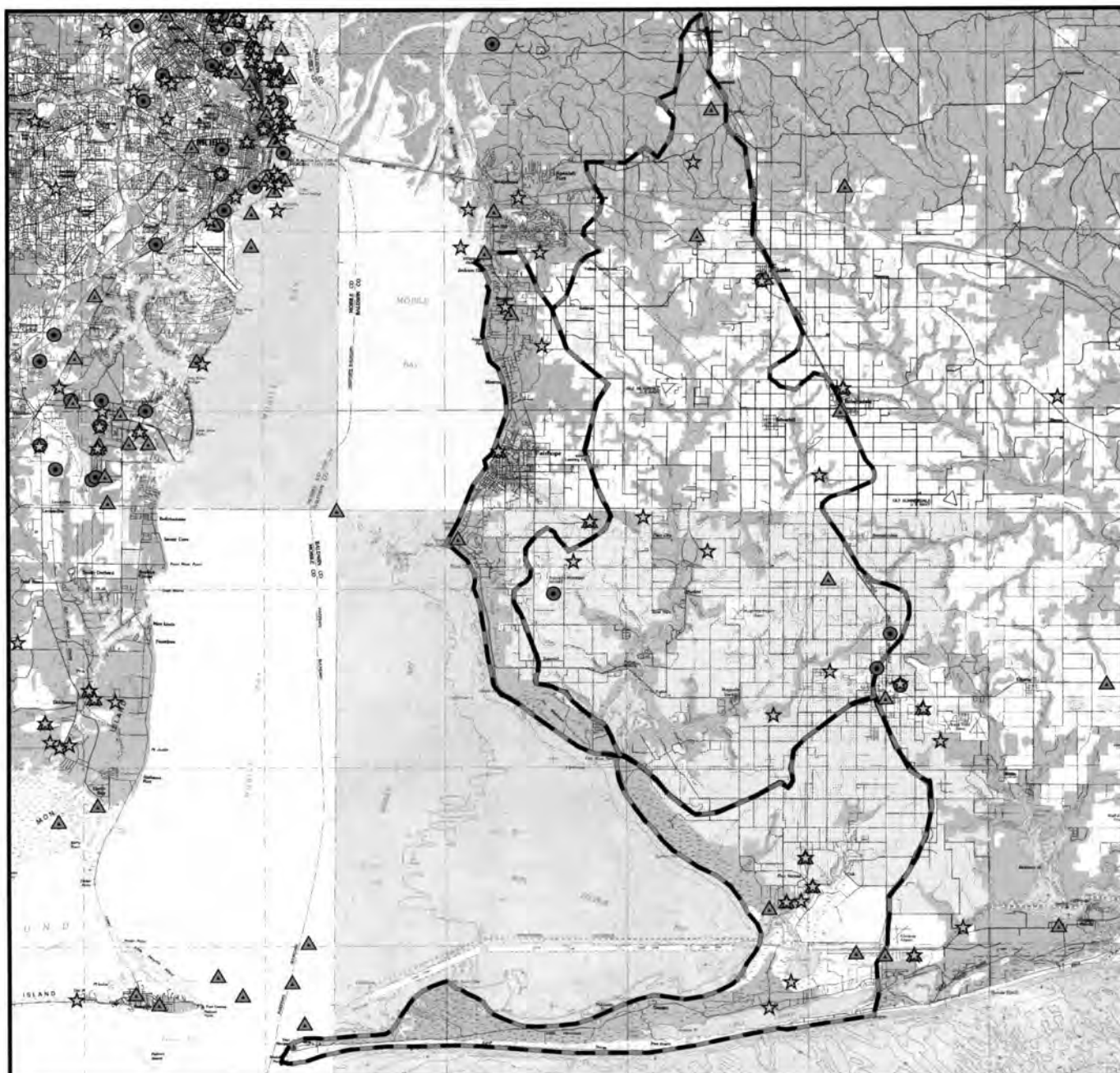


<b>THREE-MILE CREEK AND CHICKASAW CREEK WATERSHEDS</b>	
Water Use Classifications	Three-Mile Creek: Agricultural and Industrial; Chickasaw Creek: Fish Wildlife (throughout), Swimming, Public Water Supply (see Figure 4-3)
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status  NPS Impairment Assessment	Three Mile Creek – non (17.4 miles) due to nutrients, pH, organic enrichment/D.O. (attributed to municipal point source, storm sewers, irrigated crop production, aquaculture) Three-Mile Creek (10 miles) impaired by pesticides, metals, nutrients, organic enrichment/D.O., pathogens, oil and grease (attributed to urban and industrial runoff). Chickasaw Creek (15 miles) impaired by nutrients, siltation (attributed to agriculture, construction, urban runoff)
Uses/Activities	Three-Mile Creek is mostly channelized and used for urban drainage and flood control; however, headwaters include municipal park lake used for recreation. Watershed of Three Mile Creek is urban/suburban. Chickasaw Creek is used for recreation, with one tributary (Eight Mile Creek) used as public water supply for City of Prichard. Watershed is urban/suburban in lower reaches, and mostly rural (agricultural/silvicultural) in upper regions. Crude oil extraction in upper regions.
Coastal Zone Jurisdiction	Limited proportion of watershed is below 10-ft. contour
Urban Stormwater (MS4) Jurisdiction	Yes (Three-Mile Creek watershed). Partial (Chickasaw Creek watershed)
Municipal Jurisdictions	Mobile County, cities of Mobile, Chickasaw, Prichard, Citronelle
Public Water Supply	Mobile Area, Prichard, Semmes, Kushla, Turnerville, Citronelle.
Public Wastewater Sewerage	Public sewer is available in urban/suburban areas, however, a large proportion of rural areas utilize septic tanks.
Point Source Considerations	Several point sources in urbanized areas, lesser in upper, rural areas of watershed.
Non-Point Source Considerations	Urban stormwater runoff in lower regions; agricultural and silvicultural stormwater runoff in upper regions; construction/development.
Remarks	Source water (Eight Mile Creek) for City of Prichard drinking water has recently been subject of publicity regarding pollution status.

<b>BAYOU SARA, COLD CREEK, AND CEDAR CREEK WATERSHEDS</b>	
Water Use Classifications	Fish & Wildlife (throughout); Swimming, Public Water Supply (see Figure 4-3)
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status  NPS Impairment Assessment	Norton Creek – non (1 mile) due to organic enrichment/D.O. (attributed to industrial point source). Bayou Sara – non (140 sq. mi.) due to pesticides (attributed to natural). Cold Creek Swamp – non (1 sq. mi.) due to metals (attributed to in-place contaminants). None performed.
Uses/Activities	Industrial / Commercial / Residential development on lower reaches of Bayou Sara watershed (Saraland, Satusma) along Mobile River. Upper reaches (west of Hwy. 43) are mostly rural (agricultural / silviculture). Lower reaches of Cold Creek Watershed along Mobile River and Highway 43 (Creola, LeMoyne, Axis) have long term chemical manufacturing sites; whereas upper reaches are mostly rural (agriculture, silviculture). Similarly, Cedar Creek watershed is mostly rural except near Highway 43 / Mobile River. Alabama Power Company electric generating plant (Barry) is located on Mobile River. Crude oil extraction in upper regions of watersheds. Note: Most all industrial facilities referenced in the lower portions of these watersheds discharge directly into the Mobile River, which is part of the “Mobile – Tensaw Delta” sub-area.
Coastal Zone Jurisdiction	Limited proportion of sub-area is below 10-ft. contour.
Urban Stormwater (MS4) Jurisdiction	Limited (Saraland , Creola regions)
Municipal Jurisdictions	Mobile County, cities and towns of Saraland, Satsuma, Citronelle, Creola, and Mount Vernon.
Public Water Supply	Saraland, Satsuma, Citronelle, LeMoyne, Mt. Vernon
Public Wastewater Sewerage	Public sewer is available in urban/suburban areas. A large proportion of watershed is rural and utilizes septic tanks.
Point Source Considerations	Several point sources along Hwy 43 bordering Mobile-Tensaw Delta associated with major industries. Substantial regulatory agency focus has been given to these industries in recent years. Point sources are limited in upper regions of watersheds.
Non-Point Source Considerations	Urban stormwater runoff in lower reaches; Agricultural and silvicultural runoff in upper watershed areas; construction/development.
Remarks	Three “Superfund” National Priority List (NPL) Sites are located within this sub-area (these are the only NPL sites in the MBNEP area).

<b>MOBILE-TENSAW DELTA</b>	
Water Use Classifications	Fish & Wildlife (throughout); Swimming (see Figure 4-3)
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status  NPS Impairment Assessment	Mobile River – partial (19 miles) due to nutrients, pH, organic enrichment/D.O., temperature/thermal modification (attributed to natural and unknown sources). Tensaw River – partial (4 miles) due to temperature/thermal modifications (attributed to unknown source). None performed
Uses/Activities	Recreation; Fisheries; Navigation (Mobile River); Industrial Water Supply (Mobile River); Silviculture; Wildlife Habitat and Preserve; Wetlands
Coastal Zone Jurisdiction	Yes
Urban Stormwater (MS4) Jurisdiction	No (some bordering areas, such as Saraland, Satsuma, Creola, and Daphne, are subject to urban stormwater regulation).
Municipal Jurisdictions	Mobile County and Baldwin County. Cities and towns bordering sub-area include Saraland, Satsuma, Creola, Mount Vernon, Spanish Fort, Daphne.
Public Water Supply	Mobile River above Barry Steam Plant is classified as Public Water Supply
Public Wastewater Sewerage	N.A.
Point Source Considerations	Several point sources, mostly industrial, are present along Mobile River – see discussion for “Bayou Sara, Cold Creek, Cedar Creek Watersheds”, otherwise, point sources are limited.
Non-Point Source Considerations	Distributaries of Mobile-Tensaw-Delta may be considerably influenced by upstream river input above MBNEP boundary; lower regions of sub-area subject to urban stormwater input; agricultural / silvicultural practices in local watersheds draining from both counties; silvicultural practices within the Delta.
Remarks	Shallow draft navigation along the Mobile River connects the Port of Mobile with the inland river navigation systems. Land transportation corridors transecting the Delta include highway (I-65) and railroad.

NORTH BALDWIN COUNTY WATERSHEDS	
Water Use Classifications	Fish & Wildlife (throughout)
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status NPS Impairment Assessment	None Assessed None Assessed
Uses/Activities	Watersheds of this sub-area are mostly rural (agricultural/silvicultural), excepting lower area of Spanish Fort and Daphne, which are commercial and residential, and experiencing continued development.
Coastal Zone Jurisdiction	Limited portions of sub-area are below 10-ft. contour.
Urban Stormwater (MS4) Jurisdiction	Limited to Daphne region.
Municipal Jurisdictions	Baldwin County, cities of Spanish Fort, Daphne, Bay Minette.
Public Water Supply	Stapleton, Stockton, Tensaw, Bay Minette, Daphne, Spanish Fort
Public Wastewater Sewerage	Public sewer service is available in urban areas and towns. Most of the sub-area is rural and utilizes septic tanks.
Point Source Considerations	Limited
Non-Point Source Considerations	Silvicultural practices in rural areas; urban runoff and construction practices in southern portion of sub-area (Spanish Fort, Daphne).
Remarks	



- ◆ National Priority List (NPL) Sites
- ☆ Permit Compliance System (PCS) Locations
- ▲ Industrial Facilities Discharge (IFD) Locations
- Toxic Release Inventory (TRI) 1992 Locations
- ▨ Eastern Shore Watersheds Sub-area
- ▨ Weeks Bay Watershed Sub-area
- ▨ Bon Secour River Watershed & Ft. Morgan Peninsula Sub-area



7 0 7 Miles

SCALE: ( 1 : 325,000)

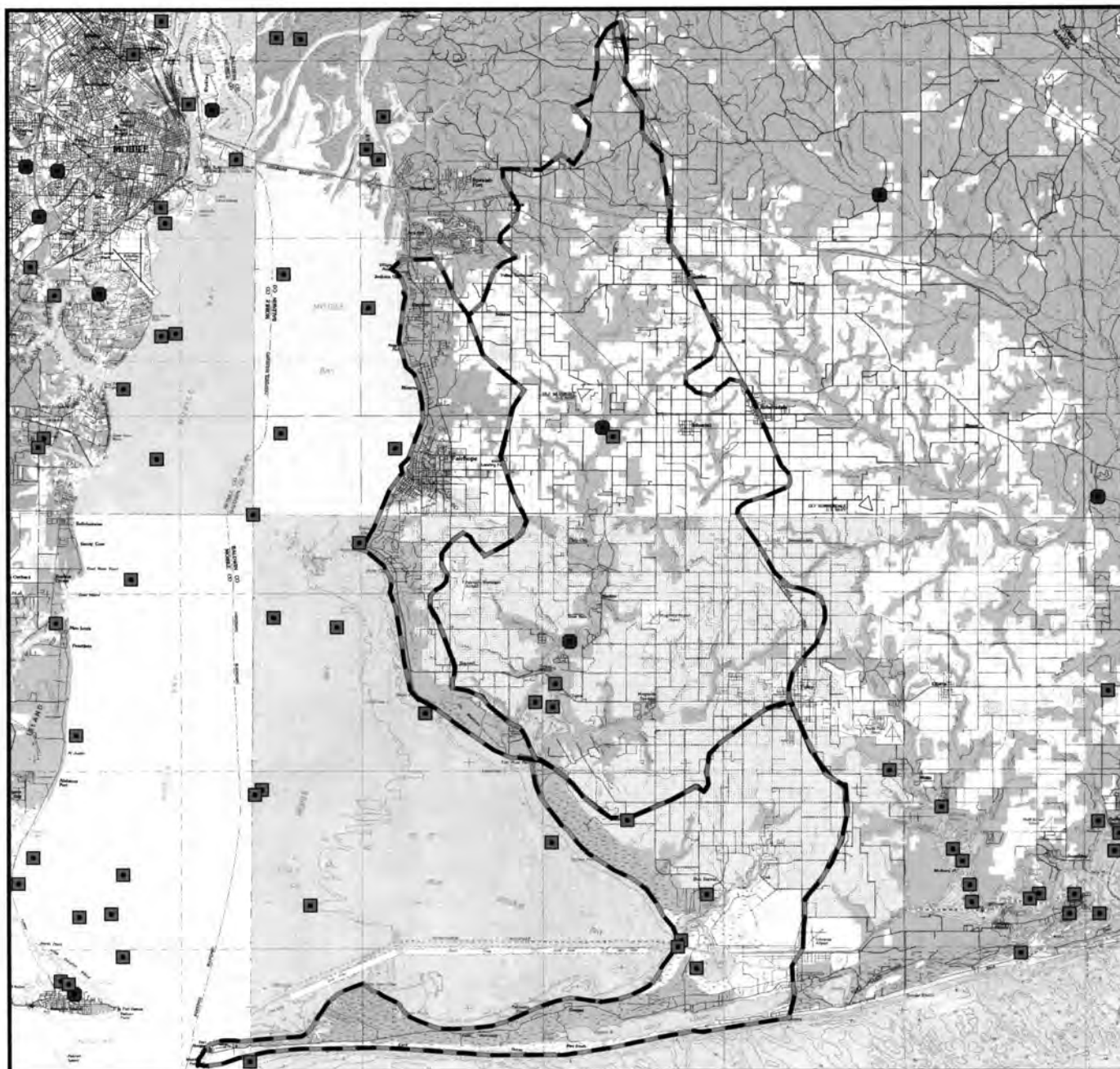


**Preliminary Characterization of Water  
Quality of the MBNEP Study Area**

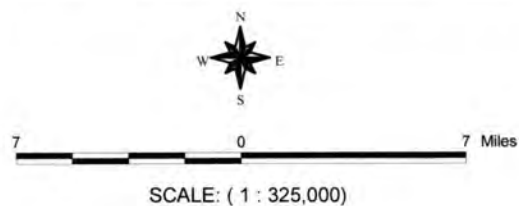
**Thompson Engineering** 

**TAI ENVIRONMENTAL  
SCIENCES, INC.** 

**Bon Secour River Watershed & Ft. Morgan Peninsula Sub-Area  
Weeks Bay Watershed Sub-area  
Eastern Shore Watershed Sub-area  
Showing Point Source Data Locations from  
EPA's BASINS GIS**



- National Sediment Inventory (NSI) Stations
- USGS Gage Stations
- Drinking Water Supply Locations
- ≡ Eastern Shore Watersheds Sub-area
- ≡ Weeks Bay Watershed Sub-area
- ≡ Bon Secour River Watershed & Ft. Morgan Peninsula Sub-area



**Preliminary Characterization of Water Quality of the MBNEP Study Area**

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**Bon Secour River Watershed & Ft. Morgan Peninsula Sub-Area  
 Weeks Bay Watershed Sub-area  
 Eastern Shore Watershed Sub-area  
 Showing Monitoring Data Locations from  
 EPA's BASINS GIS**

<b>EASTERN SHORE WATERSHEDS</b>	
Water Use Classifications	Fish & Wildlife (throughout); Swimming (see Figure 4-3)
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status NPS Impairment Assessment	None Assessed None Assessed
Uses/Activities	Predominant land use is residential and commercial. Bayside recreational opportunities are abundant, marina/dockage facilities are provided for mostly private vessels.
Coastal Zone Jurisdiction	Limited portions are below 10-ft. contour.
Urban Stormwater (MS4) Jurisdiction	Yes (Daphne, Fairhope, Baldwin County)
Municipal Jurisdictions	Baldwin County, cities of Daphne, Fairhope
Public Water Supply	Daphne, Fairhope
Public Wastewater Sewerage	Public sewer is provided in most of sub-area, but septic tanks are utilized in some portions.
Point Source Considerations	Limited
Non-Point Source Considerations	Urban stormwater runoff, construction / development practices
Remarks	The Eastern Shore has and continues to experience considerable development and growth.

<b>WEEKS BAY WATERSHED</b>	
Water Use Classifications	Fish and Wildlife (throughout); Swimming (see Figure 4-3); Weeks Bay has been given special designation of Outstanding National Resource Water.
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status NPS Impairment Assessment	Fish River – non (8 miles) due to pH (attributed to natural sources). Fish River (30 miles) impaired by pesticides, nutrients, organic enrichment / D.O., pathogens (attributed to urban runoff).
Uses/Activities	Recreation, Fisheries (Recreational), Habitat – Preserve, Research. Watershed is largely rural (agricultural) but is exhibiting increased development pressures for residential and commercial land use.
Coastal Zone Jurisdiction	Limited (areas bordering Weeks Bay, Fish River, and Magnolia River).
Urban Stormwater (MS4) Jurisdiction	Limited
Municipal Jurisdictions	Baldwin County; cities of Fairhope, Robertsedale, Loxley
Public Water Supply	Belforest, Fairhope, Foley, Loxley, Robertsedale, Silverhill.
Public Wastewater Sewerage	Public sewer is provided in developed areas, but septic tanks are largely utilized throughout watershed.
Point Source Considerations	Limited
Non-Point Source Considerations	Agricultural; runoff from commercial / suburban areas; construction / development; water-related recreational activities; unpaved roads, septic tanks.
Remarks	Weeks Bay is a National Estuarine Research Reserve. Additionally, a comprehensive cooperative study of the watershed is currently underway (The Weeks Bay Watershed Project) and a Draft Management Plan has been prepared.



<b>BON SECOUR RIVER WATERSHED AND FT. MORGAN PENINSULA</b>	
Water Use Classifications	Fish and Wildlife (throughout); Swimming and Shellfish harvesting (see Figure 4-3).
Use Impairment Identified (ADEM, 1996 305(b) report): Use Support Status  NPS Impairment Assessment	Gulf Intracoastal Waterway – non (4 miles) due to nutrients, organic enrichment / D.O. (attributed to surface runoff and natural) None Assessed.
Uses/Activities	Recreation, Fisheries (commercial and recreational), Navigation, Tourism, Habitat and Preserve. The Bon Secour River watershed is mostly rural (agricultural), with seafood landing and processing industries situated at Bon Secour. However, the upper portion of the watershed south of Foley along Hwy 59 has experienced considerable development and growth. The Little Lagoon and Ft. Morgan Peninsula areas west of Gulf Shores continue to exhibit development and growth, chiefly spurred by tourism and recreational activities.
Coastal Zone Jurisdiction	A substantial portion of this sub-area is within coastal zone (10-ft. contour) jurisdiction.
Urban Stormwater (MS4) Jurisdiction	No
Municipal Jurisdictions	Baldwin County; cities and towns of Bon Secour, Foley, Gulf Shores.
Public Water Supply	Foley, Gulf Shores
Public Wastewater Sewerage	Public Sewer provided in developed areas, but septic tanks are used in some portions of sub-area.
Point Source Considerations	Localized concerns may exist, such as municipal wastewater systems, seafood processing plants. Overall point source concerns appear limited.
Non-Point Source Considerations	Agricultural; construction / development; runoff from commercial / residential areas; septic tanks.
Remarks	

## **APPENDIX IV**

### **TABULATIONS OF NUMBERS OF INFORMATION RECORDS WHEN SEARCHED BY ISSUE CATEGORIES COMPARED TO TYPE OF DOCUMENT OR DATA SET, PARAMETER GROUPS, SPATIAL LOCATION DESIGNATION, AND TEMPORAL RANGE**

**Note:** The tabulated search results presented in these tables are intended only to display general statistics on the number of records within the Information Record Database, when queried by Issue Categories, parameter descriptors, spatial coverage and temporal limits. The reader should refer to the text for discussion and evaluation of the Information Record data sets. The search compilations were performed before completion of the full Information Record Database, and the numbers therefore represent approximations.

**Table IV-1. Information Record Database search results for the pathogens issue microbiological indicators parameter and pathogens parameter by document type (na = not applicable).**

<b>Issue or Parameter(s)</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>Issue: Pathogens</b>	<b>69</b>	<b>150</b>	<b>49</b>	<b>268</b>
<b>Parameter: Microbiological Indicators</b>	<b>na</b>	<b>127</b>	<b>36</b>	<b>163</b>
<b>Parameter: Pathogens</b>	<b>na</b>	<b>79</b>	<b>22</b>	<b>101</b>
<b>Parameter: Microbiological Indicators and Pathogens</b>	<b>na</b>	<b>53</b>	<b>20</b>	<b>73</b>

**Table IV-2. Information Record Database search results of pathogen issue by “Location on Map” and document type.**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	<b>49</b>	<b>21</b>	<b>25</b>	<b>95</b>
<b>Mobile County</b>	<b>1</b>	<b>6</b>	<b>3</b>	<b>10</b>
<b>Baldwin County</b>	<b>4</b>	<b>9</b>	<b>3</b>	<b>16</b>
<b>Mobile Bay</b>	<b>12</b>	<b>21</b>	<b>5</b>	<b>38</b>
<b>Delta</b>	<b>1</b>	<b>3</b>	<b>0</b>	<b>4</b>
<b>Dog River</b>	<b>2</b>	<b>10</b>	<b>0</b>	<b>12</b>
<b>Fowl River</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>Mississippi Sound</b>	<b>5</b>	<b>5</b>	<b>1</b>	<b>11</b>
<b>Bon Secour Bay</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>4</b>
<b>Weeks Bay</b>	<b>2</b>	<b>8</b>	<b>3</b>	<b>13</b>
<b>Offshore</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>3</b>

**Table IV-3. Information Record Database search results for the microbiological indicators parameter by “Location on Map” and document type (na = not applicable).**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	na	18	16	<b>34</b>
<b>Mobile County</b>	na	5	3	<b>8</b>
<b>Baldwin County</b>	na	6	3	<b>9</b>
<b>Mobile Bay</b>	na	16	4	<b>20</b>
<b>Delta</b>	na	2	0	<b>2</b>
<b>Dog River</b>	na	10	0	<b>10</b>
<b>Fowl River</b>	na	1	0	<b>1</b>
<b>Mississippi Sound</b>	na	3	1	<b>4</b>
<b>Bon Secour Bay</b>	na	2	0	<b>2</b>
<b>Weeks Bay</b>	na	5	3	<b>8</b>
<b>Offshore</b>	na	0	1	<b>1</b>

**Table IV-4. Database search results for the pathogens parameter by “Location on Map” and document type (na = not applicable).**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	na	15	12	<b>27</b>
<b>Mobile County</b>	na	2	3	<b>5</b>
<b>Baldwin County</b>	na	4	2	<b>6</b>
<b>Mobile Bay</b>	na	13	1	<b>14</b>
<b>Delta</b>	na	0	0	<b>0</b>
<b>Dog River</b>	na	7	0	<b>7</b>
<b>Fowl River</b>	na	0	0	<b>0</b>
<b>Mississippi Sound</b>	na	3	0	<b>3</b>
<b>Bon Secour Bay</b>	na	0	0	<b>0</b>
<b>Weeks Bay</b>	na	2	0	<b>2</b>
<b>Offshore</b>	na	2	0	<b>2</b>

**Table IV-5. Information Record Database search results for the pathogens issue (I = Path), microbiological indicators parameter (P = MI) and pathogens parameter (P = Path) by quad selection and document category. Document category is technical publication unless otherwise noted (DB = database / raw data and S = summary / review publication). The USGS quadrangle names for each of the MBNEP sub-areas are given as well as the number of records represented by each sub-area.**

<b>MBNEP Sub-Area</b>	<b>USGS Quadrangle Names</b>	<b>I = Path.</b>	<b>P = MI</b>	<b>P = Path.</b>
<b>“Offshore”</b>	Petis Bois Island, Petis Bois Pass, Fort Morgan NW, Fort Morgan, Saint Andrews Bay, Pine Beach, Gulf Shores Exte	<b>21</b>	<b>20</b>	<b>6</b>
<b>“Mississippi Sound and Dauphin Island”</b>	Kreole, Grand Bay SW, Grand Bay, Isles aux Herbes, Heron Bay	<b>28</b> DB = 4	<b>23</b> DB = 2	<b>11</b> DB = 1
<b>“Mobile Bay”</b>	Little Dauphin Island, Little, Point Clear, Bon Secour Bay, Bellefontaine, Point Clear, Hollingers Island, Daphne	<b>45</b> DB = 4	<b>40</b> DB = 2	<b>19</b> DB = 1
<b>“East Fowl River and Deer River Watersheds” and “Dog River Watershed”</b>	Coden, Bellefontaine, Theodore, Hollingers Island, Spring Hill, Saint Elmo	<b>42</b> DB = 5	<b>36</b> DB = 3	<b>21</b> DB = 2
<b>“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”</b>	Mobile, Chickasaw	<b>55</b> DB = 5	<b>46</b> DB = 2	<b>35</b> DB = 2
<b>“Mobile-Tensaw Delta”</b>	Bridgehead, Hurricane, The Basin, Stiggins Lake, Bilbo Island	<b>20</b> DB = 1	<b>18</b> DB = 1	<b>10</b>
<b>“Three-Mile Creek and Chickasaw Creek Watersheds”</b>	Kushla, Chunchula, Georgetown, Semmes, Citronelle West	<b>13</b> DB = 3	<b>10</b> DB = 1	<b>5</b>
<b>“Bayou Sara, Cold Creek and Cedar Creek Watersheds”</b>	Creola, Mount Vernon, Citronelle East, Sims Chapel, Calvert	<b>20</b>	<b>18</b>	<b>10</b>
<b>“North Baldwin County Watersheds”</b>	Tensaw, Blacksher, Vaughn, Perdido, Bay Minette North, Bay Minette South, Stapelton, Carlton, Chrysler, McCullough	<b>7</b> S = 1	<b>5</b>	<b>4</b>
<b>“Eastern Shore”</b>	Daphne, Point Clear	<b>22</b> DB = 2	<b>21</b> DB = 2	<b>9</b> DB = 1
<b>“Weeks Bay Watershed”</b>	Magnolia Springs, Silver Hill, Robertsedale, Foley	<b>40</b> DB = 6	<b>36</b> DB = 4	<b>25</b>
<b>“Bon Secour River Watershed and Ft. Morgan Peninsula”</b>	Bon Secour Bay, Gulf Shores	<b>39</b> DB = 4	<b>36</b> DB = 2	<b>19</b> DB = 1

**Table IV-6. Information Record Database search results for the pathogens issue, microbiological indicators parameter and pathogens parameter by sample matrix.**

<b>Sample Matrix</b>	<b>Issue: Pathogens</b>	<b>Parameter: Microbiological Indicators</b>	<b>Parameter: Pathogens</b>
Water	179	156	<b>88</b>
Water Only	41	39	<b>8</b>
Sediment	105	92	<b>66</b>
Sediment Only	1	2	<b>0</b>
Wastewater	51	45	<b>32</b>
Wastewater Only	4	4	<b>3</b>
Tissue (biological)	82	59	<b>49</b>
Tissue (biological) Only	7	0	<b>5</b>
Other	73	15	<b>14</b>
Other Only	3	1	<b>1</b>
Additional Matrix Searches			
Water + Sediment	102	90	<b>64</b>
Water + Wastewater	45	41	<b>27</b>
Water + Tissue (biological)	75	59	<b>44</b>
Water + Sediment + Tissue (biological)	53	44	<b>34</b>
Water + Sediment + Wastewater	29	27	<b>19</b>
Water + Wastewater + Tissue (biological)	25	23	<b>18</b>
Water + Sediment + Wastewater + Tissue (biological)	19	18	<b>15</b>
Sediment + Wastewater	29	27	<b>19</b>
Sediment + Tissue (biological)	53	44	<b>34</b>
Wastewater + Tissue (biological)	25	23	<b>18</b>

**Table IV-7. Information Record Database Information Database search results for the pathogens issue, microbiological indicators parameter and pathogens parameter by 5-year time intervals.**

Date Interval		No. of Documents		
From	To	Issue: Pathogens	Parameter: Microbiological Indicators	Parameter: Pathogens
1995	1998	42	30	13
1990	1994	57	37	29
1985	1989	41	33	22
1980	1984	42	31	22
1975	1979	52	44	33
1970	1974	37	31	18
1965	1969	18	16	8
1960	1964	13	9	6
1955	1959	7	5	4
1950	1954	11	8	4
1945	1949	12	8	4
1940	1944	8	5	4
1935	1939	6	3	2
1930	1934	6	3	2
1925	1929	6	3	2
1920	1924	6	3	2
1915	1919	5	2	1
1910	1914	3	0	0
1905	1909	3	0	0
1900	1904	3	0	0
1800's		3	0	0

**Table IV-8. Information Record Database search of the toxic chemicals issue for “Location-On-Map”, by document type.**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	39	19	14	<b>72</b>
<b>Mobile County</b>	3	16	3	<b>22</b>
<b>Baldwin County</b>	2	14	2	<b>18</b>
<b>Mobile Bay</b>	15	27	3	<b>45</b>
<b>Delta</b>	2	8	1	<b>11</b>
<b>Dog River</b>	1	10	0	<b>11</b>
<b>Fowl River</b>	0	0	0	<b>0</b>
<b>Mississippi Sound</b>	6	5	0	<b>11</b>
<b>Bon Secour Bay</b>	1	1	0	<b>2</b>
<b>Weeks Bay</b>	3	5	2	<b>10</b>
<b>Offshore</b>	2	3	0	<b>5</b>



**Table IV.9. Information Record Database search results of the toxic chemicals issue for “Quad Selection”, by document type.**

<b>MBNEP Sub-Area</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
“Offshore”	1	12	0	<b>13</b>
“Mississippi Sound and Dauphin Island”	1	16	0	<b>17</b>
“Mobile Bay”	2	34	0	<b>36</b>
“East Fowl River and Deer River Watersheds” and “Dog River Watershed”	2	29	0	<b>31</b>
“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”	2	63	0	<b>65</b>
“Mobile-Tensaw Delta”	1	31	2	<b>34</b>
“Three-Mile Creek and Chickasaw Cree Watersheds”	0	8	0	<b>8</b>
“Bayou Sara, Cold Creek and Cedar Creek Watersheds”	0	14	2	<b>16</b>
“North Baldwin County Watersheds”	1	5	0	<b>6</b>
“Eastern Shore”	1	17	0	<b>18</b>
“Weeks Bay Watershed”	0	29	0	<b>29</b>
“Bon Secour River Watershed and Ft. Morgan Peninsula”	1	21	0	<b>22</b>

**Table IV-10. Information Record Database search results for parameter groupings: “Toxic Metals”, “Pesticides/PCBs/Herbicides”, “Trace Organics”, and “Bioassay/Toxicity”, by “Location-On-Map”.**

<b>Location on Map</b>	<b>P = Toxic Metals</b>	<b>P = Pesticides/ PCBs/ Herbicides</b>	<b>P = Trace Organics</b>	<b>P = Bioassay/ Toxicity</b>
<b>NEP Area</b>	30	18	12	26
<b>Mobile County</b>	19	5	6	15
<b>Baldwin County</b>	16	7	3	11
<b>Mobile Bay</b>	32	16	13	33
<b>Delta</b>	6	3	1	6
<b>Dog River</b>	13	6	0	3
<b>Fowl River</b>	1	0	0	1
<b>Mississippi Sound</b>	6	3	2	4
<b>Bon Secour Bay</b>	0	0	0	0
<b>Weeks Bay</b>	3	2	0	3
<b>Offshore</b>	6	2	2	3

**Table IV-11. Information Record Database search results for parameter groupings: “Toxic Metals”, “Pesticides/PCBs/Herbicides”, “Trace Organics”, and “Bioassay/Toxicity”, by “Quad Selection”.**

<b>MBNEP Sub-Area</b>	<b>P = Toxic Metals</b>	<b>P = Pesticides/ PCBs/ Herbicides</b>	<b>P = Trace Organics</b>	<b>P = Bioassay/ Toxicity</b>
“Offshore”	17	0	2	12
“Mississippi Sound and Dauphin Island”	18	11	5	15
“Mobile Bay”	14	15	10	30
“East Fowl River and Deer River Watersheds” and “Dog River Watershed”	34	17	8	26
“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”	46	15	8	25
“Mobile-Tensaw Delta”	22	9	4	18
“Three-Mile Creek and Chickasaw Cree Watersheds”	8	4	1	7
“Bayou Sara, Cold Creek and Cedar Creek Watersheds”	17	6	1	12
“North Baldwin County Watersheds”	4	2	0	2
“Eastern Shore”	21	11	6	18
“Weeks Bay Watershed”	34	10	4	10
“Bon Secour River Watershed and Ft. Morgan Peninsula”	26	6	3	13

**Table IV-12. Database search results of Nutrient Overloading Issue by “Location on Map” and document type.**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	34	18	13	<b>45</b>
<b>Mobile County</b>	0	15	5	<b>20</b>
<b>Baldwin County</b>	2	20	4	<b>26</b>
<b>Mobile Bay</b>	12	30	3	<b>45</b>
<b>Delta</b>	2	3	0	<b>5</b>
<b>Dog River</b>	2	11	0	<b>13</b>
<b>Fowl River</b>	0	1	0	<b>1</b>
<b>Mississippi Sound</b>	5	6	0	<b>11</b>
<b>Bon Secour Bay</b>	1	1	0	<b>2</b>
<b>Weeks Bay</b>	1	12	7	<b>20</b>
<b>Offshore</b>	3	5	0	<b>8</b>

**Table IV-13. Database search results for the nutrient overloading issue (I = Nutr.), nutrient overloading parameter (P = Nutr.) and organic contamination parameter (P = Org.) by quad selection. The USGS quadrangle names for each of the MBNEP sub-areas are given as well as the number of records represented by each sub-area.**

<b>MBNEP Sub-Area</b>	<b>USGS Quadrangle Names</b>	<b>I = Nutr.</b>	<b>P = Nutr.</b>	<b>P = Org.</b>
<b>“Offshore”</b>	Petis Bois Island, Petis Bois Pass, Fort Morgan NW, Fort Morgan, Saint Andrews Bay, Pine Beach, Gulf Shores Exte	<b>28</b>	<b>17</b>	<b>17</b>
<b>“Mississippi Sound and Dauphin Island”</b>	Kreole, Grand Bay SW, Grand Bay, Isles aux Herbes, Heron Bay	<b>25</b>	<b>18</b>	<b>20</b>
<b>“Mobile Bay”</b>	Little Dauphin Island, Little, Point Clear, Bon Secour Bay, Bellefontaine, Point Clear, Hollingers Island, Daphne	<b>47</b>	<b>36</b>	<b>39</b>
<b>“East Fowl River and Deer River Watersheds” and “Dog River Watershed”</b>	Coden, Bellefontaine, Theodore, Hollingers Island, Spring Hill, Saint Elmo	<b>36</b>	<b>29</b>	<b>31</b>
<b>“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”</b>	Mobile, Chickasaw	<b>43</b>	<b>39</b>	<b>41</b>
<b>“Mobile-Tensaw Delta”</b>	Bridgehead, Hurricane, The Basin, Stiggins Lake, Bilbo Island	<b>23</b>	<b>19</b>	<b>21</b>
<b>“Three-Mile Creek and Chickasaw Creek Watersheds”</b>	Kushla, Chunchula, Georgetown, Semmes, Citronelle West	<b>14</b>	<b>9</b>	<b>11</b>
<b>“Bayou Sara, Cold Creek and Cedar Creek Watersheds”</b>	Creola, Mount Vernon, Citronelle East, Sims Chapel, Calvert	<b>18</b>	<b>14</b>	<b>16</b>
<b>“North Baldwin County Watersheds”</b>	Tensaw, Blacksher, Vaughn, Perdido, Bay Minette North, Bay Minette South, Stapelton, Carlton, Chrysler, McCullough	<b>9</b>	<b>7</b>	<b>7</b>
<b>“Eastern Shore”</b>	Daphne, Point Clear	<b>28</b>	<b>28</b>	<b>20</b>
<b>“Weeks Bay Watershed”</b>	Magnolia Springs, Silver Hill, Robertsdale, Foley	<b>44</b>	<b>38</b>	<b>38</b>
<b>“Bon Secour River Watershed and Ft. Morgan Peninsula”</b>	Bon Secour Bay, Gulf Shores	<b>41</b>	<b>29</b>	<b>31</b>

**Table IV-14. Database search results for the nutrient overloading issue, nutrient parameter and organic contamination parameter by document type (na = not applicable).**

<b>Issue or Parameter(s)</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>Issue: Nutrient Overloading</b>	49	194	45	<b>288</b>
<b>Parameter: Nutrient</b>	na	116	34	<b>149</b>
<b>Parameter: Organic Contamination</b>	1	31	17	<b>49</b>

**Table IV-15. Temporal distribution of data within documents related to the nutrient overloading issue from the MBNEP Database.**

<b>Date Interval</b>		<b>Issue: Nutrients</b>
<b>From</b>	<b>To</b>	<b>Number of Documents</b>
1995	1998	42
1990	1994	57
1985	1989	46
1980	1984	52
1975	1979	65
1970	1974	35
1960	1969	26
1920	1959	16
1900	1919	2
1800's		0

**Table IV-16. Information Record database search results for the physical and/or hydrologic modification issue, hydrodynamic parameter, and meteorological parameter by document type.**

<b>Issue or Parameter(s)</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>Issue: Physical and/or Hydrologic Modification</b>	94	334	41	<b>469</b>
<b>Parameter: Hydrodynamic</b>	N.A.	239	35	<b>275</b>
<b>Parameter: Meteorological</b>	N.A.	112	11	<b>124</b>

**Table IV-17. Information Record Database search results of physical and/or hydrologic modification issue by “Location on Map” and document type.**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	53	40	9	<b>102</b>
<b>Mobile County</b>	0	16	4	<b>20</b>
<b>Baldwin County</b>	1	22	8	<b>31</b>
<b>Mobile Bay</b>	25	77	7	<b>109</b>
<b>Delta</b>	6	15	0	<b>21</b>
<b>Dog River</b>	3	13	0	<b>16</b>
<b>Fowl River</b>	2	4	0	<b>6</b>
<b>Mississippi Sound</b>	9	21	3	<b>33</b>
<b>Bon Secour Bay</b>	3	4	0	<b>7</b>
<b>Weeks Bay</b>	4	13	5	<b>22</b>
<b>Offshore</b>	2	12	1	<b>15</b>

**Table IV-18. Information Record Database search results of physical and/or hydrologic modification issue by “quad selection” and document type.**

MBNEP Sub-Area	Summary or Review Publication	Technical Publication	Data System/ Model/ Database	Total
“Offshore”	1	35	1	37
“Mississippi Sound and Dauphin Island”	2	25	1	28
“Mobile Bay”	2	62	3	67
“East Fowl River and Deer River Watersheds” and “Dog River Watershed”	3	33	2	38
“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”	0	27	2	29
“Mobile-Tensaw Delta”	0	18	1	19
“Three-Mile Creek and Chickasaw Creek Watersheds”	0	7	0	7
“Bayou Sara, Cold Creek and Cedar Creek Watersheds”	0	11	1	12
“North Baldwin County Watersheds”	0	7	0	7
“Eastern Shore”	1	29	3	33
“Weeks Bay Watershed”	0	20	1	21
“Bon Secour River Watershed and Ft. Morgan Peninsula”	1	20	1	22

**Table IV-19. Information Record Database search results for the Hydrodynamic parameter and Meteorological parameter, by Location-on-Map.**

Location on Map	P = Hydrodynamic	P = Meteorological
NEP Area	39	19
Mobile County	17	11
Baldwin County	26	15
Mobile Bay	67	23
Delta	9	3
Dog River	11	0
Fowl River	3	1
Mississippi Sound	20	10
Bon Secour Bay	2	0
Weeks Bay	8	8
Offshore	12	6



**Table IV-20. Information Record Database search results for the Hydrodynamic parameter and the Meteorological parameter, by Quad Selection.**

MBNEP Sub-Area	USGS Quadrangle Names	P = Hydro- dynamic	P = Meteor- ological
“Offshore”	Petis Bois Island, Petis Bois Pass, Fort Morgan NW, Fort Morgan, Saint Andrews Bay, Pine Beach, Gulf Shores Extend	24	11
“Mississippi Sound and Dauphin Island”	Kreole, Grand Bay SW, Grand Bay, Isles aux Herbes, Heron Bay	19	8
“Mobile Bay”	Little Dauphin Island, Little, Point Clear, Bon Secour Bay, Bellefontaine, Point Clear, Hollingers Island, Daphne	37	19
“East Fowl River and Deer River Watersheds” and “Dog River Watershed”	Coden, Bellefontaine, Theodore, Hollingers Island, Spring Hill, Saint Elmo	19	13
“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”	Mobile, Chickasaw	13	10
“Mobile-Tensaw Delta”	Bridgehead, Hurricane, The Basin, Stiggins Lake, Bilbo Island	10	7
“Three-Mile Creek and Chickasaw Cree Watersheds”	Kushla, Chunchula, Georgetown, Semmes, Citronelle West	6	5
“Bayou Sara, Cold Cree and Cedar Creek Watersheds”	Creola, Mount Vernon, Citronelle East, Sims Chapel, Calvert	6	6
“North Baldwin County Watersheds”	Tensaw, Blacksher, Vaughn, Perdido, Bay Minette North, Bay Minette South, Stapelton, Carlton, Chrysler, McCullough	6	4
“Eastern Shore”	Daphne, Point Clear	19	10
“Weeks Bay Watershed”	Magnolia Springs, Silver Hill, Robertsdale, Foley	11	8
“Bon Secour River Watershed and Ft. Morgan Peninsula”	Bon Secour Bay, Gulf Shores	11	8

**Table IV.21. Information Record Database search results for the Physical and Hydrological Modification issue, Hydrodynamic parameter, and Meteorological parameter by 5-year time intervals.**

Date Interval		No. of Documents		
From	To	Issue: Physical and/or Hydrologic Modification	Parameter: Hydrodynamic	Parameter: Meteorological
1995	1998	37	20	12
1990	1994	63	36	23
1985	1989	63	0	23
1980	1984	84	57	22
1975	1979	104	67	38
1970	1974	86	54	20
1965	1969	59	41	16
1960	1964	43	33	14
1955	1959	31	24	12
1950	1954	28	23	13
1945	1949	24	19	8
1940	1944	26	19	7
1935	1939	19	12	7
1930	1934	19	12	7
1925	1929	18	11	7
1920	1924	15	9	6
1915	1919	13	8	6
1910	1914	11	5	4
1905	1909	9	5	4
1900	1904	10	5	4
1800's		7	3	3

**Table IV-22. Database search results of Erosion and Sedimentation Issue by “Location on Map” and document type.**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	40	24	8	<b>72</b>
<b>Mobile County</b>	0	14	2	<b>16</b>
<b>Baldwin County</b>	0	15	2	<b>17</b>
<b>Mobile Bay</b>	12	48	0	<b>60</b>
<b>Delta</b>	2	10	0	<b>12</b>
<b>Dog River</b>	2	9	0	<b>11</b>
<b>Fowl River</b>	0	0	0	<b>0</b>
<b>Mississippi Sound</b>	5	9	0	<b>14</b>
<b>Bon Secour Bay</b>	1	3	0	<b>4</b>
<b>Weeks Bay</b>	2	10	0	<b>12</b>
<b>Offshore</b>	2	8	0	<b>10</b>

**Table IV-23. Database search results for the Erosion and Sedimentation Issue (I =Erosion and Sedimentation), were evaluated by type of IDR's and MBNEP Sub-Area. The USGS quadrangle names for each of the MBNEP sub-areas are given as well as the number of records represented by each Sub-Area.**

MBNEP Sub-Area	USGS Quadrangle Names	Summary or Review Publication	Technical Publication	Data System/ Model/ Database	Total
"Offshore"	Petis Bois Island, Petis Bois Pass, Fort Morgan NW, Fort Morgan, Saint Andrews Bay, Pine Beach, Gulf Shores Extend	0	17	0	17
"Mississippi Sound and Dauphin Island"	Kreole, Grand Bay SW, Grand Bay, Isles aux Herbes, Heron Bay	0	13	0	13
"Mobile Bay"	Little Dauphin Island, Little, Point Clear, Bon Secour Bay Bellefontaine, Point Clear, Hollingers Island, Daphne	0	28	3	31
"East Fowl River and Deer River Watersheds" and "Dog River Watershed"	Coden, Bellefontaine, Theodore, Hollingers Island, Spring Hill, Saint Elmo	0	17	2	19
"Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek"	Mobile, Chickasa	1	14	1	16
"Mobile-Tensaw Delta"	Bridgehead, Hurricane, The Basin, Stiggins Lake, Bilbo Island	0	10	0	10
"Three-Mile Creek and Chickasaw Creek Watersheds"	Kushla, Chunchula, Georgetown, Semmes, Citronelle West	0	4	0	4
"Bayou Sara, Cold Creek and Cedar Creek Watersheds"	Creola, Mount Vernon, Citronelle East, Sims Chapel, Calvert	0	5	0	5
"North Baldwin County Watersheds"	Tensaw, Blacksher, Vaughn, Perdido, Bay Minette North, Bay Minette South, Stapelton, Carlton, Chrysler, McCullough	0	2	0	2
"Eastern Shore"	Daphne, Point Clear	0	15	3	18
"Weeks Bay Watershed"	Magnolia Springs, Silver Hill, Robertsedale, Fole	0	3	0	3
"Bon Secour River Watershed and Ft. Morgan Peninsul	Bon Secour Bay, Gulf Shores	0	13	0	13

**Table IV-24. Temporal distribution of documents from the MBNEP Database of the Erosion and Sedimentation Issue and the parameter groups identified with these Information Records.**

Date Interval		No. of Documents			
From	To	Issue: Erosion and Sedimentation	Parameter: Routine Physio-Chemical	Parameter Sedimentological	Parameter: Nutrients and Oxygen Demand
1995	1998	18	9	14	9
1990	1994	40	22	26	19
1985	1989	34	20	22	17
1980	1984	40	24	26	19
1975	1979	55	38	46	31
1970	1974	40	25	28	18
1965	1969	27	16	22	14
1960	1964	18	9	13	8
1955	1959	14	7	9	6
1950	1954	10	6	6	5
1945	1949	9	5	4	4
1940	1944	9	5	4	4
1935	1939	9	5	4	4
1930	1934	9	5	4	4
1925	1929	8	4	3	3
1920	1924	8	4	3	3
1915	1919	8	3	4	2
1910	1914	5	1	1	0
1905	1909	5	1	1	0
1900	1904	6	1	1	0
1800's		8	1	3	0

**Table IV-25. Types of Information Records in the Erosion and Sedimentation Issue and selected related parameters.**

<b>Issue or Parameter(s)</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>Issue: Erosion and Sedimentation</b>	61	182	15	<b>258</b>
<b>Parameter: Routine Physio-Chemical</b>	0	109	12	<b>121</b>
<b>Parameter: Sedimentological</b>	0	154	13	<b>167</b>
<b>Parameter: Nutrients and Oxygen Demand</b>	0	88	10	<b>98</b>

**Table IV-26. Location on map and selected parameters for the Erosion and Sedimentation Issue Information Records.**

<b>Location on Map</b>	<b>I = Erosion and Sedimentation</b>	<b>P = Routine Physio-Chemical</b>	<b>P = Sedimentological</b>	<b>P = Nutrients and Oxygen Demand</b>
<b>NEP Area</b>	72	27	28	20
<b>Mobile County</b>	16	8	14	9
<b>Baldwin County</b>	17	10	15	11
<b>Mobile Bay</b>	60	19	44	12
<b>Delta</b>	12	2	9	1
<b>Dog River</b>	11	9	8	8
<b>Fowl River</b>	0	0	0	0
<b>Mississippi Sound</b>	14	6	7	4
<b>Bon Secour Bay</b>	4	1	2	1
<b>Weeks Bay</b>	12	2	5	2
<b>Offshore</b>	10	2	7	1

Table IV-27. MBNEP Sub-Area and selected parameters for the Erosion and Sedimentation Issue Information Records

MBNEP Sub-Area	USGS Quadrangle Names	P = Nutrients and Oxygen Demand	P= Routine Physio- Chemical	P= Sediment- ological
“Offshore”	Petis Bois Island, Petis Bois Pass, Fort Morgan NW, Fort Morgan, Saint Andrews Bay, Pine Beach, Gulf Shores Exte	7	8	11
“Mississippi Sound and Dauphin Island”	Kreole, Grand Bay SW, Grand Bay, Isles aux Herbes, Heron Bay	5	9	9
“Mobile Bay”	Little Dauphin Island, Little, Point Clear, Bon Secour Bay, Bellefontaine, Point Clear, Hollingers Island, Daphne	12	20	24
“East Fowl River and Deer River Watersheds” and “Dog River Watershed”	Coden, Bellefontaine, Theodore, Hollingers Island, Spring Hill, Saint Elmo	10	16	17
“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”	Mobile, Chickasaw	6	12	13
“Mobile-Tensaw Delta”	Bridgehead, Hurricane, The Basin, Stiggins Lake, Bilbo Island	3	7	9
“Three-Mile Creek and Chickasaw Cree Watersheds”	Kushla, Chunchula, Georgetown, Semmes, Citronelle West	3	3	3
“Bayou Sara, Cold Creek and Cedar Creek Watersheds”	Creola, Mount Vernon, Citronelle East, Sims Chapel, Calvert	2	4	4
“North Baldwin County Watersheds”	Tensaw, Blacksher, Vaughn, Perdido, Bay Minette North, Bay Minette South, Stapelton, Carlton, Chrysler, McCullough	1	1	1
“Eastern Shore”	Daphne, Point Clear	6	10	12
“Weeks Bay Watershed”	Magnolia Springs, Silver Hill, Robertsdale, Foley	2	2	2
“Bon Secour River Watershed and Ft. Morgan Peninsula”	Bon Secour Bay, Gulf Shores	4	5	6

**Table IV-28. Database search results of groundwater topic by “Location on Map” and document type.**

<b>Location on Map</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System/ Model/ Database</b>	<b>Total</b>
<b>NEP Area</b>	8	10	5	<b>23</b>
<b>Mobile County</b>	1	15	8	<b>24</b>
<b>Baldwin County</b>	3	16	9	<b>28</b>
<b>Mobile Bay</b>	0	3	0	<b>3</b>
<b>Delta</b>	0	2	0	<b>2</b>
<b>Dog River</b>	0	11	0	<b>11</b>
<b>Fowl River</b>	0	1	0	<b>1</b>
<b>Mississippi Sound</b>	0	1	0	<b>1</b>
<b>Bon Secour Bay</b>	0	0	0	<b>0</b>
<b>Weeks Bay</b>	1	0	0	<b>1</b>
<b>Offshore</b>	0	1	0	<b>1</b>



**Table IV.29. Database search results of groundwater topic by “quad selection” and document type.**

<b>MBNEP Sub-Area</b>	<b>Summary or Review Publication</b>	<b>Technical Publication</b>	<b>Data System Or Model</b>	<b>Database or Raw Data</b>	<b>Total</b>
<b>“Offshore”</b>	0	8	0	0	<b>8</b>
<b>“Mississippi Sound and Dauphin Island”</b>	0	7	0	0	<b>7</b>
<b>“Mobile Bay”</b>	0	13	0	0	<b>13</b>
<b>“East Fowl River and Deer River Watersheds” and “Dog River Watershed”</b>	0	36	0	3	<b>39</b>
<b>“Lower Mobile River (Mobile Harbor), including Lower Chickasaw Creek and Lower Three Mile Creek”</b>	0	31	0	1	<b>32</b>
<b>“Mobile-Tensaw Delta”</b>	0	7	0	0	<b>7</b>
<b>“Three-Mile Creek and Chickasaw Creek Watersheds”</b>	0	6	0	0	<b>6</b>
<b>“Bayou Sara, Cold Creek and Cedar Creek Watersheds”</b>	0	14	0	0	<b>14</b>
<b>“North Baldwin County Watersheds”</b>	1	6	0	0	<b>7</b>
<b>“Eastern Shore”</b>	0	7	0	0	<b>7</b>
<b>“Weeks Bay Watershed”</b>	0	28	0	0	<b>28</b>
<b>“Bon Secour River Watershed and Ft. Morgan Peninsula”</b>	0	18	0	0	<b>18</b>

**Table IV-30. Temporal distribution of groundwater documents from the MBNEP Information Record Database.**

Date Interval		Issue: Groundwater
From	To	Number of Documents
1995	1998	17
1990	1994	23
1985	1989	29
1980	1984	36
1975	1979	36
1970	1974	20
1960	1969	13
1920	1959	37
1900	1919	4
1800's		1

**APPENDIX V**

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