ADEM
TECHNICAL REPORT

A SURVEY OF THE CHICKASAW CREEK WATERSHED

An Overview of Land-Use Practices and Examination of the Effects of Development on the Aquatic Resources of the Basin

Coastal Programs
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ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
1751 CONG. W. L. DICKINSON DRIVE • MONTGOMERY, AL 36130

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AUGUST, 1997

Prepared by:

Alabama Department of Environmental Management
Mobile Branch
2204 Perimeter Road
Mobile, Alabama 36615

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EXECUTIVE SUMMARY

The Chickasaw Creek Watershed, a basin of many and diverse land uses including heavy industrial development, urban residential centers, densely populated suburban communities and rural areas, was surveyed for characterization of the land-use practices, soil types, topography, wildlife habitat and biological resources of the watershed. Some of the impacts of land development, industry, construction activities and non-point sources on water quality, aquatic habitats and biological resources are described. Although the basin possesses a considerable amount of industrial development, the effects of storm water runoff and other non-point sources were observed to have more significant impacts on the aquatic habitats of the basin. The impacts were typical of non-point related problems, i.e. turbidity and siltation from erosion, trash and debris from urban storm water runoff, and enteric bacteria contamination.

INTRODUCTION

The economic development and growth of the Alabama coastal zone during the past decade has been characterized by the transformation of woodlands and pasture into subdivisions, condominiums, shopping centers and boat marinas. Recent years have witnessed a significant population increase imposing the pressures of urban development on waterbodies which, until recently, have been somewhat removed from the direct consequences of high population density and large expanses of commercial development.

The more conspicuous effects of "urbanization" on our aquatic resources include, but are not limited to: trash and litter washed from parking lots and streets by storm runoff, loss of natural shoreline due to bulkhead and fill development, sewage and pathogenic bacteria from aging and/or overloaded sanitary systems and sediments contaminated by urban run-off tainted with oil, pesticides and chemical residue. But perhaps the more serious and widespread of these consequences have been decreased water clarity, increased rates of stream siltation and losses of aquatic habitat caused by erosion from land disturbance activities. (Alabama Department of Environmental Management 1989, 1994 and 1995; National Research Council 1990; U.S. Environmental Protection Agency 1991 and 1992, U.S. Fish and Wildlife Service 1990).

Over the last quarter century significant progress has been achieved in the prevention and reversal of water quality degradation both in the state of Alabama and across the United States. The majority of this improvement has been realized through increasingly stringent standards imposed on industrial and municipal point source discharges. Although these measures have been effective in controlling the waste water discharged from industrial facilities and municipal sanitary treatment plants, the National Pollutant Discharge Elimination System (NPDES) program which provided the regulatory mechanism for this has, until the 1980's, failed to address the impacts from land-clearing operations, urban runoff and other non-point sources (U.S. Environmental Protection Agency 1991).

Increased occurrence and severity of these problems have resulted in a need for updated programs for monitoring surface waters. Furthermore, the losses of aquatic habitats and impairment of water quality have necessitated that erosion from cleared land, runoff of urban stormwater and other non-point sources of pollution be effectively controlled, especially in areas experiencing intensive real estate development (National Research Council 1990; U.S. Fish and Wildlife Service 1990).

In the pursuit of more effectual protection of the state's aquatic resources, the Alabama Department of Environmental Management (ADEM) has established a multi-year agenda of watershed surveys as a component of the Department's "Water Quality and Natural Resource Monitoring Strategy for Coastal Alabama" (Alabama Department of Environmental Management 1993). The initial guidance for the development of a methodology for watershed surveys was provided by the watershed protection approach (WPA) instituted by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency 1991 and 1992).

Monitoring and management of aquatic systems traditionally has been approached from the perspective of studying the characteristics of a waterbody and the influences of municipal and industrial development immediately proximate to the waters of interest. The majority of monitoring programs fall into three basic categories: short-term intensive surveys, monitoring of emergency episodes and long-term and routine monitoring of fixed stations (trends tracking) (National Research Council 1990).

Customarily, stream and lake surveys have focused on specific point source discharges and their receiving waters for the purpose of lessening the environmental effects of wastewater effluents (i.e., waste-load allocation studies). Although this concept has been beneficial in achieving the improvements in water quality realized over the past quarter century it does not always account for the impacts of urban development and construction. Short-term monitoring related to episodic events (i.e., oil spills, raw sewage discharges and chemical releases) has provided valuable information on acute effects of certain pollutants but has not allowed study of more subtle long-term changes (Alabama Department of Environmental Management 1993; National Research Council 1990; U.S. Environmental Protection Agency 1991 and 1992).

The strategy of regularly and periodically monitoring a network of fixed stations has been valuable for tracking long-term trends in water quality. However, routine trends monitoring is not, as a rule, designed for sampling in conjunction with storm events. Indeed, routine monitoring trips often are conducted on days of fair weather as would be the choice of most field personnel! Therefore, trends monitoring frequently fails to detect the ephemeral but significant changes in water quality that are the result of stormwater runoff from urban areas. Environmental agencies also have a tendency to conduct trends monitoring primarily for evaluating waters with regard to wastewater discharges. Consequently, short term and/or localized but serious degradation to surface water quality from non-point sources has been overlooked, if not altogether ignored. (National Research Council 1990; U.S. Environmental Protection Agency 1991).

The WPA however, emphasizes a multi-discipline approach for more effective protection of aquatic resources. This strategy includes, but is not limited to, the incorporation of land-use information, census data and municipal development plans. The WPA also makes use of a wider scope of field investigations which includes; examination of impairments to recreational uses of water and their potential as risks to human health, investigation of stormwater runoff, analyses of sediment chemistry, assessment of aquatic habitats and evaluation of shoreline alterations, the extent of stream channelization and similar modifications of waterways. Field surveys also should take into account the effects of natural forces such as storms, climatological extremes, topography and soil characteristics which have the potential for significantly influencing water quality (National Research Council 1990; U.S. Environmental Protection Agency 1991).

The WPA also emphasizes involvement of local government, businesses and, most importantly, the citizens of the watershed. Regulation by a municipal or county agency often is viewed more favorably by local residents than control at the state or federal level. Education of the business community, local officials and citizens as to the property damage (both public and private) caused by uncontrolled stormwater runoff provides a better appreciation on both sides as to the need for control of erosion and urban runoff. Finally, the results of the study should be developed into a plan for remediating existing degradation, reducing the sources of contamination and avoiding additional deterioration from future development (U.S. Environmental Protection Agency 1991; U.S. Fish and Wildlife Service 1991).

A demonstration study of the Dog River Watershed (DRW) in Mobile County was conducted in 1993 through 1995 by the ADEM Mobile Field Branch. This was followed by a survey of the Bon Secour River Watershed in 1995. Findings and recommendations of these surveys, along with the methodology utilized for stream surveillance, field investigations and sampling are detailed in published reports (ADEM 1994, 1995 and 1996). Experience obtained from the surveys of the Dog River and Bon Secour River Watersheds has allowed ADEM to refine the basic WPA strategy and develop an approach pertinent to the drainage basins in the coastal plains of Alabama.

Valuable lessons learned from the previous studies include:

- Erosion from land clearing operations, construction sites, excavation, and road fill were the most significant contributors to water quality degradation (turbidity) and losses of aquatic habitat (siltation).
- Trash and litter washed from parking lots and city streets create extremely unappealing esthetics and constitute a potentially severe marine debris problem.
- Surveys of land characteristics such as topography and soil types provide valuable information regarding the severity of some problems; especially those related to erosion and siltation.
- Monitor water quality under a wide variety of conditions paying special attention to sampling storm runoff.
- Urban non-point sources have the potential to enrich sediments with heavy metals to a degree equal to, if not greater than, industrial wastewater discharges.
- Species composition and diversity of biological communities is adversely affected by non-point pollution, sometimes to a level as severe as those impacts observed near wastewater effluent outfalls.

Also realized through the study of the Dog River and Bon Secour River Watersheds is the importance of public information and involvement. Release of the study reports generated considerable public interest in the control of non-point sources and has led to the formation of a citizens' action group. Members of this group have been actively conferring with local, state and federal officials importuning a more protective approach towards local streams and the effects of development. Citizens' interaction with developers and local officials show substantial promise for improving the control of non-point source pollution.

The response by the residents of the basin has illustrated another benefit of the watershed protection approach not realized by traditional water quality studies. The WPA reduces some environmental issues to a "lowest common denominator" for many citizens. Explanation of the causes and effects attributable to various nearby everyday activities fostering the degradation of "the stream running through my neighborhood" often better communicates to the average person the significance of the effects of development than would a study performed on an industrialized stretch of river 30 miles away.

PHYSICAL CHARACTERISTICS OF THE WATERSHED

GENERAL DESCRIPTION

The staff of the Alabama Department of Environmental Management Coastal Program selected the drainage basin of Chickasaw Creek as the watershed for building on the experience gained from the surveys of the Dog River and Bon Secour River Watersheds. Located in Mobile County (Figure 1), Chickasaw Creek is a tidally influenced stream approximately 32 miles in length. The Chickasaw Creek Watershed (CCW) encompasses an area of approximately 250 square miles and receives drainage from one major sub-basin, Eight Mile Creek, and an abundance of small tributaries. There are four small embayments, Black Bayou, Shell Bayou, Greenwood Bayou and Hog Bayou which also drain to the watershed. Most of the streams are shallow and limited to navigation by canoes and jonboats although the lower reaches of Chickasaw Creek are navigable by barge tows and small ocean going vessels.

The watershed includes a broad spectrum of development and land-use. Industrial facilities, heavy commercial operations and high density residential construction characterize the urban areas in the southeastern "corner" of the basin. The south central and southwestern portions of the CCW are suburban communities comprised mostly of residential subdivisions mixed with light commercial and retail businesses. The upper two-thirds of the watershed are predominantly rural and contain numerous communities. Forestry and row-crop agriculture make-up the bulk of land-use in these parts of the CCW.

Chickasaw Creek originates near the City of Citronelle and discharges to the Mobile River (Figure 2). The headwaters of the creek are comprised of intermittent streams draining the area south of Citronelle. Chickasaw Creek develops to a permanent stream 1.5 feet-5 feet (0.5-1.5 meters) deep and 6.5 feet-10 feet (2-3 meters) wide near the community of Gulf Crest; gradually increasing in size proceeding southeast and developing estuarine characteristics (i.e., tidal flow predominating over stream flow) between US Highway 43 and Shell Bayou. At its mouth Chickasaw Creek is approximately 1500 feet (450 meters) wide and 25-30 feet (8-9 meters) deep.

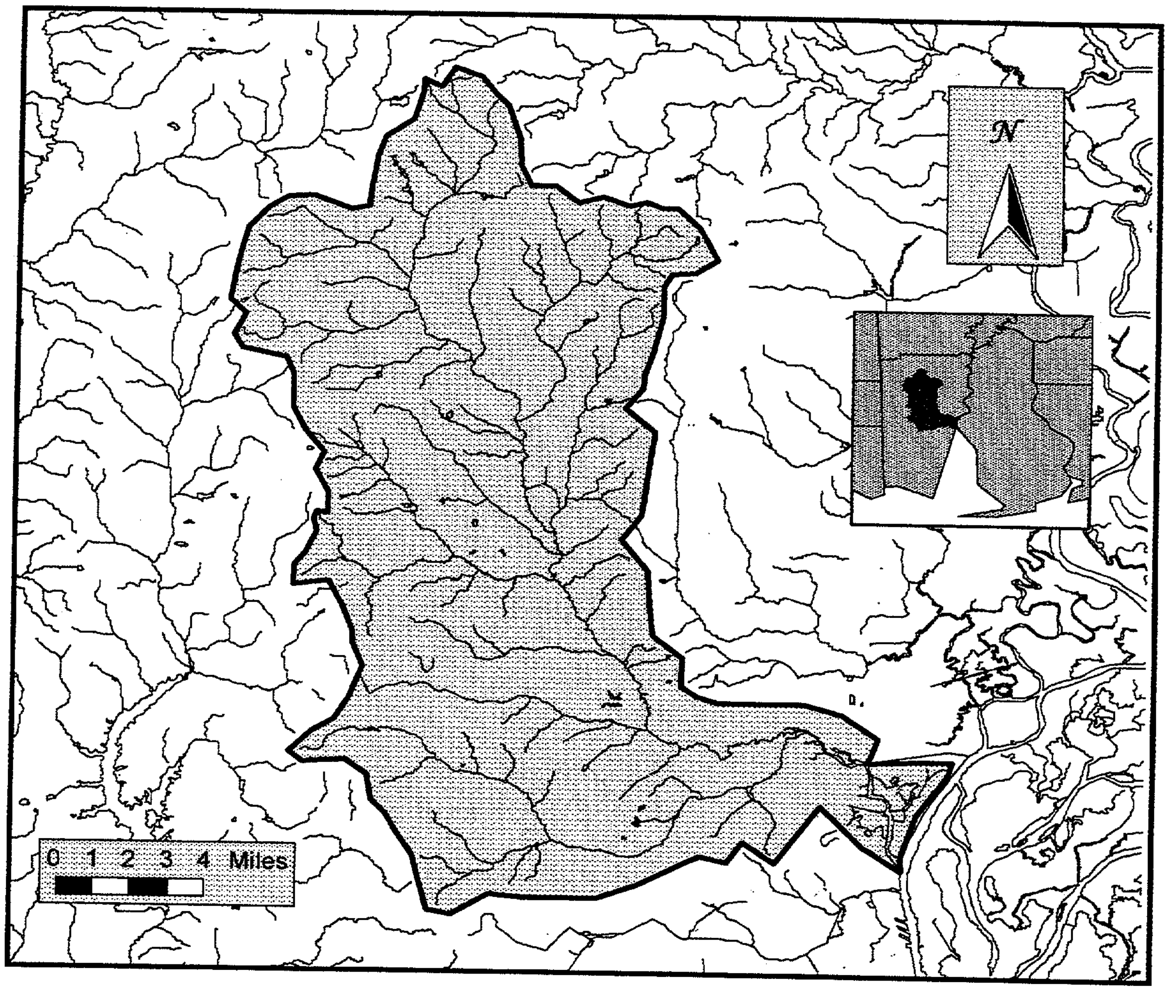


Figure 1
The Chickasaw Creek Watershed
Inset Shows Coastal Area

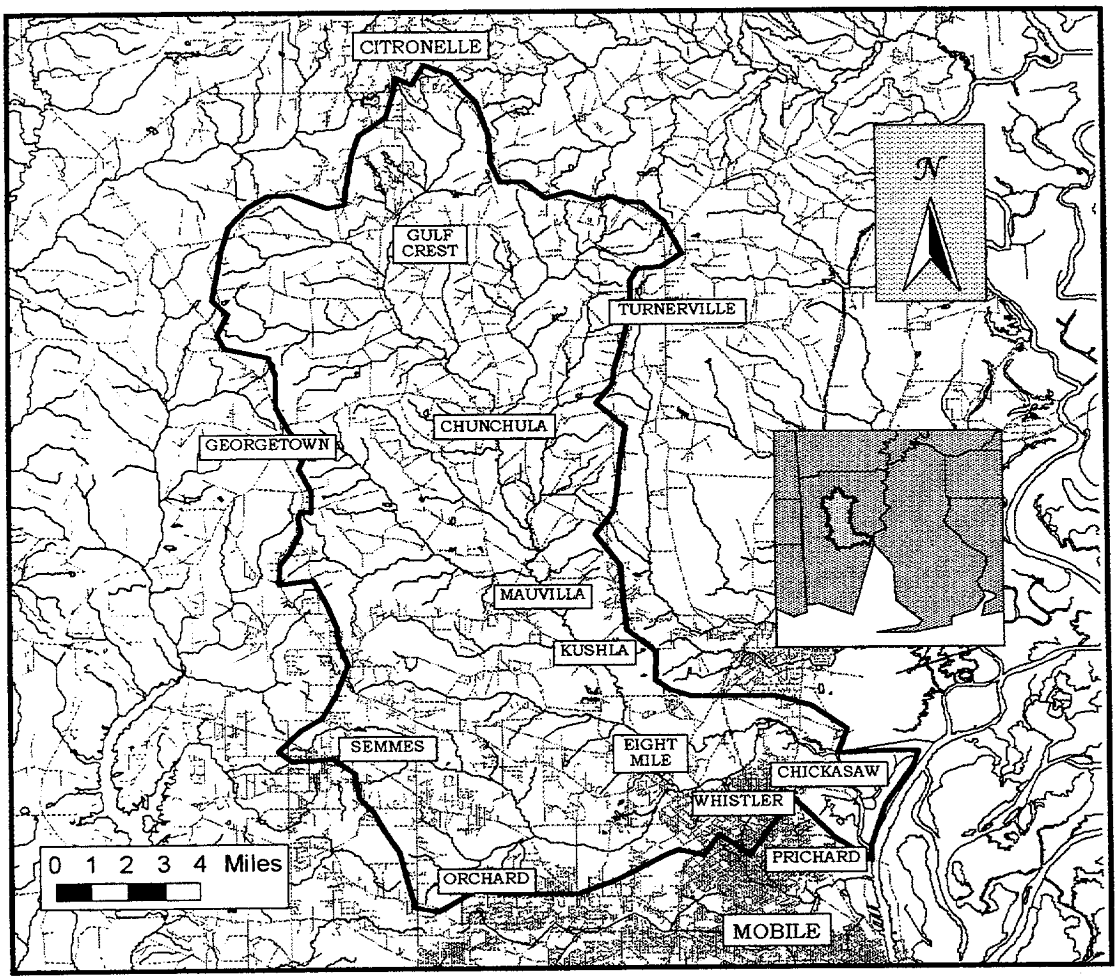


Figure 2
The Chickasaw Creek Watershed
Municipalities and Communities Shown

The average discharge of Chickasaw Creek, as measured near Kushla, is 270 cubic feet per second (cfs) and the 7-day-10-year low flow is 27 cfs (Chermock 1974, USGS 1994). Average maximum flows occur in April, 452 cfs, and average minimum flows occur in October, 179 cfs. The maximum mean discharge on record for any single month is 1792 cfs which occured during April 1955 (USGS 1994).

A federally authorized navigation channel in Chickasaw Creek is maintained by the U.S. Army Corps of Engineers. This project is authorized to maintain a depth of 17 feet and a width of 250 feet from the Mobile River to Shell Bayou, a distance of 2.6 miles (O' Neil and Mettee 1982). However, there has been no need to perform maintenance dredging in recent years due to little, if any, shoaling and naturally occurring adequate depths in the lower reaches of Chickasaw Creek (Rees, USCOE personal communication).

GEOGRAPHY

The CCW, for the most part, lies within the Southern Pine Hills and Coastal Lowlands subdivisions of the East Gulf Coastal Plain physiographic province. The lowermost reaches of Chickasaw Creek also include a small area of deltaic plains of the Mobile River system. The topography of the basin around the lower reaches of Chickasaw Creek is generally flat with little relative surface relief. Proceeding northwest through the watershed the topography becomes considerably more hilly with significant surface relief, as much as 200 feet, from stream valleys to hill crests. Surface elevations may reach as high as 330 feet in the upper part of the watershed near Gulf Crest and Citronelle. The hilly topography and steep slopes play important roles in the ways human activities affect the streams of the CCW. This will be further discusssed later in this report.

CLIMATE

The climate of the CCW is essentially subtropical with long humid summers and short mild winters. The area is strongly influenced by the Gulf of Mexico which tends to moderate temperatures throughout the year (O'Neil and Mettee 1982). The summer months are especially affected by the Bermuda High, a seasonal high-pressure system that spreads over much of the eastern gulf and south Atlantic coast from May through September (O'Neil and Mettee 1982). The prevailing southerly winds produced by the Bermuda High are high in moisture content which keeps summer temperatures along the coast lower than those inland. The average afternoon high in July, the hottest month, is 90°F (32°C) and rarely reaches 100°F (38°C) which is in contrast to inland Alabama where afternoon highs regularly approach and often break the century mark (U.S. Department of Agriculture 1980; O'Neil and Mettee 1982).

Winters are typified by prevailing northerly winds, strong frontal systems and cold, continental air masses. The oceanic nature of the climate tends to "cushion" the effects of such weather complexes and leads to mild winter temperatures ranging from average daily lows of 6°C (43°F) to average daily highs of 15°C (60°F) in January, the coldest month for the area (O'Neil and Mettee 1982).

The brevity and mildness of the winters contributes to a growing season of approximately 260 days in the CCW. The first killing frost occurs around November 20th and the last killing frost is around February 28th (Chermock 1974, O'Neil and Mettee 1982).

The Chickasaw Creek Watershed and in general coastal Alabama experience annual rainfall amounts among the highest in the continential United States. The annual amount of precipitation averages 64 inches as recorded by the National Weather Service at Bates Field located just outside the CCW (Chermock 1974, O'Neil and Mettee 1982). Rainfall is fairly evenly distributed over the year reaching its maximum during July and August (7.91 inches and 6.88 inches respectively), the peak time of thunderstorm activity, with a secondary maximum occuring during March and April (5.4 inches each) . Rainfall is at its lowest during October (2.75 inches) and November (2.53 inches) with only a trace to a quarter of an inch having been recorded several times (ibid).

GROUND WATER

Ground water resources of the watershed are abundant and of high quality (O'Neil and Mettee 1982). The permeable sands of the Pliocene-Miocene Series undifferentiated are utilized as the source of ground water for the majority of the wells in the CCW. Wells drilled into this formation usually produce adequate supplies for domestic, small business and agricultural requirements within 150 feet of the surface (ibid.). The sand beds of the Pliocene-Miocene aquifer are capable of yielding up to 2650 liters/min. (700 gallons/min.) and may produce significantly more in some instances (ibid.). Water table levels exhibit a seasonal variation related to that displayed by streamflow in Chickasaw Creek. Highest water table levels occur during March and April whereas low water tables are most likely to occur during October and November.

GEOLOGY

The surface and shallow subsurface stratigraphy of the CCW is composed of formations within the Tertiary and Quarterary Systems. More specifically this includes sands, sandstones and clays of the Miocene Series; the Citronelle Formation of the Pliocene-Pleistocene Series; terrace deposits of the Pleistocene Series; and alluvial deposits of the Pleistocene and Holocene Series (Geological Survey of Alabama 1968, O'Neil and Mettee 1982).

Alluvial and terrace deposits of the Pleistocene and Holocene Series are found in the southeastern part of the basin. Their main area of coverage begins at the mouth of Chickasaw Creek and extends west and north to the communities of Eight Mile and Orchard. These deposits also occur parallel to and in the floodplains of the streams of the basin as far north as Gulf Crest. Alluvial and terrace deposits contain gravelly sand, sand, silt and clay (Geological Survey of Alabama 1968).

In the parts of the CCW around the communities of Kushla, Chunchula and Turnerville occur the Catahoula Sandstone and Paynes Hammock Sand of the Miocene Series. Paynes Hammock Sand consists of light-colored sand and gray clay with interbedded fossiliferous marl; the Catahoula Sandstone is composed of grayish-yellow sand, gray clay and undifferentiated overlying strata of sand and clay (ibid).

Proceeding westerly towards the community of Georgetown and northerly towards the upper boundry of the watershed the Citronelle Formation caps hills and ridges. The Citronelle Formation is comprised of red, orange and brown gravelly sand with inclusions of clayballs and lenses of red, orange and brown sandy clay (O'Neil and Mettee 1982). Gravels of the Citronelle Formation are chiefly quartz and chert pebbles. A ferruginous sandstone mixed with quartz and chert gravel makes up the base of the formation (ibid). The Citronelle Formation is economically significant for its hydrocarbon resources which have been extracted since the 1950s (Friend, et al 1982).

SOIL ASSOCIATIONS OF THE WATERSHED

The physical characteristics of a watershed's terrain often are significant factors influencing the effects that land-use practices have upon the water quality and aquatic habitats of a basin (National Research Council 1990; U.S. Environmental Protection Agency 1991). Previous studies of watersheds in coastal Alabama have shown that soil type plays an important role affecting the impacts of devlopment on surface waters (Alabama Department of Environmental Management 1994 and 1995). This is especially so with the sandy and loamy soils typical of Mobile and Baldwin Counties. These soils are susceptible to erosion when vegetation is removed during land clearing operations and site preparations (U.S. Department of Agriculture 1980). Special attention to erosion control strategies is a crucial aspect of development throughout much of coastal Alabama.

Aerial photographs from the Soil Survey of Mobile County published by the the Natural Resources Conservation Service (NRCS), previously known as the U.S. Soil Conservation Service, (U.S. Department of Agriculture 1980) were examined by ADEM coastal program staff for determining soil types within the watershed. Soils in the upland portions of the watershed are a variety of sandy loam, clayey loam and loamy sand type soils. Floodplains and other low-lying areas of the basin are distinguished by hydric soils (muck) consisting largely of organic material and clays possessing poor drainage characteristics. More specifically the NRCS classifies the soils in the lower lying areas of the watershed as the Dorovan-Johnson-Levy Association. The soils of the higher, upland areas of the watershed are designated as Troup-Heidel-Bama, Troup-Benndale-Smithton, Shubuta-Troup-Benndale, Urbanland-Smithton-Benndale and Izagora-Bethera-Suffolk Associations.

Distribution of general soil types in the CCW is illustrated in Figure 3 and descriptions of soil characteristics are provided in Table 1. For more detailed delineation of soil types in the watershed readers are advised to refer to the NCRS publication *Soil Survey cf Mobile County, Alabama* (U.S. Department of Agriculture 1980) or contact their local NCRS office.

The Dorovan-Johnson-Levy unit occurs along the lower reaches of Chickasaw Creek from the mouth of the creek up to the confluence with Eight Mile Creek. This includes Hog Bayou, Shell Bayou, Black Bayou and the industrial facilities along these waters. Also included are the residential neighborhoods in the lower elevations of the northernmost sections of the City of Chickasaw and those areas around Robbers Island and immediately east of Interstate Highway 65. These are poorly drained, mucky and loamy soils with a low potential for urban development and cultivation due to wetness and inadequate drainage.

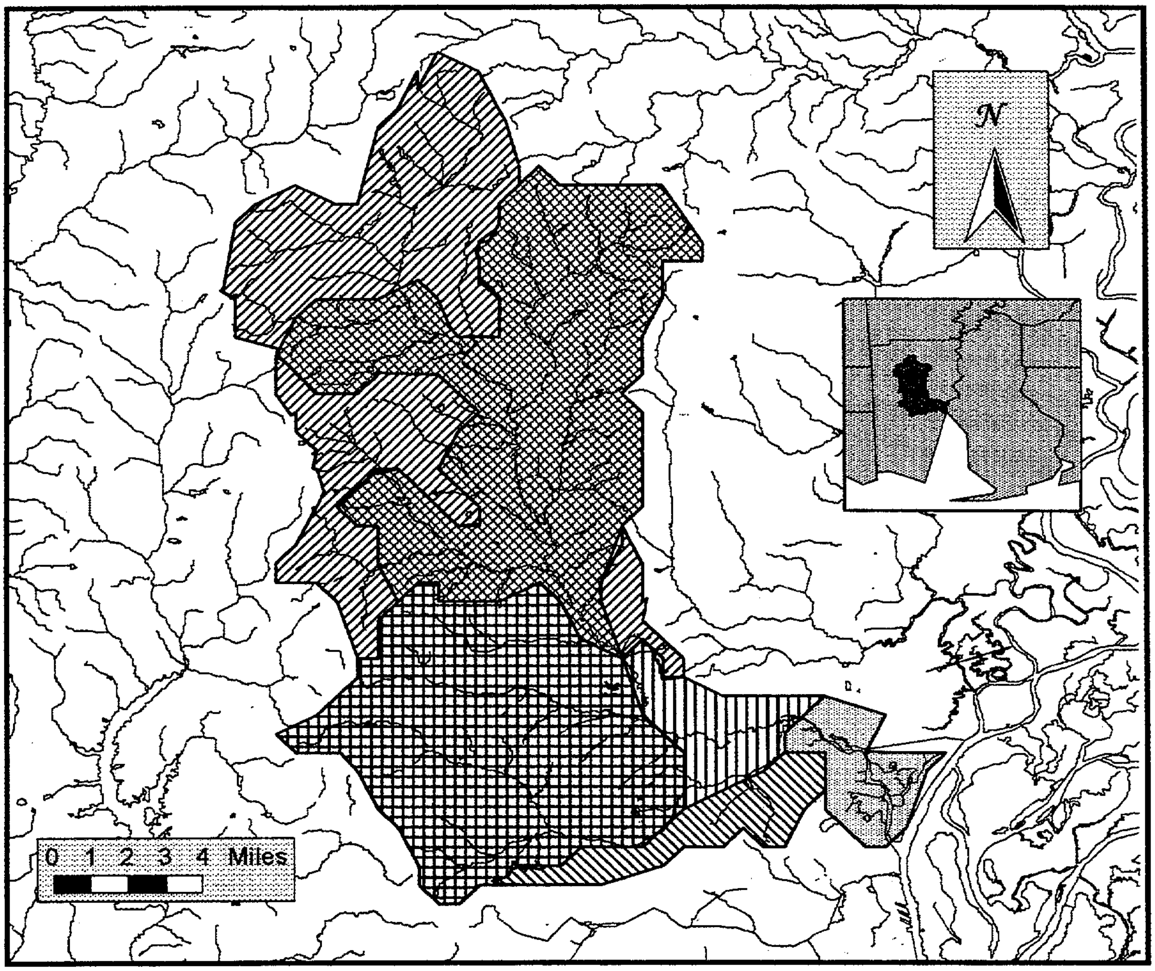
The Izagora-Bethera-Suffolk unit is found around the University of Mobile and along the lower reaches of Eight Mile Creek including the community of Eight Mile and those lands alond US Highway 45 between Eight Mile and the community of Kushla. This soil unit has good drainage characteristics on the sandy loam Suffolk soils of the higher slopes but poor drainage on the Izagora and Bethera soils of the lower slopes and flats.

The Urbanland-Smithton-Benndale unit includes most of the City of Chickasaw west of US Highway 43, the westernmost part of the City of Prichard including Whistler and the northernmost part of the Forest Hill area in the City of Mobile. Urban land is defined by soil scientists as land with soil obscuring structures (U.S. Department of Agriculture 1980). This soil unit drains well on the ridgetops and higher slopes; however, the Smithton soils on the lower slopes and flat areas drain poorly. This soil unit has poor to fair potential for development, the main limitation being the drainage problem on the Smithton soils.

The Troup-Heidel-Bama unit appears in the southwestern sections of the watershed and includes the communities of Orchard, Crawford, Kushla, Semmes and Lott. The topography of this area is one of broad ridge tops and steep side slopes along natural drainage courses. Land of this soil unit classification has good potential for urban and agricultural development. A tendency for erosion and low water availability of the Troup soils are the limiting factors controlling development on these soils (U.S. Department of Agriculture 1980).

The Shubuta-Troup-Benndale unit occurs along US Highway 45 from Kushla through Chunchula to approximately 2 miles south of the community of Gulf Crest. This soil unit follows the valleys of Log and Meekers Creeks towards Turnerville to the northeast and extends west of Chunchula to the north of the community of Georgetown. These areas have more pronounced surface relief than the eastern and southern parts of the CCW and drain well. This soil unit possesses fair to good suitability for urban and residential development. The easily erodable nature and low water availability of the Troup soils are the limiting factors controlling development on these soils (U.S. Department of Agriculture 1980).

The Troup-Benndale-Smithton unit is found in three separate sections of the CCW, the east central part of the basin along the western limits of the City of Saraland, the west central part of the CCW immediately around the Georgetown community and the uppermost part of the watershed between Gulf Crest to the City of Citronelle. These areas also have more pronounced surface relief than the eastern and southern parts of the basin. This soil unit is well drained on slopes and ridgetops but has poor drainage on the lower elevations. The potential for urban and residential development is poor to fair, the erodeable nature of the Troup soils on slopes is the main limitation for construction and development (U.S. Department of Agriculture 1980).



DOROVAN-JOHNSTON-LEVY:
IZAGORA-BETHERA-SUFFOLK:
URBAN LAND-SMITHTON-BENNDALE:
TROUP-HEIDEL-BAMA:
SHUBUTA-TROUP-BENNDALE:
TROUP-BENNDALE-SMITHTON:

Figure 3
Soil Associations of the Chickasaw Creek Watershed

Table 1

General Soil Associations of the Chickasaw Creek Watershed

Dorovan-Johnson-Levy

Soils of this unit are poorly drained mucky and loamy. These soils have formed in thick deposits of organic residues and alluvial sediments on bottom lands.

The organic Dorovan soils are found on level areas and shallow depressions. Johnson soils are a mucky loam at the surface with an underlying sandy layer, this soil type occurs along streams and in wetlands. Levy soils are loamy at the surface and have a clayey subsoil. Levy soils occur parallel to streams and often serve as a demarcation of the stream's floodplain.

This soil unit is best used as for woodlands and wetland wildlife habitat. The potential for cultivation and urban development is poor due to soil wetness and slow drainage.

Izagora-Bethera-Suffolk

Soils of this unit vary between poor and good drainage characteristics. Formed in loamy and clayey alluvial sediments on stream terraces.

The loamy Izagora soils are on flats and gentle slopes along streams. The clayey Bethera soils are found in depressions and narrow drainageways. Suffolk soils are a sandy loam found on the higher sharper slopes adjacent to drainageways.

This soil unit has good potential for woodland use and is suitable for wildlife habitat on the better drained Izagora and Suffolk soils. The potential for use as pasture and cropland is fair to good although wetness during the early spring may delay tillage. Its usefulness for urban development is poor due to slow permeability and flooding tendencies.

Troup-Heidel-Bama

Soils of this unit are well drained, have loamy subsoils and are formed in loamy marine sediments on nearly level to undulating uplands.

Troup soils are on side slopes and the more sloping ridgetops. Heidel and Bama soils are on the more level ridgetops. Troup soils have thick loamy sand surface layers; Heidel and Bama soils have sandy loam surface layers

This unit has good to fair potential for cultivated crops and pastures. Minimum tillage, contour farming and terracing are needed in the sloping areas. Erosion and the low available water capacity of Troup soils are the main limitations for farming. Potential for urban and woodland use is good. Potential for wildlife habitat is good to fair.

Urban land-Smithton-Benndale

Urban land areas on nearly level to gently rolling terrain intermingled with poorly drained to well drained soils with loamy subsoils. Found on upland areas and formed in riverine and marine loamy sediments. Where not altered by development, the landscape is one of broad flats surrounded by ridgetops.

The poorly drained Smithton soils are found along streams and on broad flat areas; the well drained Benndale soils are on upper side slopes and ridgetops. Urban land includes sidewalks, streets, parking lots, buildings and other structures that obscure the soil and impede natural drainage.

This unit has poor potential for most uses other than the continued urban development and its potential for urban use is only fair, the main limitation being the poorly drained Smithton soils.

Table 1 cont.

General Soil Associations of the Chickasaw Creek Watershed

Shubuta-Troup-Benndale

Soils of this unit are well drained and formed in clayey and loamy marine sediments on uplands. The loamy Shubuta and Benndale soils are found mostly on the flatter ridgetops and upper side slopes. Troup soils are a thick loamy sand found on lower side slopes and the more sloping ridgetops.

These soils have a good potential for use as woodlands. Their potential for cultivation and pastureland is fair, the limitations being the short-choppy nature of the slopes, and a low water capacity and tendency for erosion on the Troup soils. The suitability of this soil unit for urban and residential development is fair to good. The slow permeability and low strength for roadway support on the Shubuta soils and the easily eroded Troup soils being the most significant limitations. This soil unit has good potential for management as wildlife habitat and for recreational use.

Troup-Benndale-Smithton

These soils are poorly to well drained and are formed in loamy fluvial and marine sediments on uplands. The thick sandy Troup soils are found mostly on narrow ridgetops and steep side slopes. The loamy well drained Benndale soils occur on the broader ridgetops and on the more gentle side slopes. The poorly drained Smithton soils are located along drainageways and in depressions.

This soil unit has good potential for use as woodland. The potential for cultivation is poor to fair and the potential for pastureland is fair. Excessive slope, the low water capacity and readily erodable characteristics of the Troup soils plus the poor drainage of the Smithton soils are the limitations on agricultural uses. The urban and residential developmental potential is poor to fair. The steep slopes of the erosion prone Troup soils and the wetness of the Smithton soils are the primary limitations.

WATER QUALITY OF THE WATERSHED

The historical water quality database for the CCW is significantly more extensive than was the case for the Dog River and Bon Secour River Watersheds. ADEM has monitored the water quality at two trend stations on Chickasaw Creek for approximately 20 years. Prior to the establishment of the regularly monitored stations Chickasaw Creek had been one of the streams of primary interest during development of the Water Quality Management Plan for Mobile & Baldwin Counties (Mobile Area 208 Study) in the 1970's.

Historical monitoring efforts have indicated a severe problem with low concentrations of dissolved oxygen in Chickasaw Creek downstream of the confluence with Eight Mile Creek (South Alabama Regional Planning Commission 1979, ADEM water quality trend database). However, past monitoring also indicated that Chickasaw Creek is relatively clean and free of significant impairments of water quality upstream of the confluence with Eight Mile Creek (South Alabama Regional Planning Commission 1979).

Until recently the section of Chickasaw Creek between Eight Mile Creek and the Mobile River, including Hog Bayou, received the highest combined point source loadings of total nitrogen, total phosphorous and biochemical oxygen demand (BOD) of any stream in Coastal Alabama (South Alabama Regional Planning Commission 1979). The sources of wastewater included two large pulp and paper operations, two municipal wastewater treatment facilities and several inorganic chemical manufacturing plants. Sediments in the lower reaches of Chickasaw Creek have for numerous years contained excessive amounts of organic carbon and mineral nutrients. These qualities combined with the characteristic salt wedge stratification of a estuary have combined to endow lower Chickasaw Creek with a great amount of environmental stress.

There also is a recent history of citizens' complaints regarding excessive turbidity and fish kills in Chickasaw Creek. These incidents are routinely investigated by the ADEM Mobile Branch Office. The findings usually have shown that the valid complaints of the former catagory occur in the upper watershed following storm events and those of the latter happen in the lower reaches downstream of US Highway 43 during the summer months and periods of low stream flows.

Chickasaw Creek is assigned a water use classification of Agricultural and Industrial (A&I) from its mouth to US Highway 43. This classification has been due to the stream's historical usage. The most significant impairment to water quality in this stretch has been and continues to be hypoxia (low concentrations of dissolved oxygen) of the bottom waters. This condition has been attributed to a high sediment oxygen demand and salt wedge induced vertical stratification (South Alabama Regional Planning Commission 1979, Alabama Coastal Area Board 1980). Between US Highway 43 and the University of Mobile campus, Chickasaw Creek is assigned a water use-classification of fish and wildlife (F&W) and from the University of Mobile to its headwaters Chickasaw Creek is assigned a use-classification of swimming and whole body water-contact sports.

The major sub-basin in the CCW, Eight Mile Creek, is classified as F&W from its mouth to the City of Prichard's municipal water supply intake. Between the water supply intake and US Highway 45, Eight Mile Creek is assigned a use-classification of public water supply (PWS); then above Highway 45 to its headwaters Eight Mile Creek is classified as F&W. Other streams within the watershed, including several named and many unnamed tributaries have not been assigned a specific use classification; however, those segments are considered as fish and wildlife waters pursuant to ADEM Administrative Code (335-6-11-.01(5)). For a summary of the water quality criteria applicable to these classifications please refer to Table A-1 in the appendix.

BIOLOGICAL RESOURCES OF THE WATERSHED

PLANT COMMUNITIES

The Chickasaw Creek Watershed contains a wide diversity of plant communities ranging from the submersed grassbeds and brackish marshes of lower Chickasaw Creek and its tidially influenced tributaries to the pine forests of the upland tributaries and headwaters. (Chermock 1974; Sapp, Cameron and Stout 1976; Stout and LeLong 1981)

UPLANDS

The dominant plant association in the uplands of the CCW is the longleaf pine-oak community. Species abundant in this community include: longleaf pine (*Pinus palustrus*), southern red oak (*Quercus falcata*), laurel oak (*Quercus hemispherica*), dogwood (*Cornus florida*), southern magnolia (*Magnolia grandiflora*) and persimmon (*Diospyros virginiana*) (Stout and LeLong 1981). The natural suitability of this terrain for pine trees has led to the establishment of a productive timber economy in the watershed.

The understory of the upland forest includes the shrub species winged sumac (*Rhus copallinna*), sparkleberry (*Vaccinium arboreum*), blueberry (*Vaccinium elliottii*) and huckleberry (*Gaylussicia dumosa*). Some of the herbaceous species common to the upland woods of the study area are foxglove (*Agalinis* spp.), milkweed (*Asclepias* spp.), sandhill lupine (*Lupinus diffusus*) and goldenrod (*Solidago* spp). Panic grasses (*Panicum* spp.), broomsedges (*Andropogon* spp) and windmill grass (*Gymnopogon ambiguus*) are some of the common grass plants of the basin.

WETLANDS

The wetlands habitats of the CCW vary between the narrow strips of bottomland swamp along the basin's upland streams to the cypress swamps and brackish marshes near the mouth of Chickasaw Creek.

Along the upper three-fourths of Chickasaw Creek and its upland tributaries the wetlands plants commonly found include: umbrella-sedges (*Cyperus* spp.), buttonbush (*Cephalanthus occidentials*), smartweeds (Polygonum spp), pickerelweed (*Pontederia cordata*), broad-leaved arrowhead (*Sagittaria latifolia*) and cattails (*Typha* spp.) (Stout and LeLong 1981; Sapp, Cameron and Stout 1976).

In the vicinity of Chickasabouge Park, Interstate-65 and Highway 43 the watershed is distinguished by areas of forested wetlands (swamps) along streambanks and on low-lying, better drained flat terrain. The canopy of the forested wetlands is comprised of swamp tupelo (*Nyssa sylvatica*), red maple (*Acer rubrum* spp.), sweet gum (*Liquidamber styraciflua*) and bald cypress (*Taxodium distichum*). Common understory species of the forested wetlands are wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*), groundsel trees (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), St. John's wort (*Hypericum fasciculatum*) and pepper bush (*Clethra alnifolia*) (Chermock et al. 1975; Sapp, Cameron and Stout 1976; Stout and LeLong 1981).

Along the lower reaches of Chickasaw Creek and within the small inlets and bayous near its mouth transitional-brackish marshes occur. These wetlands are subjected to a variable salinity regime in addition to the stresses of flooding and exposure. Bulrush (*Scirpus* spp), sawgrass (*Cladium jamaicense*), wildmillet (*Echinochloa crusgalli*) and torpedo grass (*Panicum repens*) are common in the lower salinity environments, whereas giant cordgrass (*Spartina cynosuroides*), spike grass (*Distichlis spicata*) and black needlerush (*Juncus roemerianus*) become dominant as salinity increases (*ibid*).

ANIMAL LIFE OF THE BASIN

INVERTEBRATES:

Information on the invertebrate fauna of the CCW is somewhat better known than was the case of the Dog River and Bon Secour River Watersheds. This knowledge is primarily limited to studies of lower Chickasaw Creek in the immediate vicinity of the industrial facilities.

Surveys of the benthic infauna of Mobile Bay and the surrounding waters indicate that the lowland streams subjected to frequent or prolonged tidal incursions possess a community primarily composed of polychaete worms and amphipods (Parker 1960; Vittor 1973; Chermock 1974; U.S. Army Corps of Engineers 1978, Marine Environmental Sciences Consortium (MESC) 1980 and 1981, Heard 1982; Hopkins and Valentine 1989 and ADEM 1990). The coastal streams not subjected to salinity intrusions are populated primarily by aquatic insects, oligochaete worms, amphipods and isopods (Chermock 1974; O'Neil and Mettee 1982; Mettee et al 1983; Hopkins and Valentine 1989).

Organisms in a tidally influenced stream must either be adapted to a wide range of environmental variables (salinity, flow, exposure at low tide etc.) or they must be opportunists with the capability of rapidly colonizing disturbed habitats. The ability to tolerate low concentrations of dissolved oxygen is also an advantage because many tidally influenced streams of the area experience periods of hypoxia due to poor flushing characteristics and salinity stratification during times of low flow (Heard 1982; Williams 1984; Pennak 1989). The dominant species of the benthic habitats include the polychaetes *Mediomastus ambeseta, Streblospio benedicti, Glycinde solitaria, Leitoscoloplos robustus, Paramphinome pulchella, Sigambra spp.* and *Hobsonia florida*; and the amphipods *Corophium* spp, and *Gammarus* spp. (Parker 1960; Vittor 1973; Chermock 1974; U.S. Army Corps of Engineers 1978; MESC 1980 and 1981; Heard 1982; Hopkins and Valentine 1989; ADEM 1990).

Those species inhabiting the upland streams avoid the stress imposed by salinity variations. However, the variable flows of coastal streams subject the community to rapidly occurring flood conditions and streambed scour during storm events, contrasted with prolonged periods of low water and its attendant stresses of habitat crowding and exposure (Chermock 1974; Mettee et al 1983; Pennak 1989). These factors tend to favor species with the ability to remain in or on the substrate, endure high current velocity, survive sudden displacement and transport downstream and tolerate exposure (Hynes 1972; Pennak 1989).

Dominant species of the upland coastal streams include midge fly larvae (*Chironomus* spp., *Cryptochironomus* spp., *Procladius* spp. and *Polypedilum* spp.), mayfly nymphs (*Stenonema* spp., *Isonychia* spp. and *Hexigenia* spp.) crane fly larvae (*Tipula* spp.), stonefly nymphs (*Acroneuria* spp. and *Perlesta* spp.), aquatic beetles (*Stenelmis* spp. and *Dubiraphia* spp.), caddis fly larvae (*Cheumatopsyche* spp. and *Hydropsyche* spp.), dragonfly nymphs (*Gomphus* spp. and *Progomphus* spp.), damselfly nymphs (*Agrion* spp. and *Ischnura* spp.), amphipods (*Gammarus* spp.) isopods (*Asellus* spp.), and oligochaete worms (*Limnodrilus* spp.) (Chermock 1974; O'Neil and Mettee 1982; Mettee et al, 1983 and Hopkins and Valentine 1989).

Several species of crayfish are known to occur in the streams and ponds of Mobile County; these are, *Orconectes immunis, Fallicambarus byersi, Cambarellus* (3 species) and *Procambarus* (7 species) (Hobbs 1974). Other crustacean species common to the streams and wetlands of Mobile County, and likely to occur in the CCW, are mud crabs (*Eurypanopeus depressus, Rithropanopeus harrissi* and *Panopeus* spp.), fiddler crabs (*Uca* spp.), blue crabs (*Callanectes sapidus*) and grass shrimp (*Palaemonetes pugio*) (Chermock 1974; Heard 1982; O'Neil and Mettee 1982; Hopkins and Valentine 1989; ADEM 1990).

FISH:

Available information on the fish species of the CCW and surrounding waters primarily comes from studies of the fisheries of the Mobile Delta and Mobile Bay.

These studies indicate that the dominant species occurring in the local streams are redear sunfish (*Lepomis microlophus*), bluegill (*L. macrochirus*), orange-spotted sunfish (*L. punctatus*), longear sunfish (*L. megalotis*), green sunfish (*L. cyanellus*), black and white crappie (*Pomoxis nigromaculatus* and *P. annularis*), catfish (*Ictalurus* spp.) and largemouth bass (*Micropterus salmoides*) (Boschung 1957; Swingle 1971; Chermock 1974; Tucker 1979). The southern flounder (*Paralichthys lethostigma*) and striped mullet (*Mugil cephalus*) also are abundant in local waters and are important recreational and commercial species (Chermock 1974; Tucker 1979).

Various smaller species of fish common to the area waters, and serving as a food base for many of the larger recreationally and commercially important species, include shiners (*Notropis* spp.), sheepshead minnow (*Cyprinodon variegatus*), topminnows and killifish (*Fundulus* spp) and tidewater silversides (*Menidia beryllinna*) (Boschung 1957; Smith-Vanez 1968; Swingle 1971; Chermock 1974; Tucker 1979).

REPTILES AND AMPHIBIANS:

The varied habitats of the CCW allow for a diverse assortment of amphibian and reptilian life. The uplands of the basin serve as home for several species of toad (*Bufo* spp.) and treefrog (*Hyla* spp.). In addition, Gulf Coast box turtles (*Terrapene carolina major*), skinks (*Eumeces* spp.), green anoles (*Anolis carolinensis carolinensis*), gray rat snakes (*Elaphe obsoleta spiloides*), southern black racers (*Coluber constrictor priapus*) and copperheads (*Agkistrodon contorix contorix*) are the common reptiles of the upland habitats of the watershed. Gopher tortoises (*Gopherus polyphemus*), once common in uplands habitats throughout the coastal area, are occasionally found in the hilly terrain of the western CCW (Chermock 1974; Mount 1975; O'Neil and Mettee 1982).

The moist pine flatwoods, swamps and marshes of the area are likely to contain cricket frogs (*Acris* spp.), bullfrogs (*Rana catesbeiana*) and salamanders (*Ambystoma* spp. and *Pseudotriton* spp) as an amphibian community. Reptiles common to the moist pinewoods and wetlands of the CCW are snapping turtle (*Chelydra serpentina serpentina*), Mississippi diamondback terrapin (*Malaclemys terrapin pileata*), cooters (*Pseudemys* spp.) water snakes (*Nerodia* spp) and cottonmouth (*Agkistrodon piscivorous leucostoma*). Alligators (*Alligator mississippiensis*) are likely inhabitants of the wider stretches of streams and bayous of the basin. The pigmy rattlesnake (*Sistrurus miliarius*), canebrake rattlesnake (*Crotalus horridus*) and diamondback rattlesnake (*Crotalus adamantus*) occur throughout the watershed but are most commonly found in swamps, marshes and pine flatwoods (*ibid*).

BIRDS:

The CCW, as does coastal Alabama in general, possesses a rich and diverse avian fauna. The variety of habitats in the area allows for upland ground birds, raptorial species, songbirds, shore birds, wading birds and other waterfowl to inhabit the basin (Chermock et al, 1975, Imhof 1976 and Johnson 1979).

Among upland habitats of, and generally throughout, the CCW **permanent resident species** (i.e. those which nest and occur throughout the year) include the red-tailed hawk (*Buteo jamaicensis*), black vulture (*Coragyps atratus*), turkey vulture (*Cathartes aura*), bobwhite (*Colinus virginianus*), turkey (*Meleagris gallopavo*), American woodcock (*Philohela minor*), mourning dove (*Zenaida macroura*), Chuck-will's-widow (*Camprimulgus carolinensis*), screech owl (*Otus asio*), barred owl (*Strix varia*), Carolina chickadee (*Parus carolinensis*), Carolina wren (*Thyrothorus ludovicianus*), mockingbird (*Mimus polyglottus*), brown thrasher (*Toxostoma rufum*), red-winged blackbird (*Agelaius phoeniceus*), cardinal (*Cardinalis cardinalis*) rufus sided towhee (*Pipilo erythrophthalmus*) and killdeer (*Charadrius vociferus*) (Chermock et al, 1975 and Imhof 1976).

Also included as permanent residents of aquatic and shoreline habitats are the snowy plover (*Charadrius alexandrinus*), Forster's tern (*Sterna forsteri)*, laughing gulls (*Larus atracilla*), black skimmer(*Rynchops niger*), brown pelican(*Pelacanus occidentalis*), great blue heron(*Ardea herodias*), snowy egret (*Egretta thula*), black-crowned night heron (*Nycticorax nycticorax*) and clapper rail (*Rallus longiostris*) (Chermock 1974; Imhof 1976 and Johnson 1979).

The avian fauna of the CCW includes a significant number of species which occupy the area for only a portion of the year. These temporary residents may be grouped into the categories of winter resident, summer resident or migrant.

Winter residents are those species which nest in the north during the summer and overwinter in the coastal area. These primarily tend to be waterfowl, shorebirds and songbirds. The wintertime population of birds in the basin includes, in addition to the permanent residents, the yellow bellied sapsucker (*Sphyrapicus varius*), scissor-tailed flycatcher (*Muscivora forficata*), eastern phoebe (*Sayornis phoebe*), Bewick's wren (*Thryomanes bewickii*), house wren (*Troglodytes aedon*), winter wren(*Troglodytes troglodytes*), robin (*Turdus migratorius*), sharp-tailed sparrow (*Ammospiza caudacuta*) evening grosbeak (*Hesperiphona vespertina*) and whip-poor-will (*Caprimulgus vociferus*) (Chermock 1974; Imhof 1976; O'Neil and Mettee 1982).

Wetlands habitats and shorelines of the watershed are winter residences for the common loon (*Gavia immer*), horned grebe (*Podiceps auritus*), double-crested cormorant (*Phalacrocorax auritus*), hooded merganser (*Lophodytes cucullatus*), common merganser (*Mergus merganser*), pintail (*Anas acuta*), green-winged teal (*Anas crecca*), mallard (*Anas platyrhynchos*), American coot (*Fulica americana*), semipalmated plover (*Charadrius semipalmatus*), Caspian tern (*Hydroporgne caspia*), Bonaparte's gull (*Larus philadelphia*), white pelican (*Pelacanus erythrorhynchos*) and marsh hawk (*Circus cyaneus*) (Chermock 1974; Chermock etal, 1975; Imhof 1976).

Summer residents are those species which nest in the area for the summer and migrate south for the winter. Summer residents common throughout the CCW include the cattle egret (*Bubulcus ibis*), common nighthawk (*Chordiles minor*), chimney swift (*Chaetura pelagica*), Acadian flycatcher (*Empidonax virescens*), great-crested flycatcher (*Myiarchus crinitus*), barn swallow (*Hirundo rustica*), purple martin (*Progne subis*), wood thrush (*Hylocichla mustelina*), Swainson's warbler (*Limnothlypis swainsonii*) prothonotory warbler (*Protonotaria citrea*) and summer tanager (*Piranga rubra*). (Chermock 1975 and Imhof 1976).

In the wetlands habitats of the CCW during the summer are found the green heron (*Butroides virescens*), little blue heron (*Florida caerula*), Louisiana heron (*Hydranassa tricolor*), least bittern (*Ixobruchus exilis*), Yellow-crowned night heron (*Nyctanassa violacea*) and osprey (*Pandion haliaetus*) (Chermock 1974, Chermock et al, 1975 and Johnson 1979).

Migrant species are those which pass through the area as they move between the summer nesting grounds in more northern latitudes and overwintering habitats in the south. Typical migrant species occurring in the CCW during the spring and fall migration seasons are various warblers (*Dendroica* spp.), flycatchers (*Empidonax* spp.), cliff swallow (*Petrochelidon pryrronota*), blue grosbeak (*Guiraca caerulea*), bobolink (*Dolichonyx oryzivorus*) and ruby-throated hummingbird (*Archilochus colubris*) (Chermock et al, 1975 and Imhof 1976). In the marshes, mud flats and shore habitats of the CCW, the American bittern (*Botaurus lentigenosus*), perigrine falcon (*Falco perigrinus*), Canada goose (*Branta canadensis*), blue goose (*Chen caerulescens*), black rail (*Lateralis jamaicensis*), spotted sandpiper (*Actitis macularia*), stilt sandpiper (*Micropalama himantopus*), black tern (*Childonias niger*) and roseate tern (*Sterna dougalli*) are commonly occurring species (Chermock et al, 1975 and Johnson 1979).

MAMMALS:

The literature reviewed regarding the biological resources of the CCW indicates that 48 species of non-domesticated, terrestrial mammals inhabit the area (Holliman 1963; Linzey 1970; Chermock et al. 1975; and Holliman 1979).

Mammalian species common throughout Mobile County and the CCW include the opossum (*Didelphis marsupialis pigra*), eastern cottontail rabbit (*Sylvilagus floridanus mallurus*), gray squirrel (*Sciurus carolinensis carolinensis*), striped skunk (*Spilogale putorius putorius*) and raccoon (*Procyon lotor varius*). The swamps and marshes of the basin are suitable habitat for the swamp rabbit (*Sylvilagus aquaticus littoralis*), beaver (*Castor canadensis carolinensis*), Louisiana muskrat (*Ondatra zibethicus rivalicius*), river otter (*Lutra canadensis canadensis*) and mink (*Mustella vison mink*). The white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus floridanus*) and gray fox (*Urocyon cinereoargenteus floridanus*) are the only larger mammals likely to occur in the CCW and their presence is confined to relatively undeveloped, sparsely settled areas in the watershed (Linzey 1970; Chermock et al 1975 and Holliman 1979).

The Florida black bear (*Ursus americanus floridanus*), red wolf (*Canis niger*) and Florida panther (*Felis concolor coryi*) once were common to Mobile County. However, these species have gradually declined in numbers to the point where they have practically vanished from the area (Chermock 1957; Linzey 1970; and Chermock et al. 1975).

Five of the mammalian species common to Mobile County have been introduced from exotic lands. These are the nine-banded armadillo (*Dasypus novemcinctus mexicanus*), black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus brevirostris*) and nutria (*Myocastor coypus bonariensis*) (O'Neil and Metee 1982).

Additionally, there are 9 species of marine mammals known to inhabit the north central gulf coast. Of these, only the bottlenose dolphin (*Tursiops truncatus*) and spotted dolphin (*Stenella plagiodon*) are regular inhabitants of the waters of coastal Alabama (Caldwell and Caldwell 1973). The Florida manatee (*Trichetus manatus latirostris*) also has been sighted in Alabama waters; however, these sightings have usually occurred in the higher salinity and clearer waters of the tidal passes in the lower bay (ibid).

ENDANGERED SPECIES

The CCW also is within the habitat range of some forty-six faunal species which are listed either as threatened or endangered (Boschung 1976; U.S. Department of the Interior 1980). Five species of crayfish, genera *Cambarellus* and *Procambarus*, listed as special concern by Bouchard (1976), have been collected from coastal Alabama. Two of these, *Cambarellus diminutus* (the smallest species of crayfish in the world) and *Procamberus evermanni* have been collected from Mobile County (O'Neil and Mettee 1982). The slow-flowing, low-gradient streams of the watershed provide suitable habitat for these species and others with similar requirements.

There are six species of fish considered as endangered, threatened or of special concern which have been collected from coastal Alabama (Ramsey 1976). One of these, the pigmy killifish (*Leptolucania omnata*) a species of special concern, is likely to inhabit the small streams of the CCW. The other five species either inhabit large rivers or are rare occurrences of displaced individuals (O'Neil and Mettee 1982).

Four rare species of amphibians, considered as threatened, endangered or of special concern, are known to inhabit the basin. The endangered flatwoods salamander (*Ambystoma cingulatum*) and the threatened dusky gopher frog (*Rana areolata sevosa*), inhabitants of moist pinewoods, have been collected from the CCW by Loding (1922) although no collections have occurred since then (O'Neil and Mettee 1982). The river frog (*Rana heckscheri*) and greater siren (*Siren lacertina*) are species of special concern which occur in Mobile County (*ibid*).

Nine species of reptiles listed as either endangered, threatened or of special concern are potential residents of the CCW (Boschung 1976; U.S. Department of the Interior 1980). The gopher tortoise (*Gopherus polyphemus*), indigo snake (*Drymarchon corais couperi*) and eastern diamondback rattlesnake (*Crotalus adamanteus*), once abundant in the area, are now classified as threatened, endangered and of special concern respectively (Mount 1976). Their decline in numbers is due, for the most part, to habitat destruction and the practice utilized by rattlesnake hunters of pouring gasoline into gopher tortoise holes for the purpose of driving snakes out of the burrows (O'Neil and Mettee 1982).

The black pine snake (*Pituophis melanoleucus*), listed as endangered, and the pine woods snake (*Rhadinea flavilata*), listed as of special concern, are inhabitants of the pine forest and flatwoods of Mobile County (Mount 1976). The Alabama red-bellied turtle (*Pseudomys alabamensis*) is considered threatened due to its small range and population (Mount 1976). This aquatic turtle is restricted to the lower Mobile River drainage and is a potential resident of the streams in the CCW. Also listed as of special concern and likely to reside in the basin are the Florida green water snake (*Nerodia cyclopion floridana*) and the Florida soft-shell turtle (*Trionyx ferox*) (Mount 1976).

However, not all of the species listed as either endangered or threatened are near their extinction. The most noteable recovery of such a species indigenous to the watershed is the American alligator (*Alligator mississippiensis*). Once hunted to such an extent that the population in coastal Alabama all but disappeared, their numbers are on the increase because of strict protective measures (O'Neil and Mettee 1982). This large reptile resides in the marshes and bayous of lower Chickasaw Creek.

Twenty-two species of birds considered as endangered, threatened or of special concern (Boschung 1976; U.S. Department of the Interior 1980) are known to occur in Mobile County and the CCW at some time of the year, ten of these are breeding resident species.

The brown pelican (*Pelacanus occidentalis*) has experienced a "swing of the pendulum" with respect to its numbers in coastal Alabama. Once a historical common resident of the area, the pelican population declined through the 1950's, 1960's and 1970's resulting in its listing as endangered (Boschung 1976; U.S. Department of the Interior 1980). However, the numbers of this species have been on the increase over the past decade; it appears to have made a comeback and the population of coastal Alabama is no longer listed as either endangered or threatened (O'Neil and Mettee 1982).

Also known to the area and listed as endangered is the bald eagle (*Haliaeetus leucocephalus*) (Boschung 1976; U.S. Department of the Interior 1980). This species is a breeding resident of the gulf coast and nests along the shoreline of open water; their numbers have steadily declined throughout their range. Loss of nesting habitat, poaching and the effects of pesticides on reproduction are factors contributing to their diminished numbers. (Keeler 1976; O'Neil and Mettee 1982).

Avian species of the area listed as of special concern are the swallow-tailed kite (*Elanoides forficatus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's Hawk (*Accipiter cooperi*) and red-shouldered hawk (*Buteo lineatus*) (Boschung 1976). These species have declined in numbers for the same reasons as the bald eagle and osprey.

Five mammalian species listed as either threatened or of special concern have been recorded from Mobile County, these are the Florida yellow bat (*Lasiurus floridanus*), southeastern myotis bat (*Myotis austroriparius austroriparius*), Bayou gray squirrel (*Sciurus carolinensis fuliginosus*), Florida panther (*Felis concolor coryi*) and black bear (*Ursus americanus floridanus*). The black bear and panther, both listed as endangered (Boschung 1976; U.S. Department of the Interior 1980), are unlikely residents of the CCW due to anthropogenic activity and a lack of suitable habitat. The Florida yellow bat and the southeastern myotis bat are classified as being of special concern (Boschung 1976). These species are seldom seen in the watershed but are potential inhabitants of wooded areas and old buildings. The bayou gray squirrel is found in the swamps and bayous of Mobile County (Dusi 1976).

LAND USE AND DEVELOPMENT IN THE WATERSHED

GENERAL REVIEW

The most significant difference between the Chickasaw Creek Watershed and the watersheds previously surveyed (Dog River and Bon Secour River) is the extensive industrial development along the lower reaches of Chickasaw Creek and the tributaries Hog Bayou and Black Bayou (Figure 4). Industrial operations in the southeastern "corner" of the CCW began in the early 1900's, making this one of the first watersheds in coastal Alabama to experience heavy constructon, drastic alteration of the shoreline, and large volumes of industrial wastewater discharges (Chermock 1974).

Residential structures dominate the urban landscape of the CCW. High density single-family developments and multiple-family housing account for the majority of the land area of the watershed classified as urban use. The City of Chickasaw, which lies almost entirely within the watershed, and the Whistler community of the City of Prichard contain heavily developed residential sections combined with the light commercial operations (retail stores and restaurants) and recreational property (ballparks and playgrounds) typical of residential areas.

The Whistler community also contains several light manufacturing operations and warehouse facilities which cover a significant area and play an important role in the local economy (Friend, et al 1982). This section of the watershed has been settled since the 19th century and has been an active and economically important part of the Mobile area for many years.

West of the cities of Chickasaw and Prichard are the suburban communities of Forest Hill and Orchard within the city of Mobile. The land development in these areas has followed the trend seen throughout most of suburban Mobile, primarily residential subdivisions, business and light commercial construction. These communities experienced considerable development during the 1960s and 1970s but construction over the past decade has been less active.

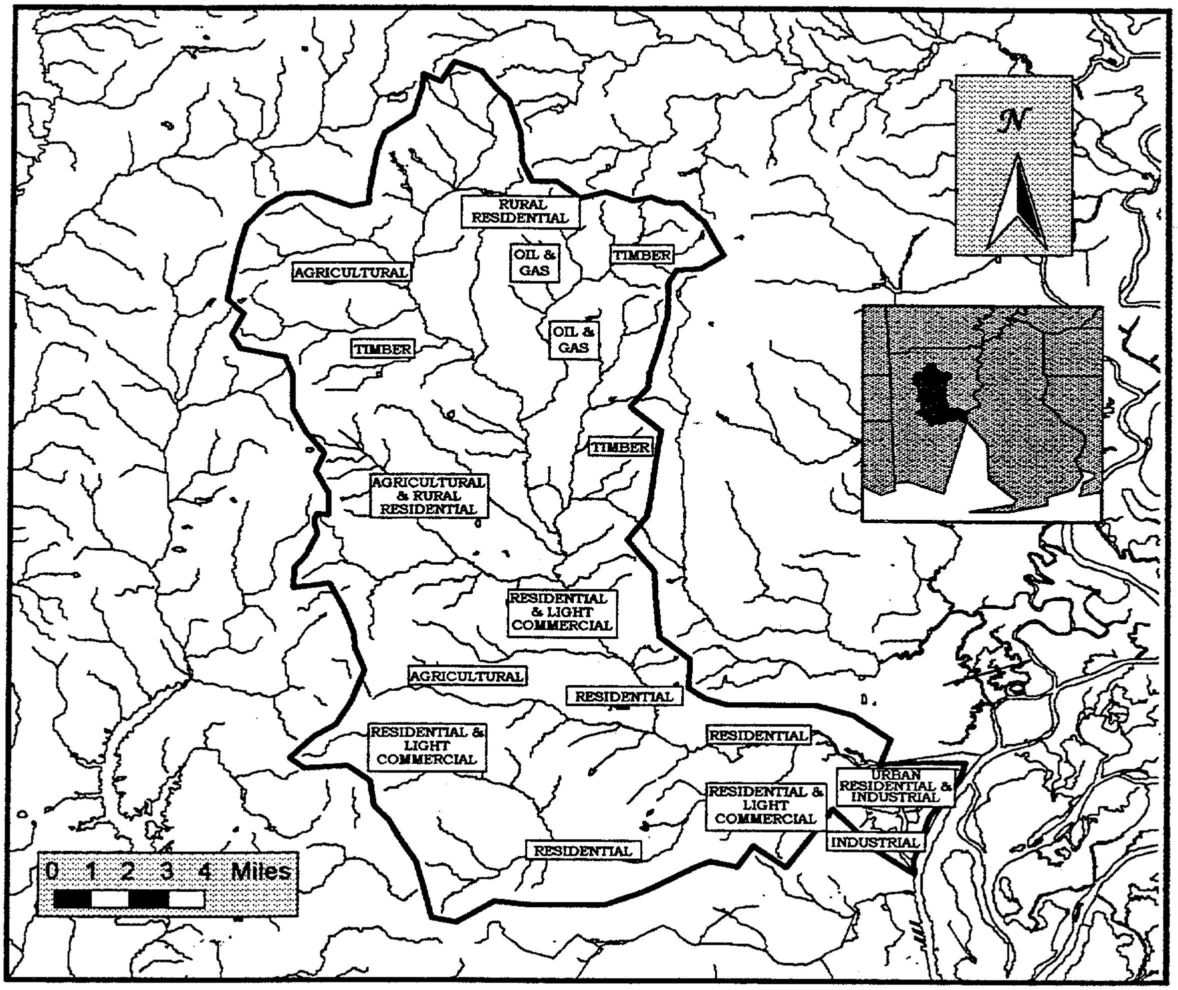


Figure 4
Land Use Catagories in the Chickasaw Creek Watershed

Proceeding northwest to the communities of Crawford, Semmes and Lott in the western side of the basin and north to the community of Eight Mile at the northwest limit of Prichard, the density of development begins to significantly decrease. Single family residences account for the vast majority of construction in these communities. Many of the residences in these communities are sited on lots of one acre or more. Subdivision development in the Crawford and Semmes communities has been fairly active in recent years and is expected to increase in the near future.

Agriculture is the predominant use of land around these communities. Horticultural nursery operations make-up a valuable component of the agriculture of these communities especially along US Highways 45 and 98. Most of the commercial enterprises in this part of the watershed are small retail "shopping centers", restaurants, automobile dealers and various repair shops.

Moving out of the urban parts of the basin, the largest building complex is the University of Mobile located north of Eight Mile. Founded in 1961 as Mobile College, the university occupies 765 acres including a woodlands study center on Chickasaw Creek. Immediately downstream of the university campus is the other large development outside of the urban areas of the CCW, Chickasabouge Park. Chickasabouge Park encompasses 1050 acres of bay forest along the banks of Chickasaw Creek and provides a relatively pristine setting for hiking, swimming, fishing and recreational day activities. The park includes numerous plant and animal species considered rare or of special concern, examples being the Atlantic White Cedar and alligator (Friend et al 1982).

Continuing northward the watershed becomes decidedly more rural in setting including large expanses of woodlands. The communities of Kushla, Mauvilla, Chunchula, Georgetown and Gulf Crest are included in this region which makes-up approximately two-thirds of the total area of the basin. Land use in the upper basin is largely devoted to timber production, row crop agriculture and residential structures.

Hydrocarbon extraction and processing are significant activities in the vicinity of Chunchula. The Chunchula Gas Field is located about 2 miles northeast of Chunchula and has been in production for 20 years. Although the amount of land utilized for hydrocarbon production in the CCW is minor relative to the total area of the basin, these activities have the potential for causing critical impacts to the residents, wildlife and aquatic resources of the watershed.

The Chickasaw Creek Watershed also has the distinction of possessing five landfill facilities. The largest of these being the Chunchula Sanitary Landfill operated by Mobile County and located approximately 4 miles northwest of the community of

Chunchula. International Paper Co. maintains a landfill near Kushla for use by its Mobile Mill for disposal of flyash, solids from the mill's wastewater treatment plant, pulp wastes and general trash. The City of Prichard operates a sanitary landfill for household wastes and other refuse collected by the city; this facility is located on Bellcase Rd north of Alabama Highway 217 (Lott Road). A fourth landfill, the Southside Disposal Station (formerly the Lott Rd. Landfill), is located on Alabama Highway 217 and is authorized for accepting industrial wastes from local chemical and paper manufacuring facilities. A fifth facility, the Brownlee Landfill is located near the Prichard municipal landfill and is permitted for the disposal of debris from land clearing and non-hazardous materials from demolition operations. The primary impact to the watershed from these operations has been the siltation of streams and wetlands in the Eight Mile Creek and Seabury Creek sub-basins . Significant washouts and erosion from the Southside Disposal Station has been documented by the ADEM Mobile Branch Office on several occasions.

INDUSTRIAL FACILITIES

As mentioned earlier in this report the high degree of industrial development and commercial activities in the CCW are in significant contrast to the low degree of such development in the Dog River and Bon Secour River Watersheds. Industrial development in the CCW began in the 19th Century centered around timbermills and shipping. Early this century the pulp and paper industry developed, taking advantage of the locally abundant pulpwood resoures and surface water necessary for paper production. Electrical generation works, shipyards, modern port operations and chemical manufacturing facilities have since followed (Chermock 1974; Friend, *etal* 1982).

The area of the CCW east of U.S. Highway 43 has developed to become almost entirely industrial in land-use (Figure 5). Present industrial facilities in this section include Kimberly Clark Tissue Co., S.D. Warren Paper Co., International Paper Co., Occidential Chemical, CYTEC (formerly American Cyanimid), Jones Chemical Co., UOP Molecular Sieves (formerly Linde Division-Union Carbide), Alabama Power Co.-Chickasaw Steam Plant, Coastal Mobile Refining Co., Shell Oil (formerly Louisana Land and Exploration Co.) and Chickasabouge Lumber Co. Warrior Gulf and Navigation operates berthing and maintainance facilities for barges and towboats on Chickasaw Creek near the mouth of Greenwood Bayou. The City of Chickasaw also owns port facilities on the creek. These operations are capable of accomodating ocean going vessels. Additionally, there are numerous storage warehouses, freight truck operations, industrial equipment distributors and chemical suppliers which operate closely with the industry. A list of the major facilities and their products is given in Table 2.

This dense concentration of manufacturing operations and associated wasterwater discharged to Chickasaw Creek has, in the past, contributed significantly to severely degraded water quality (depletion of dissolved oxygen) in the lower reaches of Chickasaw Creek (South Alabama Regional Planning Commission 1979; Alabama Coastal Area Board 1980). However in recent years the bulk of the wastewater produced by industrial processes in this section of the creek has been discharged via upgraded treatment plants to the Mobile River. The industrial facilities discharging process wastewater and stormwater runoff to the watershed operate under the conditions and limitations of permits issued by the Department through the National Pollutant Discharge Elimination System (NPDES). A brief summary of the discharge limitations and monitoring requirements of the permitted facilities is given in Table A-2 in the appendix.

Industrial development in the CCW west of Highway 43 consists primarily of light manufacturing, equipment repair, freight shipping and service related businesses. These commercial operations are chiefly concentrated in the communities of Whistler, Eight Mile, Crawford and Semmes. Although none of these facilities is classified as a major industry, their contribution to the local economy is very significant.

The nature of the operations at the manufacturers and other businesses in these communities is such that the characteristics and low volumes of wastewaters produced have been suitable for discharge to either a municipal sanitary system or septic tank. This means most of the businesses along Eight Mile Creek and Chickasaw Creek west of the confluence with Eight Mile Creek have operated without a need to discharge process wastewater to a receiving stream.

However, expanding areas of paved surfaces and the growing knowledge of the potential harm to aquatic life from non-point sources have resulted in requirements that businesses using or storing petroleum products, solvents, paint and otherwise hazardous materials obtain an NPDES stormwater permit and abide by the conditions specified. Basically this means operating in a manner that minimizes the runoff of oily substances, mineral matter and other substances of potential harm to aquatic life.

Between Eight Mile and the community of Lott are located a storage facility (tank farm) and metering station operated by the Amerada Hess Oil Co. Also in this area is a metering station operated by Koch Petroleum (formerly United Gas Pipeline).

At the time of this study there were four natural gas pipelines and two oil pipelines crossing the CCW in the area bounded by Eight Mile, Chunchula, Orchard and Lott.

Continuing north through the watershed, the only area of significant industrial development is northeast of the community of Chunchula. The Union Oil Company of California operates a gas processing plant for the purpose of removing the hydrogen sulfide from natural gas produced from wells in the Chunchula Gas Field. Liquified petroleum gas, propane and butane, is sold to distributors and the molten sulfur removed from the processed gas is sold to industrial users. Also in the Chunchula area are storage tank installations and a cryogenic gas production facility.

Table 2

A List of Major Industrial Facilities in the Chickasaw Creek Watershed

Company Name	Product	SIC Code
Kimberly Clark Paper Co.	Tissue, tissue products & paper towels	2621
S.D. Warren Co.	Bleached kraft & fine papers	2621
International Paper Co.	Bleached kraft & fine papers	2621
CYTEC	Industrial inorganic chemicals	2819
Occidential Chemical	Chlorine & caustic soda	3514
Jones Chemical Co.	Sodium hypochlorite & Chemical repackaging	5161
Eagle Chemical	Dessicant (silica gel)	2819
UOP	Molecular sieves (gas purifiers)	2819
Alabama Power Co. Chickasaw Steam Plant	Electrical generation	4911
Shell Oil Co. (formerly LL&E)	Gasoline and refined petroleum products.	2911
Coastal Mobile Refining Co.	Asphalt	2951

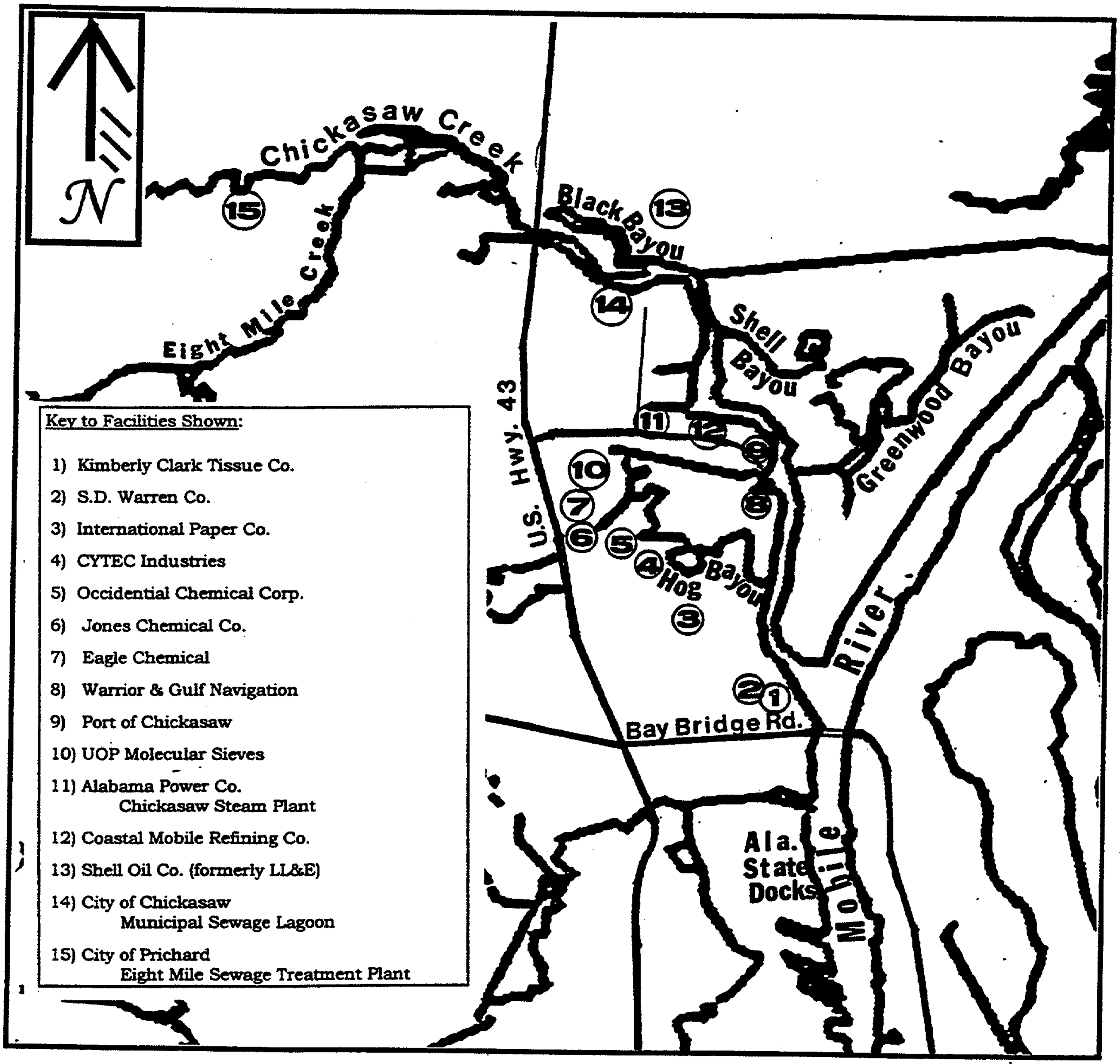


Figure 5

Industrial Facilities and Municipal Wastewater Treatment Plants in the Chickasaw Creek Watershed

WATERSHED ASSESSMENT

Land reconnaissance of the watershed by motor vehicle was begun in October 1995 and continued through September 1996. These efforts were undertaken to update the aerial photographic information from the SCS Soil Survey and land-use maps provided by the South Alabama Regional Planning Commission, identify ongoing physical impacts to the streams of the watershed and collect information on the water quality and aquatic life of the basin. During July and August of 1996 the land surveys were supplemented with surveys of the lower reaches of Chickasaw Creek and its estuarine embayments from a motor boat.

ONGOING DEVELOPMENT

New construction within the southeastern portion of the watershed is proceeding at a slow rate of activity. This includes the urban sections in and immediately around the City of Chickasaw and the City of Prichard. These areas have been densely populated and well developed for several decades; therefore there remains little acreage available for new structures. Ongoing construction in this part of the basin mostly is in the manner of additions to existing industrial operations, expansion of warehouses and renovations to old and outmoded production facilities. Residential construction was observed to consist of single houses going-up on individual lots sited in densely populated neighborhoods.

At the time of the survey it was noted that along U.S. Highway 43 in Chickasaw several businesses were conducting renovation and remodeling operations but all appeared to be additions to existing facilities. On the west side of Chickasaw construction recently was completed on several gasoline and food convienence stores, resturants and motor inns.

Because of the densely developed urban land in the southeastern part of the CCW general urban non-point sources would appear to present the greatest potential for adverse impact to the aquatic habitats and water quality of the basin. Management of urban stormwater by the municipal agencies signed to the NPDES Permit for the Mobile Area Municipal Separate Storm Sewer System (MS4 Permit) is expected to provide an adequate means of control of these sources. This will be discussed more in the section on stream surveys and impacts to water quality.

Currently there are several residential construction projects ongoing in the Eight Mile community. A subdivision development is nearing completion just off Alabama Route 217 (Lott Road) and a few individual houses are in various stages of construction near the University of Mobile. Site preperations are underway for several developments along Alabama Route 213 (Shelton Beach Road) near the university.

Although not involving the construction of new subdivisions or shopping centers, the catagory of land-use presenting the greatest potential for damaging Eight Mile Creek and other streams of the immediate vicinity of Eight Mile and Indian Springs is that of borrow pits or "dirt" pits. Erosion and runoff from borrow pits can, if left unchecked, discharged enormous quantities of silt to surface waters (ADEM 1989; South Alabama Regional Planning Commission 1979, 1993 and 1994). This condition is sometimes further complicated with the issue of abandoned pits and landowners unable or unwilling to reclaim the site.

Numerous sites in the area between Lott Road and U.S. Highway 98 (Moffett Road) have supplied fill dirt, sand and clay for construction projects in the Mobile area for the past 30 years or so. A number of these have sat unused for over a decade. Siltation has become noticeable in the Eight Mile Creek sub-basin, particularly in the streams near and along Bear Fork Road, Highpoint Boulevard, Shelton Beach Road and Myers Road. Likewise, Seabury Creek north of Lott Road has accumulated significant amounts of sediment from borrow pits and unpaved road cuts. Much of the accumulated material in Seabury Creek appeared to be deposited during the study. The situation has become severe enough so that Seabury Creek at U.S. Highway 45 has lost a well defined stream channel and has been turned into a weedy mudflat with shallow braided channels. When the study commenced in October 1995 Seabury Creek at Highway 45 could be sampled under all flow regimes; however by August 1996 the growth of vegetation and accumulation of silt had created a site that was essentially unsampleable.

The Forest Hill and Orchard communities in Mobile currently have considerable activity with new street construction and renovations to shopping centers. Residential construction appeared to be limited to a few scattered individual lots, but no large subdivision projects. Urban non-point sources such as parking lots and street drains would appear to present the greatest potentiality for adversely affecting aquatic habitats and water quality. These areas are within the city limits of Mobile and should benefit from the implementation of the MS4 permit requirements.

The communities of Crawford, Semmes and Lott are undergoing relatively moderate growth at the time of this survey. New development in these areas seems to be single family dwellings, small retail businesses and light commercial. Horticultural nursery operations around Semmes also appear to be expanding. These businesses might be expected to experience continuing growth supplying stock for landscaping new developments in the Mobile area.

Although these communities are unincorporated and not designated as urban areas the growth of business and commercial developments still brings an increase of storm water runoff from parking lots, driveways, roofs and storage areas. Control of these various non-point sources is presently the best protection of the streams in these communities. Presently, erosion and siltation is not a significant problem in this portion of the CCW. However, this is due to the lack of site clearing operations for large developments rather than a lack of potential for erosion. The sandy loam soils of these communities have physical characteristics making them subject to erosion on cleared land if erosion control measures are not implemented.

The part of the watershed around and including the communities of Kushla, Mauvilla, Chunchula, Georgetown and Gulf Crest accounts for approximately two-thirds of the total area of the basin and is the least rapidly changing section of the CCW. Population growth is slow in these communities; therefore residential construction is limited to scattered individual sites on larger acreage plots rather than subdivision lots. Small retail businesses, automotive repair and gasoline convenience stores dominate the commercial development in these communities.

This part of the watershed is characterized by numerous, almost innumerable, unpaved roads. During the watershed survey it was noticed that a sizeable proportion of the residents in these communities lives on the unpaved roads and provide a considerable volume of traffic. The sandy-loamy soils and steep slopes along streams present conditions highly favorable for erosion and siltation. This was the situation observed at several locations in the upper parts of the CCW and was especially noticeable at stream crossings and other locations where road cuts were near to a stream. Considering that some of the roads have existed since the turn of the century it is likely that these problems have been occurring for a number of years. Control of erosion from the unpaved roads in and around Chunchula, Turnerville, Georgetown and Gulf Crest should greatly benefit the streams of the CCW.

ASSESSMENT OF THE BASIN'S WATER QUALITY

Materials and Methods:

Monitoring stations were established at four sites on Chickasaw Creek, at two sites on Eight Mile Creek and at bridge crossings over several of the tributaries to Chickasaw Creek. The locations of these stations are illustrated in Figure 6 and a description of the stations is listed in Table 3. As was the case with the surveys of the Dog River and Bon Secour River Watersheds, the purpose of monitoring the water quality was not to establish long term trends through sampling on a regular periodic schedule. Rather it was to examine how the streams of the basin are affected by a wide variety of conditions, especially high flows immediately after storms and low flows during hot weather.

The previous surveys of watersheds were helpful in educating the ADEM Coastal Program Staff as to the appropriate parameters to analyze. The *in situ* field measurements, temperature, pH, dissolved oxygen, conductivity and salinity have become standard procedure wherever and whenever possible. Turbidity, ammonia, nitrate, phosphate and fecal coliforms also have proven to be useful for assessing non-point source impacts to streams.

Also considered were the reports on file at the ADEM Mobile Branch Office of investigations of discharges of brine from oil and gas production facilities in the Chunchula and Citronelle fields. With the potential for saline waters affecting the streams of the CCW, it was decided to analyze for hardness, total dissolved solids (TDS) and chlorides (Cl). These parameters allow some measure of monitoring the potential changes of water quality should releases of brine occur. A complete list of the water quality parameters analyzed is given in Table 4.

The intent of the sampling schedule was to assess the streams within the basin at the high and low ends of annual flow regimes, during and immediately following storm events as well as during "average" flow periods. This schedule also was to support the biological monitoring by documenting seasonal and storm event effected variations of water quality potentially affecting the aquatic communities of the CCW.

The monitoring sites were sampled three times during the fall low-flow season of October and November, twice during the late winter-early spring rainy season of February and March, and six times during the summer to represent the season of afternoon thundershowers interspersed with dry periods varying between two days to two weeks. The summer sampling also served as the period for monitoring the effects of storm water runoff from urban and rural areas. In addition, samples for fecal coliform analysis were collected on four sampling trips during August and early September at approximately equally spaced intervials. Although not intended as a rigidily structured sanitary survey, the sampling during this time should provide a good indication as to the suitability of the basin's waters for recreational usage.

At each monitoring site, water temperature, pH, dissolved oxygen, conductivity and salinity were measured. These measurements were taken near the surface for shallow depth wading stations, those a meter deep or less, and as vertical profiles at 0.5 meter intervals for stations greater than a meter in depth and sampled from a boat. Air temperature, wind speed, cloud cover and general weather conditions also were noted.

Water samples were collected by either a Kemmerer bottle or a two gallon plastic bucket. Immediately following collection a 250 ml portion of each sample was placed in a sterile Nalgene jar for bacterial analysis and stored on ice. A second portion was transferred to a one liter plastic jug and preserved with sulfuric acid for nutrient analyses. A third portion was placed in a two liter plastic jug and preserved on ice for the remaining analyses. All samples were returned the same day to the ADEM Mobile Branch Lab and signed over to the laboratory staff. Collection and transportation of all samples was performed according to the methods specified in the Department's Standard Operating Procedures (SOP). Strict chain of custody was maintained for sample transfer throughout the study.

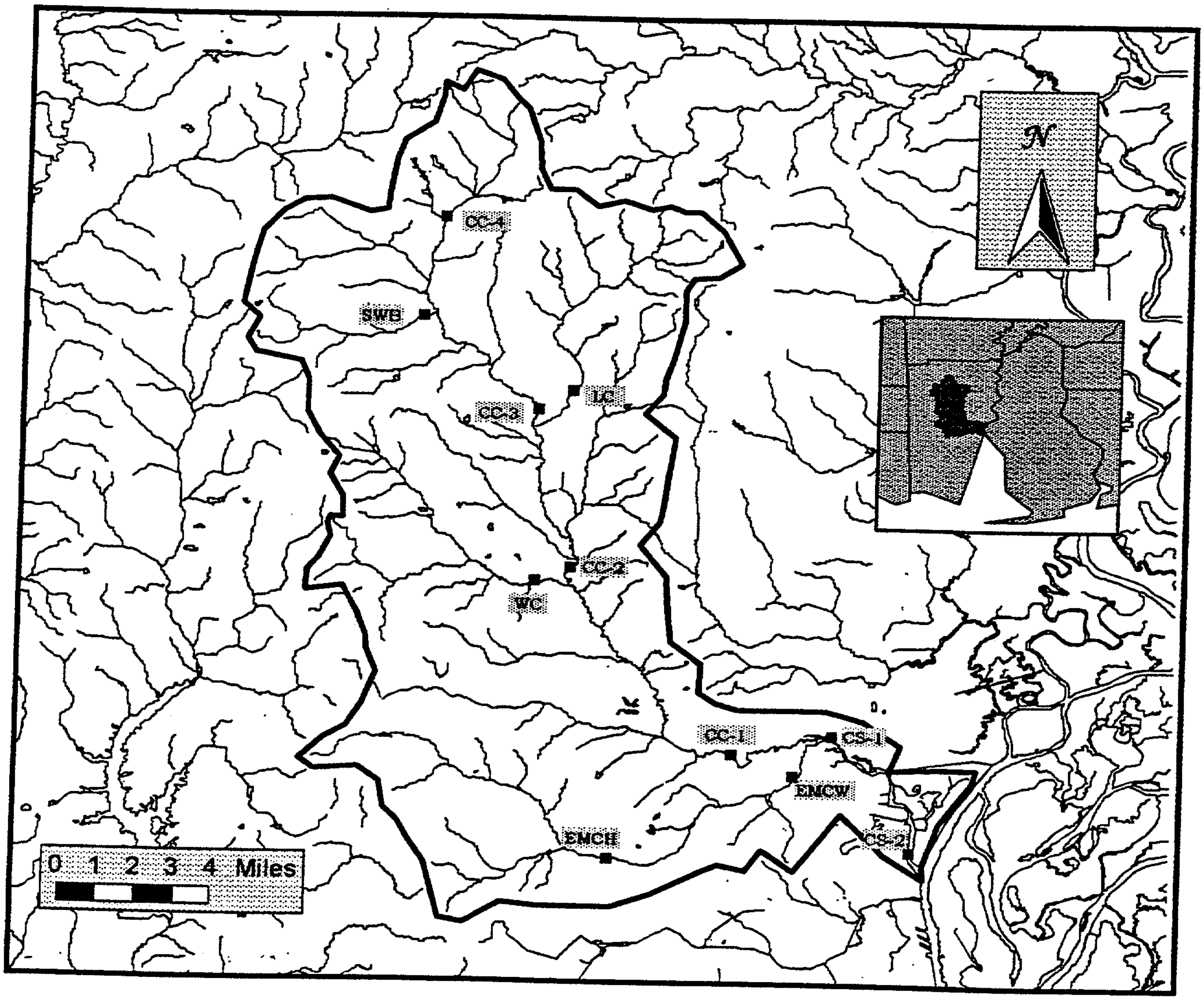


Figure 6
Locations of Stream Monitoring Sites

Table 3
Descriptions of Stream Monitioring Sites

Station I.D.	Stream & Site Location
CC-1	Chickasaw Creek @ Ala. Highway 213 (Shelton Beach Rd.) near Eight Mile. Natural stream course, wooded banks with a few scattered umbrella sedges, cattails, pickerelweed and other aquatic vascular plants. Stream depth 1-2 meters.
CC-2	Chickasaw Creek @ Mobile County Rd. 55 (Kali-Oka Rd.) near Kushla. Natural stream course with trees and shrubs along both banks. Slope along banks moderately steep, numerous overhanging tree branches but sparse aquatic vegetation. Stream depth 0.5-1 meter.
CC-3	Chickasaw Creek @ Mobile County Rd. 63 (Roberts Rd.) near Chunchula. Natural stream course with densely wooded banks. Overhanging trees shade nearly all of the creek. Some pickerelweed and arrowhead in still waters along the banks. Station depth 0.3-0.5 meter.
CC-4	Chickasaw Creek @ Old Gulf Crest Rd. near Gulf Crest. Natural stream course but a significant amount of sediment deposition is present throughout this stretch. Both stream banks densely wooded with redbay, red maple and alder. Smartweed and other grasses present in open areas; arrow-arum and water lily present in quiet pools. Station depth 0.5-1.5 meter.
CS-1	Chickasaw Creek @ the U.S. Hwy 43 bridge crossing near Chickasaw. Natural stream course but some structures (piers, boat slips and marinas) along the banks. Station depth 6 meters.
CS-2	Chickasaw Creek @ CSX rail bridge near the confluence with the Mobile River. Stream course has been modified by channel dredging and stream bank excavation. Industrial area with numerous bulkheads, docks and other structures along the west bank and a wastewater aerstion basin on the east bank. Station depth 9 meters.
LC	Log Creek @ Mobile County Rd. 63 near Chunchula. Steep gradient natural stream course with a slight amount of sediment deposition in eddies along stream banks. Moderately steep banks with dense plant cover although surrounding area has been recently logged. Station depth 0.3-0.5 meter.
EMCW	Eight Mile Creek @ Whistler St. in Whistler. Natural stream course with well vegetated banks. Surrounding area is residential/commercial urban land with a large percentage of hard surface cover. Station depth 1.5 meters.

Table 3 cont.
Descriptions of Stream Monitioring Sites

Station I.D.	Stream & Site Location
EMCH	Eight Mile Creek @ Highpoint Blvd. in Mobile. Natural stream course with wooded stream banks. Arrow-head and pickerelweed along the shore in quiet eddies. Station is downstream of several subdivisions and light commercial developments which have existed for 15 to 30 years. This area also has a number of borrow pits and large cleared sites which drain to Eight Mile Creek. The streambed at this site has accumulated a considerable amount of sediment. Station depth 0.5-1.5 meters.
WC	Williams Creek @ Mobile County Rd. 55 (Kali-Oka Rd.) near Kushla. Natural stream course with trees and shrubs along both banks. Slope along banks moderately steep, numerous overhanging tree branches but sparse aquatic vegetation. Sediment deposition moderate. Stream depth 0.5-1 meter.
SWB	Sweetwater Creek @ U.S. Hwy 45 near Chunchula. Stream has been altered somewhat by channelization and stream bank stabilization (rip-rap) near highway. Vegetation is mostly grasses and shrubs, no overhanging vegetation along banks. Land upstream of this site is mostly wooded but includes the Mobile County Sanitary Landfill. Site has received a moderate amount of sediment deposition. Station depth 0.2-1 meter.

Table 4

Water Quality Parameters Analyzed

In situ measurements	Laboratory analyses
Water Temperature	Turbidity
pH	Total Suspended Solids
Dissolved Oxygen	Total Dissolved Solids
Conductivity	Hardness
Salinity	Chloride
	Ammonia
	Total Kjeldahl Nitrogen
	Nitrate
	Phosphate
	Fecal Coliform

Results:

The overall water quality was observed to show considerable improvement compared to the conditions at the time of the Mobile Area 208 Study. At sites where comparisons could be made, the levels of total nitrogen, phosphate, biochemical oxygen demand and fecal coliforms were significantly lower than was the case twenty years ago. Dissolved oxygen (DO) concentrations near the surface and at depths above the halocline in the lower reaches of Chickasaw Creek were notably improved compared to the data of the 208 study. However, DO values measured below the halocline were less than 2 milligrams per liter throughout lower Chickasaw Creek during the months of June through September. The lignin and tannic acid discoloration which was so distictive in the vicinity of Hog Bayou and the mouth of Chickasaw Creek has diminished to a more natural tannin color of coastal streams. Floating debris and trash were noted after rainstorms; however these items usually were confined to tributaries in urban areas and Chickasaw Creek below the confluence with Eight Mile Creek. A tabular summary of stream water quality data may be found in Table 5.

Over the past decade, those wastewater treatment plants discharging to Chickasaw Creek have been upgraded and the two largest historical dischargers (International Paper and Scott Paper) have relocated their outfalls to the Mobile River. In spite of these changes and an overall improvement of water quality, the lower reaches of Chickasaw Creek and the surrounding bayous downstream of U.S. Highway 43 continue to experience problems from low concentrations of dissolved oxygen.

This condition of very low dissolved oxygen (hypoxia) was observed to occur in association with the vertical stratification caused by the saline wedge moving with incoming and outgoing tides. The concentrations of dissolved oxygen were sufficent for supporting healthy aquatic life (i.e. > 5 mg/l) in the fresh lower density waters above the halocline; in the lower waters of the salt wedge DO rapidly decreased to less than 2 mg/l and often approached zero. The occurrence of stratification and hypoxia was more pronounced at times of low flows than at times of high flows. Warm temperatures also appeared to intensify the bottom hypoxia. It should be noted that depressed concentrations of dissolved oxygen were noted to occur only in the estuarine portions of the watershed (i.e. Chickasaw Creek and its inlets and bayous between U.S. 43 and the Mobile River) and were not observed in the flowing streams of the watershed.

This mechanism of isolating bottom waters from over lying waters and preventing transfer of oxygen has been well known for years and has been documented by several reseachers and agencies studying Alabama's coastal waters (McPherson 1970, Bault 1972, May 1973, Schroeder 1976, South Alabama Regional Planning Commission 1979, ADEM-FDER 1990 and ADEM unpublished water quality trend data 1997).

The natural conditions leading to hypoxia in the bottom waters of Chickasaw Creek has been exacerbated by the presence of a high sediment oxygen demand brought about by the accumulation of organic rich sediments (South Alabama Regional Planning Conmmission 1979, Alabama Coastal Area Board 1980). Untreated process wastewaters were routinely discharged to Chickasaw Creek and Hog Bayou until the 1970's. The slow rate of flushing in the estuarine part of the basin also promotes retention of accumulated matter on the bottom (South Alabama Regional Planning Commission 1979). Salt wedge migration and salinity stratification can exert a natural stress on aquatic life; however nutrient enrichment and a slowly flushing system magnify the effect.

The streams within the urban parts of the watershed (Prichard and Chickasaw) possessed fairly good overall water quality relative to streams monitored by the Department in other densely developed areas. The water quality use classification of fish and wildlife was maintained throughout the study for the stretch of Chickasaw Creek running from the University of Mobile to the U.S. Highway 43 Bridge.

Sampling of these sites during times of high runoff following rainstorms indicated that although turbidity and fecal coliforms do increase for a short time the fish and wildlife classification is maintained. Nonetheless, the urban tributaries of the CCW, in particular Gum Tree Branch, were noted to carry significant amounts of floating trash and debris following a rainstorm. Stream debris in these areas appears mostly to come from street curb drains and the parking lots of retail businesses and shopping centers.

Monitoring of streams in the suburban areas of Orchard, Semmes and Eight Mile indicated that siltation was the primary impairment to water quality. For Eight Mile Creek this was most severe near Highpoint Boulevard, Bear Fork Road and Myers Road. For Seabury Creek turbidity and siltation were obvious problems for most of the length of the stream from Lott Road to U.S. Highway 45. As prevously mentioned, Seabury Creek at the U.S. 45 bridge crossing accumulated enough silt during the study to degrade from a moderately silted-in stream with a defined channel to a heavily silted-in weedbed.

Soil erosion and runoff from borrow pits (active and inactive) appear to be the primary cause of problems in these streams. Secondary contributions of silt also come from numerous pieces of property along Bear Fork Road, Shelton Beach Road and Lott Road. These sites look as if they have been cleared for several years but have seen no development or construction of any type.

Minor amounts of trash and litter were observed at various places along Eight Mile Creek and Red Creek. The amount of floating debris in these streams was not nearly as noticeable as in Gum Tree Branch. However, this condition likely is the result of the less densely populated neighborhoods and the smaller proportion of the area covered by commercial development, parking lots and other impervious surfaces relative to the urban areas of the watershed. The ongoing development and continuing population growth in these communities has the potential to increase the problem.

The bridge crossings over Red Creek and Eight Mile Creek also have served as trash disposal sites for what appears to have been a considerable number of years. Household refuse, old tires, discarded appliances, worn-out mattresses and other items too numerous to mention were observed by Department personnel at several sites. The utilization of bridges as trash dumps was observed to be at its worst at the Highpoint Boulevard Bridge on Eight Mile Creek.

Nutrient data for water samples collected from Eight Mile Creek and Seabury Creek show that these streams have higher nitrate concentrations than the average for streams of Coastal Alabama monitored by the Department. The levels of nitrate also appeared to have a seasonal trend towards higher concentrations in the spring and summer months and lower concentrations in the fall and winter. This is typical for streams receiving a significant quantity of runoff from suburban lawns and other landscaped properties (National Oceanic and Atmospheric Administration 1987; National Research Council 1990; U.S. Fish and Wildlife Service 1991; U.S. Environmental Protection Agency 1991; ADEM-FDER, 1991). Although higher than the average for area streams, the concentrations of nitrate observed at the time of this study are not considered an impairment to water quality. However this also is another aspect to consider as Orchard, Semmes, Eight Mile and other nearby communities continue to grow.

The fecal coliform data for Eight Mile Creek and Seabury Creek were well below the limit specified for fish and wildlife waters (geometric mean of 1000 colonies per 100 milliliters of sample, single sample maximum of 2000 colonies per 100 ml of sample). Storm events did not appear to cause sudden significant increases of bacterial counts in these streams.

In the upper two-thirds of the CCW including Kushla, Chunchula, Georgetown, Turnerville and Gulf Crest the streams were primarily affected by siltation. This was more evident at the bridge crossings of unpaved roads and at locations where the slopes along streambanks had been cleared. Streams especially affected are Williams Creek near Smithtown and Oak Grove, Log Creek near Chunchula and Chickasaw Creek at the bridge crossing of Old Gulf Crest Road and at several locations between Gulf Crest and Oak Grove.

Fecal coliform data for the streams in the upper basin indicates the presence of minor short-term impairments of these streams' suitability for recreational activities. Chickasaw Creek is assigned a state water use-classification of swimming and other whole body water-contact sports (fecal coliform geometric mean criterion of 200 colonies per 100 ml) for the stream segment beginning at the University of Mobile and extending to the headwaters of the creek. On a couple of the stream surveys the fecal coliform counts in the upper reaches of Chickasaw Creek (stations CC-2, CC-3 and CC-4) were greater than 1000 colonies per 100 milliliters ; however, these values are representative of monitoring conducted during cool wet weather conditions. Summer monitoring produced fecal coliform values consistantly less than 200 colonies per 100 ml in the upper part of the CCW and geometric means for the duration of the study were in the range of 135-150 colonies per 100 ml.

Log Creek, Williams Creek and all other streams located within the upper basin are assigned a use-classification of fish and wildlife. These streams met the bacterial standard for fish and wildlife waters throughout the study; however the criterion for swimming was achieved during the summer monitoring.

Data from laboratory analyses did not reveal problems indicative of excessive nutrient concentrations in the upper reaches of Chickasaw Creek and associated tributaries. The sparse population and low density of development are likely contributors to this quality.

As mentioned earlier, analyses of stream waters for hardness, total dissolved solids and chlorides were added to the list of laboratory parameters for this study, the rationale for this being that if brine from gas production in the Chunchula Field was entering Chickasaw Creek in significant quantities then evidence of such would manifest itself as incresed values of these parameters downstream of the field relative to upstream qualities. Comparison of the data from Chickasaw Creek at Gulf Crest with the data from the sites at Chunchula and Oak Grove indicated no difference; likewise a comparison of the data from Log Creek at Roberts Road with Log Creek near Turnerville shows similar levels of these dissolved substances.

Stream debris and trash in this part of the watershed was mostly limited to "dump sites" at bridge crossings. The bridge crossings of Mobile County Road 55 (Kali-

Oka Road) over Williams Creek and Chickasaw Creek and the bridge crossing of Mobile County Road 63 (Roberts Road) over Log Creek are the recipients of numerous old tires, plumbing fixtures, appliances and beer cans. The most unique item found at these repositories of surplus merchandise was a cylinder of nitrous oxide on the banks of Williams Creek.

Special Investigations:

During the course of the survey of the CCW, personnel of the Mobile Branch of ADEM and the U.S. Department of Justice conducted an investigation of illegal discharges of wastes from a septic tank pump-out operation to Red Creek, a tributary of Eight Mile Creek, off Schillinger Rd. Agents from the Federal Bureau of Investigation (FBI) and field investigators from ADEM documented the discharge of thousands of gallons of untreated septic tank wastes from pump-out trucks which by law should have been transported to a wastewater treatment plant for proper disposal. Discharge of such materials presents a threat for exposing swimmers downstream to serious threats from pathogenic bacteria and viruses. The investigation led to convictions and incarcerations for those involved with the crime.

TABLE 5 SUMMARY OF WATER QUALITY MONITORING DATA

LOCATION		WATER TEMP. (DEG C)	pH (S.U.)	D.O. (mg/L)	CONDUCTIVITY (µmhos/cm)	TURBIDITY (NTUs)	BOD-5 mg/L	TSS mg/L	TDS mg/L	Cl^- mg/L	HARDNESS $CaCO_3$ mg/L	NITRATE NITROGEN (mg/L)	AMMONIA NITROGEN (mg/L)	TOTAL KJELDAHL NITROGEN (mg/L)	PHOSPHATE (mg/L)	* FECAL COLIFORM (mg/L)
CS-1	AVERAGE	20	6.3	7.83	108	13.4	1.4	9.2	79.5	20.4	17.1	0.012	0.069	0.42	0.008	185
	MAXIMUM	27	7.6	10.20	286	34	1.9	41.0	175.0	62.3	32.0	0.025	0.177	0.89	0.025	1,080
	MINIMUM	11	5.2	6.70	37	3.9	1.0	2.0	46.0	6.0	6.0	0.009	0.004	0.09	0.004	4
CS-2	AVERAGE	22	6.8	7.16	2,095	24.8	2.3	16.0	1016.6	482.4	213.3	0.142	0.089	0.88	0.412	185
	MAXIMUM	31	7.3	8.70	6,010	71	3.6	54.0	3030.0	1680	528	0.540	0.225	1.60	0.881	1,080
	MINIMUM	12	5.9	5.50	189	12	1.3	5.0	61.0	30.0	21.0	0.009	0.004	0.32	0.081	4
CC-1	AVERAGE	20	6.5	7.93	30	5.8	1.1	5.6	41.4	4.4	11.2	0.014	0.052	0.47	0.015	167
	MAXIMUM	26	7.6	9.44	35	9	1.3	9.0	53.0	5.3	22.0	0.050	0.090	1.20	0.091	314
	MINIMUM	12	5.6	6.89	24	4.7	0.9	3.0	35.0	3.0	6.0	0.009	0.004	0.09	0.003	80
CC-2	AVERAGE	21	6.7	7.34	25	4.9	1.8	4.2	43.3	4.1	9.4	0.021	0.064	0.68	0.013	138
	MAXIMUM	26	9.8	8.75	32	7.6	2.3	8.0	51.0	4.7	14.0	0.040	0.115	1.10	0.092	1,520
	MINIMUM	11	5.2	5.57	22	3.5	1.0	3.0	37.0	3.0	6.0	0.009	0.011	0.09	0.003	40
CC-3	AVERAGE	21	6.3	7.67	24	4.3	1.6	4.7	39.2	3.7	8.1	0.026	0.109	0.70	0.011	150
	MAXIMUM	26	7.6	9.68	30	8	2.8	7.0	46.0	4.3	10.0	0.050	0.172	1.70	0.075	1,080
	MINIMUM	11	4.9	6.80	22	2.3	1.0	3.0	35.0	3.0	6.1	0.008	0.044	0.09	0.002	70
CC-4	AVERAGE	20	6.5	7.34	25	3.2	1.3	3.1	47.0	3.7	8.4	0.009	0.035	0.62	0.026	83
	MAXIMUM	26	7.6	9.54	29	5.2	2.0	6.0	121.0	4.7	11.0	0.010	0.056	2.20	0.110	200
	MINIMUM	11	5.3	5.70	22	2.1	1.0	0.9	28.0	3.0	6.9	0.008	0.003	0.09	0.003	33
LC	AVERAGE	20	6.1	7.54	27	2.7	1.2	3.7	48.5	4.9	8.4	0.009	0.010	0.77	0.015	103
	MAXIMUM	25	7.6	9.64	37	4.6	1.5	6.0	53.0	10.0	12.0	0.010	0.020	1.80	0.108	480
	MINIMUM	9	5.0	6.70	23	1.3	0.9	1.0	36.0	3.9	6.0	0.008	0.003	0.42	0.003	30
EMCW	AVERAGE	20	7.0	7.64	43	9.8	2.1	7.0	45.0	5.4	16.9	0.017	0.234	0.42	0.015	283
	MAXIMUM	25	7.7	9.75	49	25	3.5	8.0	53.0	6.0	22.0	0.070	0.298	0.91	0.093	840
	MINIMUM	12	6.1	6.91	40	6	1.6	6.0	40.0	5.0	13.0	0.009	0.128	0.09	0.003	162
EMCH	AVERAGE	20	6.9	8.12	43	7.6	2.2	6.3	40.5	5.4	14.4	0.014	0.249	0.43	0.019	239
	MAXIMUM	25	7.7	9.92	50	15.5	2.7	7.0	44.0	6.0	18.0	0.030	0.350	1.20	0.108	480
	MINIMUM	13	6.2	7.40	40	5.1	1.9	5.0	35.0	5.0	12.0	0.009	0.159	0.09	0.003	110
WC	AVERAGE	21	6.7	8.15	26	4.7	2.0	4.0	39.0	4.0	8.3	0.009	0.067	0.40	0.016	212
	MAXIMUM	27	7.4	10.14	28	5.7	4.0	6.0	42.0	4.6	11.0	0.010	0.086	0.83	0.100	410
	MINIMUM	11	5.9	7.24	24	4	1.0	1.0	36.0	3.0	6.0	0.008	0.004	0.09	0.003	100
SWB	AVERAGE	20	6.4	7.82	24	4.2	1.4	3.0	36.3	4.2	11.4	0.013	0.084	0.40	0.021	161
	MAXIMUM	24	7.5	8.32	32	5.1	2.1	5.0	39.0	5.0	21.0	0.030	0.124	0.86	0.093	300
	MINIMUM	16	5.1	7.18	18	3	1.0	2.0	32.0	3.5	5.3	0.008	0.004	0.09	0.003	78

*NOTE: AVERAGE VALUES GIVEN FOR FECAL COLIFORM REPRESENT THE GEOMETRIC MEAN $GM=(X_1*X_2*X_3...X_N)^{1/N}$

SEDIMENT CHEMISTRY

Introduction:

Examination of sediments can offer insight into past conditions as well as indicating the present "pollution climate" because sediments represent a temporally integrated record of chemical conditions in a watershed. Many contaminants entering a watershed become sequestered in the sediments. This particularly is the case with estuarine watersheds as salt water promotes adsorption and precipitation of materials dissolved in the fresh water entering the system (Schropp and Windom, 1988). Furthermore, urban runoff and other non-point sources have a significant potential for contamimating sediments even in the absence of industrial wastewater discharges (U.S. Environmental Protection Agency, 1991; U.S. Fish and Wildlife Service, 1991; Baudau and Muntau, 1990 and National Research Council, 1990). Previous surveys of sediment chemistry conducted by the department have shown that the waterbodies in coastal Alabama receiving a significant amount of urban runoff are highly likely to have contaminated sediments (Alabama Department of Environmental Management, 1991, 1992 and 1995).

The objective of the sediment chemistry component of the study was to determine the concentrations of metals and the presence of excessive metal enrichment. These results were compared to a survey of natural estuarine sediments in the Alabama coastal zone which established the existence of statistically significant relationships between aluminum and eight trace metals: arsenic, barium, cadmium, chromium, copper, lead, nickel and zinc (Alabama Department of Environmental Management, 1991). These relationships may be utilized to identify unnatural concentrations of metals in estuarine sediments (Schropp and Windom, 1988; Windom *et al*, 1989 and ADEM, 1991).

This method of interpretation is based on the naturally occurring relationships between aluminum and other metallic elements. The basis for this method is that aluminum occurs naturally in all estuarine sediments and the concentrations of other metals tend to vary with the concentration of aluminum. These naturally occurring proportions of metals relative to aluminum have been reported by several investigators, Turekian and Wedepohl (1961), Taylor (1964), Duce *et al* (1976) and Schropp and Windom (1988) to be fairly constant. These relationships allow for the use of aluminum as a reference element or "normalizing factor" for identification of sediments enriched by anthropogenic activities. This concept also has been used to examine metal pollution in the Savannah River estuary (Goldberg, 1979), lead pollution in the Mississippi River (Trefey *et al.*, 1985) and metal pollution in Florida estuaries (Schropp and Windom, 1988). Additional detail regarding this technique may be found in Schropp and Windom (1988), Windom *etal* (1989) and ADEM (1991 and 1992).

Materials and Methods:

During July and August 1996 sediment samples were collected from four stations on lower Chickasaw Creek (Figure 7 and Table 6). Previous experience by the Department and other researchers have indicated that streams subject to heavy siltation by native soils and not exposed to urban runoff are unlikely to have a problem with metals contamination (Alabama Department of Environmental Management, 1991, 1992 and 1996; Baudau and Muntau, 1990). Furthermore, accumulation of metallic contaminants in sediments is usually confined to areas of fine sediment deposition (silts and clays) and tends to occur in waters at least slightly brackish in nature rather than in flowing fresh waters. Therefore sediment sampling was confined to lower Chickasaw Creek below Eight Mile Creek. Stations were selected to be representative of overall conditions and not localized or isolated problems such as boat slips, dredged channels and storm drains. The depths of stations sampled ranged from 5 meters at U.S. Highway 43 to 10 meters at the mouth of Chickasaw Creek.

Sediment cores were retrieved with an Ogeechee type core sampler (Wildlife Supply Co., cat. no. 2427-A20) equipped with a cellulose-acetate-butyrate liner tube. Sediment for metal analyses was taken from the upper five centimeters (2 inches) of each core, placed in an acid-washed glass jar and capped with a Teflon lined lid. Samples were collected in triplicate, two samples for immediate processing and the third sample for "archiving" in a freezer for future analyses in case of widely varying results between the first two.

Sample analyses began with oven-drying of sediments at 60 degrees Celsius. Weighed portions (250 mg) of each sample were placed in Teflon bombs and subjected to a total digestion process in a solution of nitric acid, hydrofluoric acid and perchloric acid at 120 degrees Celsius (Windom, *etal* 1989). Analyses were performed with a Perkin-Elmer 3030-B atomic absorption spectrophotometer (AA) equipped with a flame furnace for Al, Fe and Zn and a graphite furnace for As, Ba, Cd, Cr, Cu, Pb, Ni and Sn. A Leeman Labs Model PS-200 automated mercury analyzer was utilized for Hg analyses.

The mean values of the analyses of replicate samples were utilized as data for statistical comparisons. Statistical procedures employed in this study are detailed in Sokal and Rohlf (1969) and Filliben (1975).

Table 6

Site Locations for Sediment Cores

STATION DESIGNATION	LOCATION
CCS01	Chickasaw Creek immediately above the CSX rail bridge.
CCS02	Chickasaw Creek approximately ¼ mile downstream of Greenwood Bayou.
CCS03	Chickasaw Creek approximately ½ mile downstream of Shell Bayou.
CCS04	Chickasaw Creek approximately ¼ mile upstream of the U.S. Hwy 43 bridge.

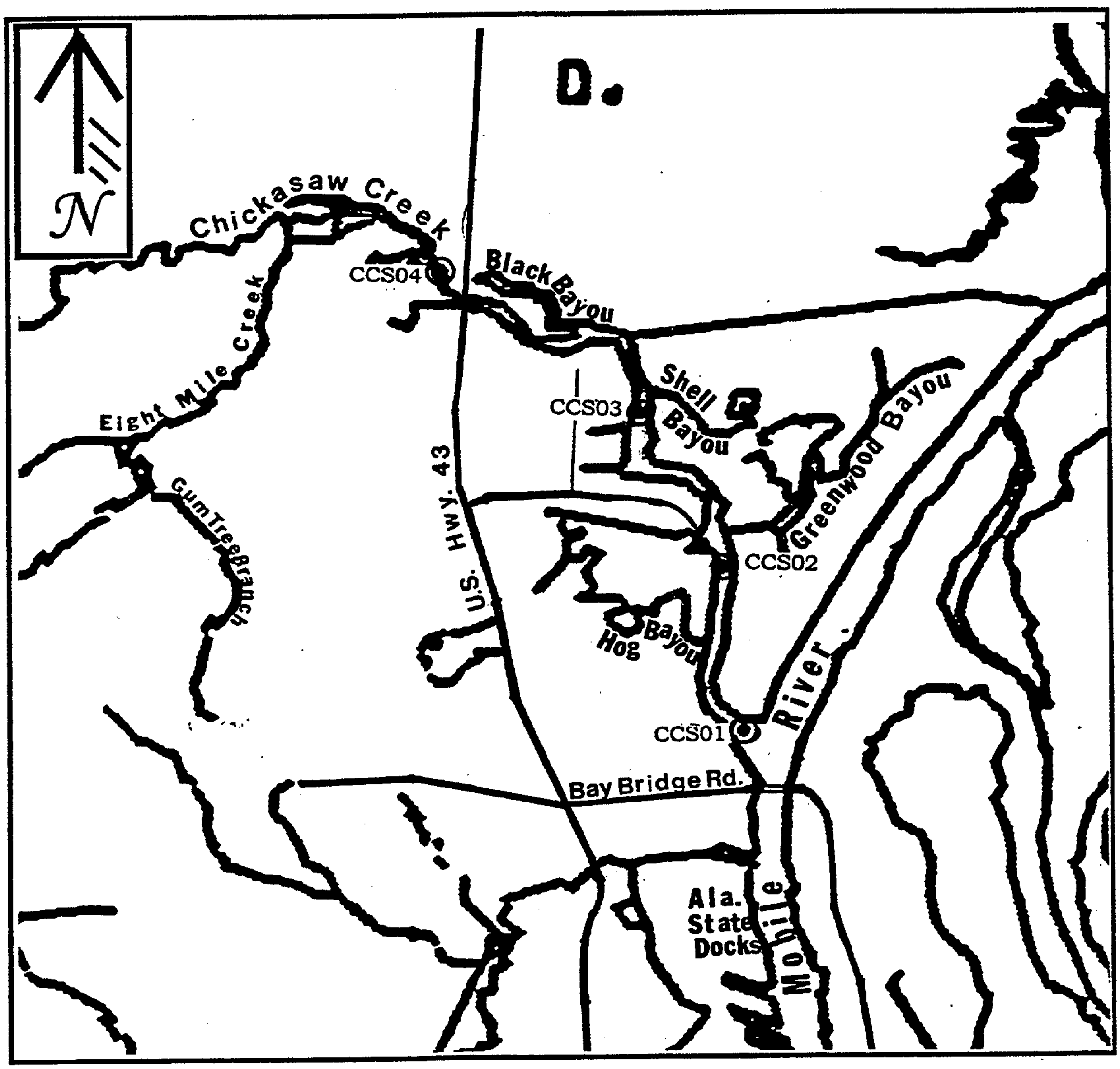


Figure 7
Locations of sites sampled for sediments.

Results:

Results of sediment metal analyses are listed in Table 7. The concentrations of eight trace metals were compared to the concentration of aluminum as described in Schropp and Windom (1988) and ADEM (1991) for determining whether sediments of the watershed were enriched with trace metals. Graphical plots of these relationships are illustrated in Figures 8a-f. Superimposed on the data plots are regression lines and 95% confidence bands for each metal/aluminum relationship as would be expected to occur if sediments were uncontaminated. The basis for determining these relationships are described by Schropp and Windom (1988) and ADEM (1990).

There is no accompanying plot for the mercury data. The findings of previous sediment studies by Schropp and Windom (1988) and the Department (ADEM, 1991) have shown that a relationship between mercury concentration and aluminum apparently does not exist. This is a consequence of the scarcity of naturally occurring mercury in the Mobile Bay drainage basin (W. Isphording, personal communication) and the fact that natural mercury concentrations are often near the limit of analytical detection where accuracy and precision are reduced.

Table 7
Results of sediment metal analyses

CHICKASAW CREEK WATERSHED SEDIMENTS

STATION	Al	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Sn	Zn
CCWS01	18,800	0.13	39.0	10.5	16,200	0.50	15	12.8	3.5	56
CCWS02	9,030	0.20	13.0	9.0	6,060	<0.40	4	9.0	3.5	28
CCWS03	36,500	0.40	61.5	31.0	25,650	0.42	18	51.0	17.0	265
CCWS04	37,075	0.30	44.0	21.5	21,125	<0.40	12	36.0	17.0	88
AVG	25,351	0.26	39.4	18.0	17,259	0.40	12.3	27.2	10.3	109
MAX	37,075	0.40	61.5	31.0	25,650	0.50	18.0	51.0	17.0	265
MIN	9,030	0.13	13.0	9.0	6,060	<0.40	4.0	9.0	3.5	28

All values are expressed as mg/kg dry wt.
All values are the average of duplicate samples

Concentrations of cadmium and nickel were within or below expected natural ranges at all stations. Copper, lead and zinc were present in amounts significantly higher than should be expected at the sites near Shell Bayou and U.S. Highway 43. Chromium values also were slightly elevated for the sediments collected at the mouth of the creek and near Shell Bayou. Although historical discharges of industrial wastewater might account for some of the higher than expected values found between Shell Bayou and the mouth of Chickasaw Creek, the excessive concentrations of copper, lead and zinc found at the site upstream of U.S. 43 are likely the result of stormwater runoff from urban areas.

Copper is widely used in wood preservatives, pesticides, soil fungicides, algaecides for controlling slime in cooling systems and anti-foulant surface coatings for boat hulls and submersed structures. Runoff containing fungicides and pesticides, and "leaching out" of wood preservatives and marine antifoulants from treated materials are the primary means by which copper enters urban watersheds (CCREM, 1987; Shutes *et al.*, 1993; US Environmental Protection Agency, 1991; US Fish and Wildlife Service,1991; Florida Department of Environmental Protection, 1993 and Baudau and Muntau, 1990).

The highest concentration of copper found in the watershed was 31 ppm (mg/kg) at the site near Shell Bayou. The recommended concentration of copper for which no adverse biological effects should be observed is 70 ppm (mg/kg) (Long and Morgan 1990). A concentration of 390 ppm (mg/kg) copper in sediments has been established as a level at which adverse biological effects are likely to occur (*ibid*). Hence the copper in sediments of the CCW, although present in elevated amounts, is not considered "toxic" to aquatic life.

Lead is commonly a constituent of paints, dyes, plastics and solder. The single largest use of lead in the United States is in lead-acid storage batteries. Prior to the trend towards unleaded gasoline over the past two decades the use of tetraethyl lead in motor fuel accounted for the single largest source of lead to the environment (Baudau and Muntau, 1990; CCREM 1987). Most of the lead in our waterways is the result of exhaust soot deposits washed from urban areas by stormwater runoff (Baudau and Muntau, 1990; CCREM 1987; Shutes *et al.*, 1993; US Environmental Protection Agency, 1991; US Fish and Wildlife Service, 1991; VanHassel *et al.*,1980). The "phase out" of lead in gasoline has virtually removed this source from further polluting waterways as well as the atmosphere. The utilization of lead as a pigment in paints and other surface coatings will continue to leach lead to aquatic environments (US Environmental Protection Agency, 1991; Baudau and Muntau, 1990).

Concentrations of lead in sediments were 36 ppm at the Highway 43 site and 51 ppm in Chickasaw Creek at Shell Bayou. Researchers have tentatively established a concentration of 35 ppm of lead in sediment as a level below which no adverse effects to aquatic life are likely to occur. Lead concentrations exceeding 110 ppm in sediments has been found to be potentially harmful to amphipods (Becker *et al.*, 1990 and Long and Morgan, 1990) brown shrimp (Vittor and Assoc., 1988), bivalves and numerous other species of aquatic animals (Chapman *et al.*, 1987 and Long and Morgan, 1990).

Zinc is an important constituent of anti-corrosive coatings for iron and steel products. Applications include marine paints, metal roofing coatings and steel girder structures. Zinc is widely utilized as a biocide and anti-corrosion additive in commercial cooling systems and boilers. As was the case with copper and lead, stormwater runoff from urban areas with a high usage of these materials is the primary path by which zinc enters aquatic environments (Shutes *et al.*, 1993; US Environmental Protection Agency, 1991; US Fish and Wildlife Service, 1991; VanHassel *et al.*,1980).

Long and Morgan (1990) have established a recommended lower threshold for zinc in sediments of 120 ppm and an upper threshold, above which adverse effects are likely, of 270 ppm. Site CCW03 near Shell Bayou exceeded the lower threshold with a value of 265 ppm. Chapman *et al.* (1991 and 1987), McLeay *et al.* (1991), Shutes *et al.* (1993) and other researchers have demonstrated that excessive concentrations of zinc have the potential for impairing the health and reproduction of crustaceans (amphipods and grass shrimp) and mollusks.

The affects of urban non-point sources and industrial activities are evident from the results of the sediment survey. Conditions such as those observed in the CCW are representative of other coastal watersheds with a high degree of urban and industrial development (Long and Morgan 1990; Delfino *et al.* 1991; US Environmental Protection Agency 1991; US Fish and Wildlife Service 1991; Florida Department of Environmental Protection 1993).

Figure 8a-8f
Plots of metal to aluminum relationships

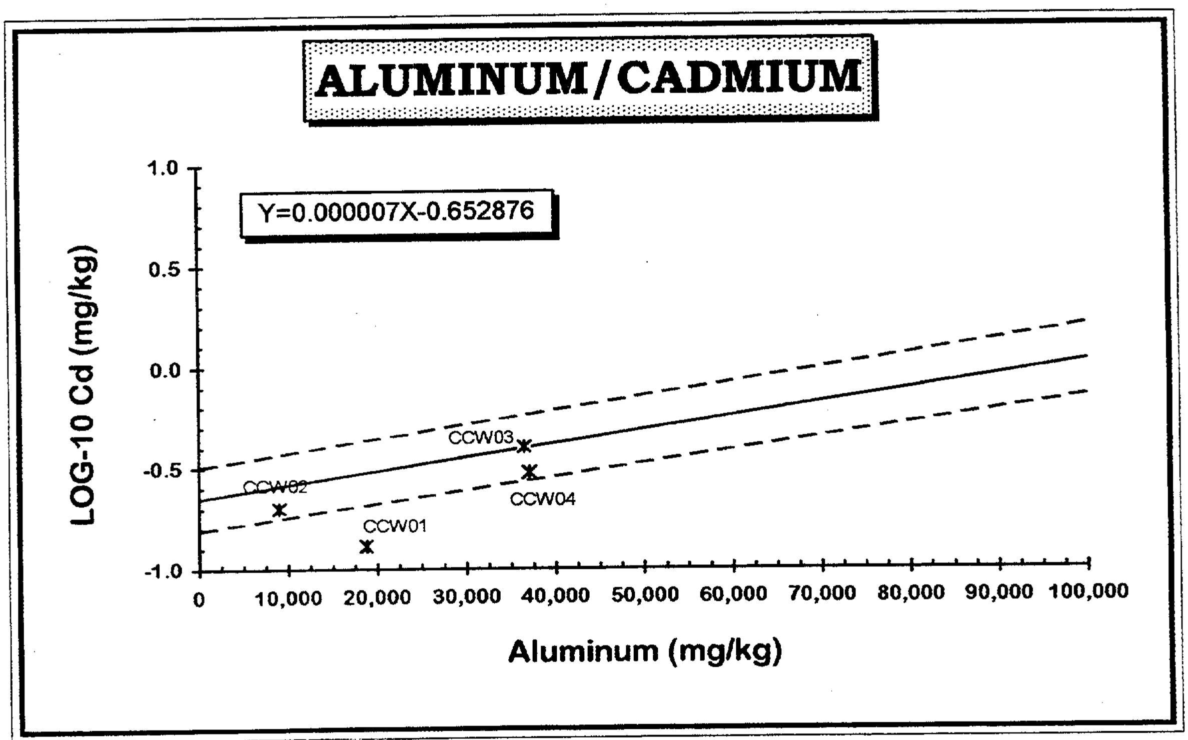


Figure 8a

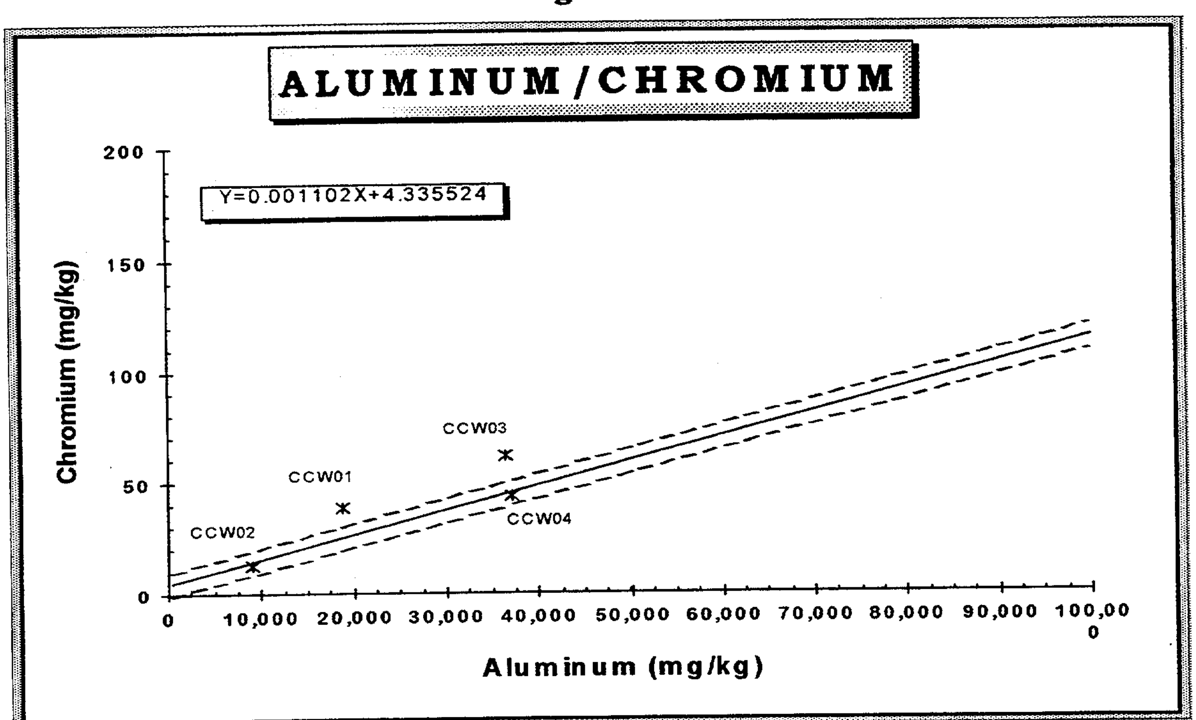
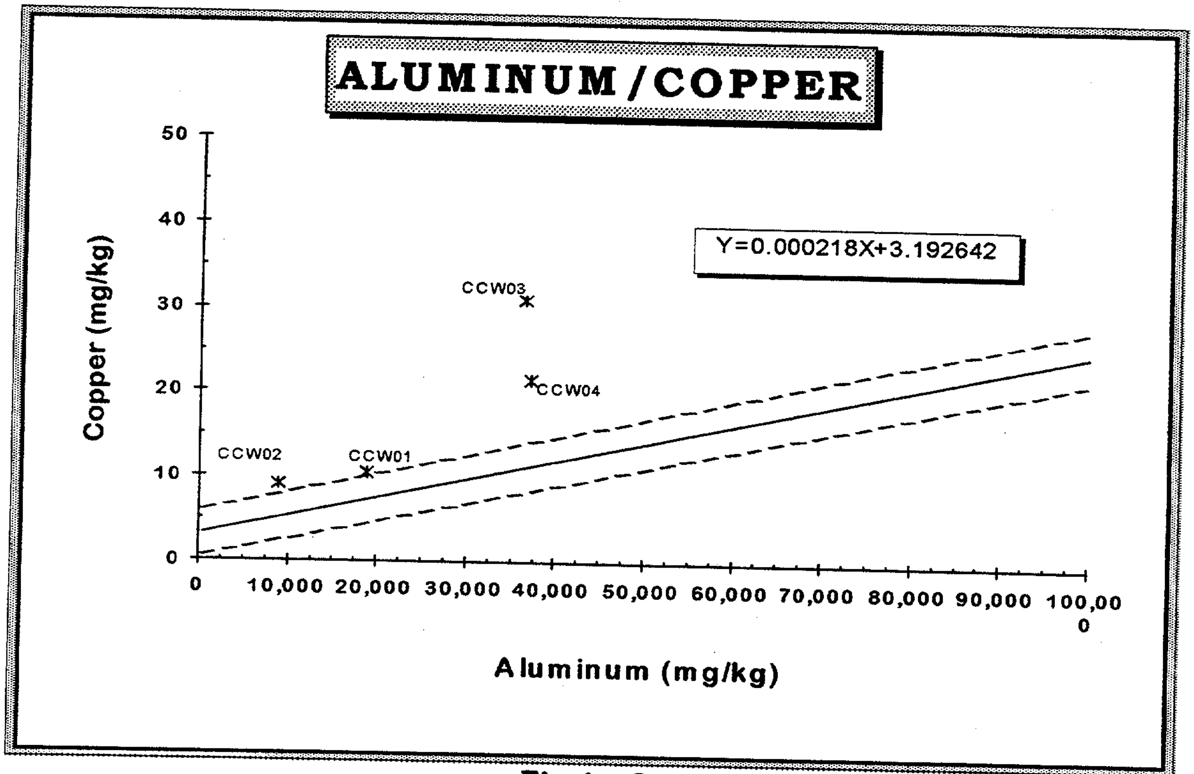


Figure 8b



Figuire 8c

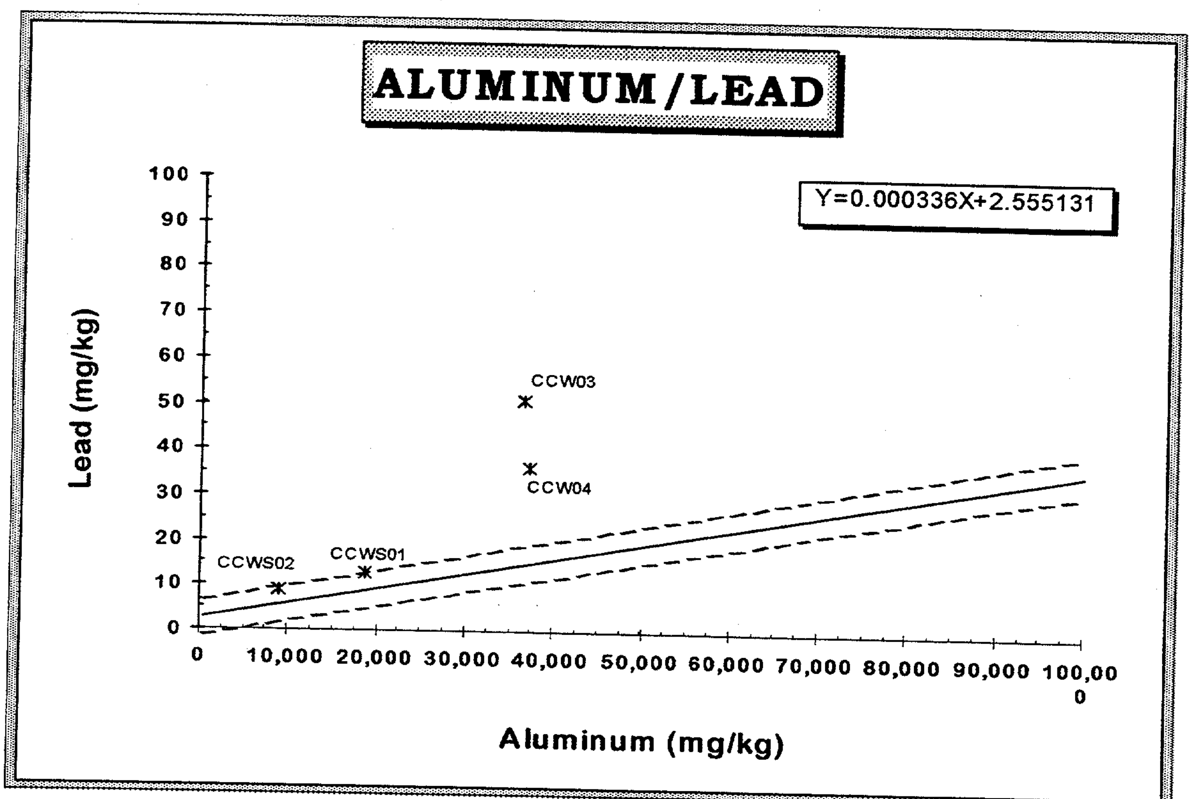


Figure 8d

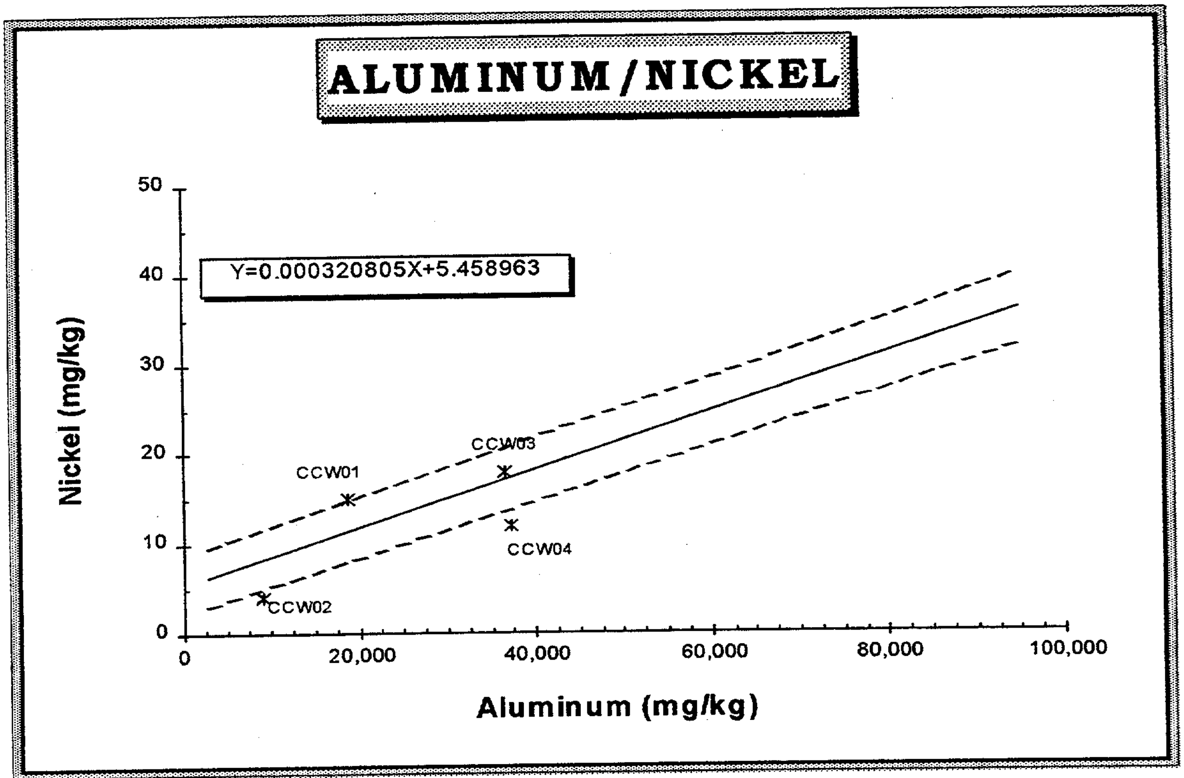


Figure 8e

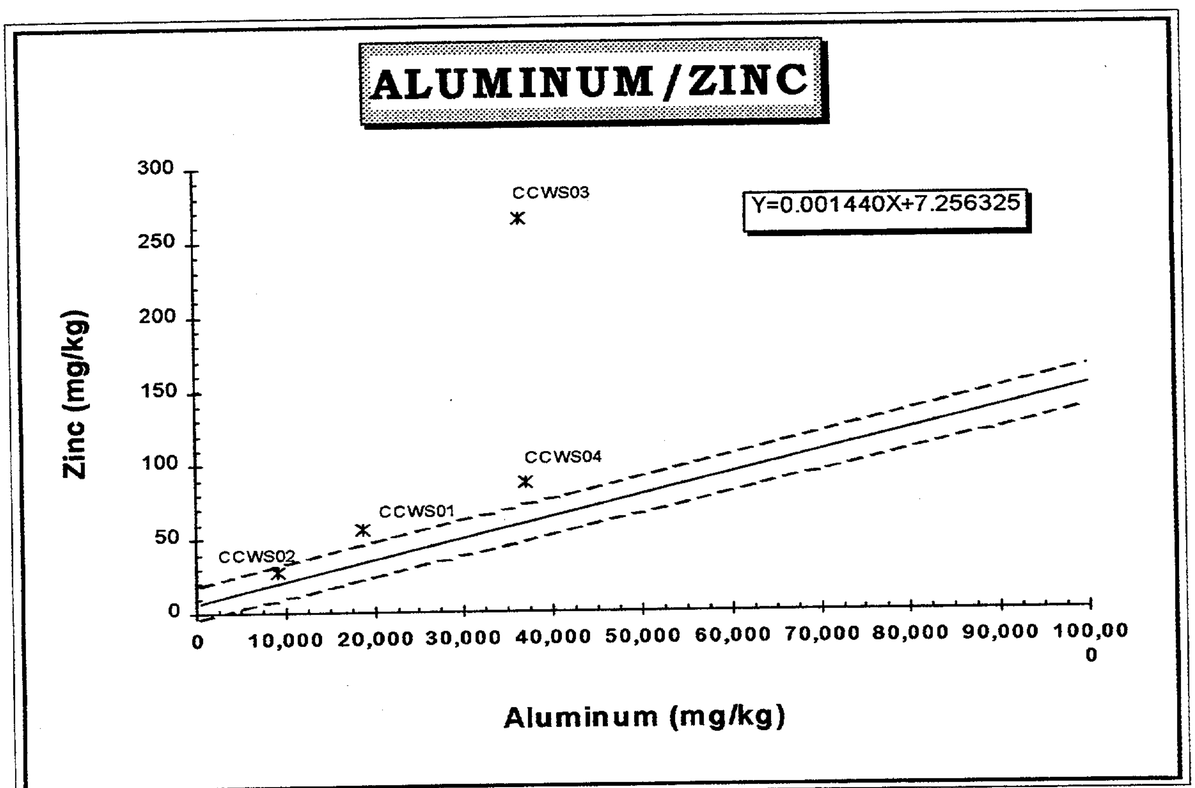


Figure 8f

ASSESSMENT OF AQUATIC INVERTEBRATE COMMUNITIES

Introduction:

Animals that do not possess a backbone such as insects. worms, snails and crustaceans are referred to as invertebrates. The many species of invertebrates inhabiting streambeds and bay bottoms are referred to as benthic invertebrates. The study of assemblages of benthic invertebrates or "communities" has become a valuable tool for monitoring surface waters by providing useful information complementing that which is obtained from physical and chemical parameters (Hart and Fuller eds., 1974; Hynes, 1971 and 1972; Mason et al., 1971; Mackenthun, 1969; Pennack, 1989; Pratt and Coler, 1976 and Wilhm, 1972).

The structure of a benthic invertebrate community in either fresh or estuarine waters is governed by numerous factors including dissolved oxygen, salinity, nutrient concentrations, turbidity, siltation and sediment characteristics. Benthic invertebrate organisms exhibit responses to changes in water quality and bottom habitats that are specific and predictable; therefore, they are good "indicators" of environmental quality (Plafkin, et al 1989; Hilsenhoff, 1987; Hynes, 1971 and 1972; Wilhm and Dorris, 1968). Information about the benthic community of a watershed combined with knowledge of the watershed's soil characteristics, topography, hydrology, water quality and land-use practices facilitates the development of more effective management plans and affords a greater degree of resource protection.

Previous studies of coastal watersheds conducted by the Department derived beneficial information from biological surveys. The effects of siltation, hypoxia and sediment contamination were clearly illustrated by the total number of organisms in the community, types of species present and the proportion of the total contributed by each species (ADEM, 1995 and 1996). Therefore it was decided to incorporate a survey of the aquatic benthic invertebrate communities in the CCW.

In Coastal Alabama, those streams exposed to frequent or prolonged tidal incursions possess a community primarily composed of polychaete worms, bivalve mollusks and amphipods (Parker 1960; Vittor 1973; Chermock 1974; U.S. Army Corps of Engineers 1978, Marine Environmental Sciences Consortium 1980 and 1981, Heard 1982; Hopkins and Valentine 1989 and ADEM 1990). The coastal streams not subjected to salinity intrusions are populated primarily by aquatic insects (i.e., the immature stages of dragonflies, mayflies, mosquitos, etc.), oligochaete worms, amphipods and isopods (Chermock 1974; O'Neil and Mettee 1982; Mettee et al 1983; Hopkins and Valentine 1989.

Objective:

The objective of the benthic biology program was to characterize the benthic macroinvertebrate community of the CCW relative to stream segments and tributaries, and evaluate the water quality and sediment chemistry for chemical and physical factors influencing the distribution of species and diversity of the community. More specifically the program sought to quantify abundance of individuals and species; examine for the presence of pollution sensitive species ("indicators") and determine community statistics at different sites in the basin. This data then can be compared and contrasted with water quality data, sediment chemistry data and land-use practices for possible associations between community vigor, condition of stream habitats and potential impacts from development.

Considering the broad nature of the watershed study it was the intention of the survey team to demonstrate benthic biology as a watershed assessment tool and not to conduct an in-depth study of the taxonomy of the basin. Therefore it was decided to limit the benthic biology program to one set of samples to be gathered at a time of low flow and warm temperatures, July through September. Low flow summer conditions provide the most stressful situation for aquatic communities with respect to hypoxia, sensitivity to wastewater discharges and salinity variations.

Materials and Methods:

Taking into account the estuarine charactristics of the lower reaches of Chickasaw Creek and the flowing freshwater streams found in the majority of the watershed it was necessary to sample both general types of waters. Three sites were chosen for flowing stream habitats and three sites for the estuarine habitats, these are illustrated in Figure 9. It was decided to conduct sampling during August and September when flows were low and environmental stress likely to be most notable. Flowing stream sites were shallow (< 1 meter deep) and were accessable for sampling by wading. Estuarine habitats were 5 to 10 meters deep and were sampled from a 16' outboard skiff. A brief description of the characteristics of each station is given in Table 8.

Macroinvertebrates were collected according to the methods outlined in the ADEM Field Operations Standard Procedures Manual Volume II- Macroinvertebrate Section (1992). Wading depth sites were sampled using a 'D' frame aquatic dip net and a kick net. Samples were field sieved through a U.S. Number 30 sieve and all material , debris and organisms, retained on the sieve was place in a 1 liter Nalgene jar and preserved for initial storage in 95% ethanol. Estuarine invertebrates were

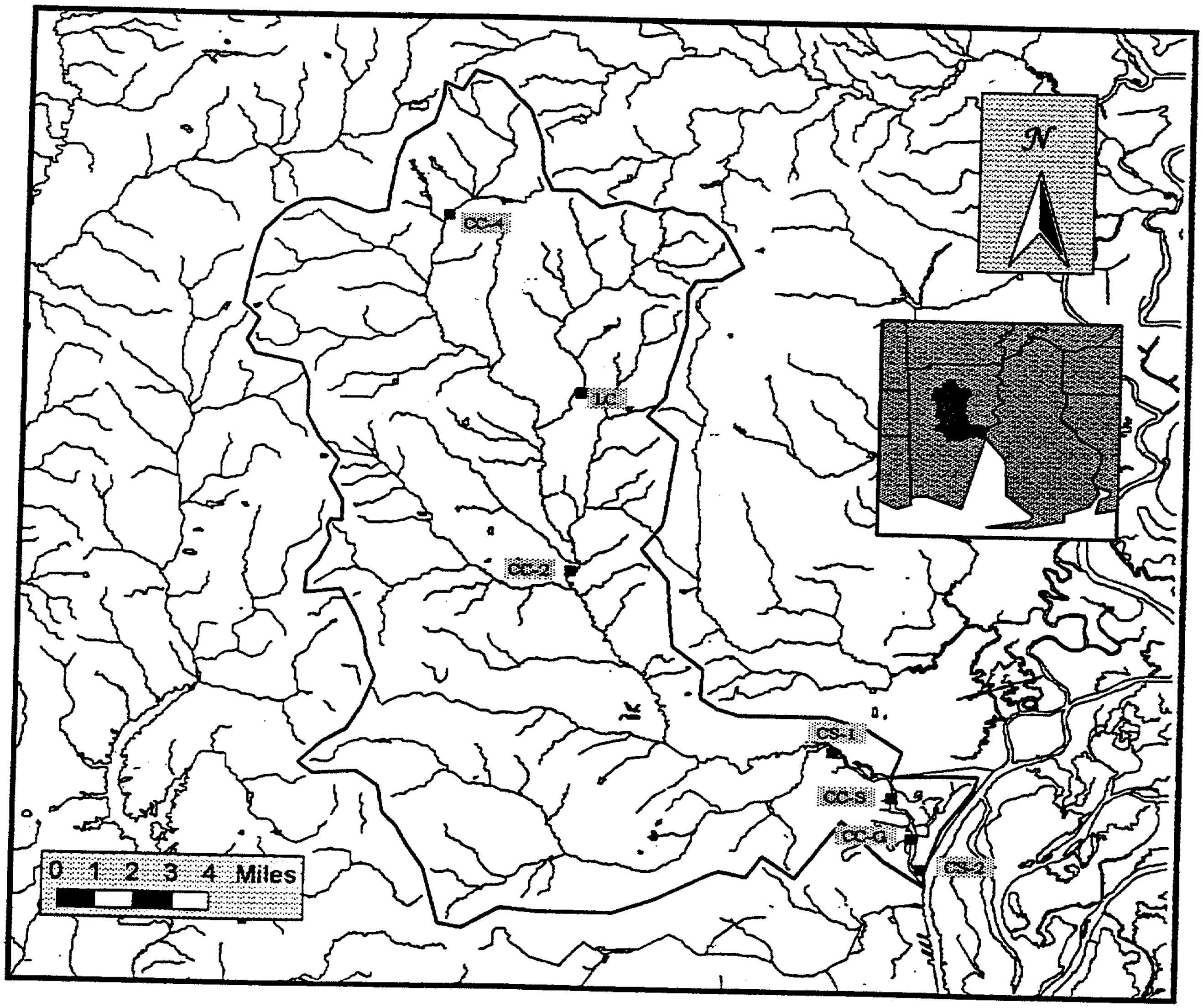


Figure 9
Locations of sites sampled for benthic invertebrates

Table 8
Descriptions of habitats at benthic invertebrate sites

Station ID	Location	Habitat
LC	Log Creek @ Chunchula Mobile County Road. 63	Steep gradient stream with well vegetated moderately sloping banks. Gravel riffle with fine sand, pebbles moderately embedded. Scattered aquatic mactrophytes with atttached bryozoan colonies. Stream shading approximately 50 percent. Depth of station 0.3 meter.
CC-4	Chickasaw Creek @ Gulf Crest Old Gulf Crest Road	Shallow gradient stream with densely vegetated slightly sloping, nearly level banks. Fine to medium sand with some leaf and twig debris. Significant sediment deposition forming "sandbars" at the insides of bends. Depth of station 0.5-1 meter.
CC-2	Chickasaw Creek @ Kushla Mobile County Road 55	Shallow gradient stream with wooded, sloping and well stabilized banks. Firm sand with pebbles and a few clay pieces. Also some intermixed leaf and twig debris. Slight amount of sediment deposition. Depth of station 1.0 meter.
CS-1	Chickasaw Creek @ U.S. Hwy 43	Estuarine station with silty-sand bottom. Streambanks partially developed with residences, piers and boat marinas. Sampled approximately one-third out from west bank. Depth of station 6 meters.
CC-S	Chickasaw Creek @ Shell Bayou	Estuarine station with a clayey-silt bottom. Shoreline vegetated on both sides in the immediate vicinity of the site but heavy industrial development upstream and downstream. Sampled approximately one-third out from the east bank. Station depth 9 meters.
CC-G	Chickasaw Creek @ Greenwood Bayou	Estuarine station with a clayey-silt bottom. Eastern shoreline is vegetated but is backed by a dredged material disposal site. Wharves and berthing slips for barges, towboats and ships are along the western bank. Station depth 9.5 meters.
CS-2	Chickasaw Creek @ mouth	Estuarine station with a clayey-silt bottom. Eastern shoreline is vegetated but is backed by a wastewater aeration basin. The streambank on the western side is lined with pilings, bulkheads and cargo docks. Station depth 9 meters

collected using a 0.023 m^2 (6 inch x 6 inch) stainless steel Ponar grab and three replicate grabs for a total area of 0.069 m^2 sampled at each station. The contents of each were field washed through a U.S. Number 35 sieve (0.5 mm mesh) and all material retained on the sieve was placed in a 1 liter Nalgene jar and preserved in a solution of 10% formaldehyde stained with rose bengal.

Upon return to the office each replicate was sieved a second time to further clean the sample of debris and sediment. The washed samples were then placed in a white enamel pan and the organisms picked from debris using needle-nose forceps and lighted magnifiers. Organisms were then placed in labeled capped vials containing 95% ethanol for temporary storage until they were identified.

Specimens were sorted and identified to the lowest possible identification level (LPIL) using optical light microscopes. Identified and counted specimens were preserved in 95% ethanol in vials labeled with the taxonomic name of the organism, location of sample site and date collected. The following references were consulted when identifying macroinvertebrate specimens: Abele and Kim (1986); Brigham, Brigham and Gnilka (1982); Fauchald (1977); Heard (1982); Holsinger (1976); Pennak (1989); Stimpson, Klemm and Hiltunen (1982); Hopkins, Valentine and Lutz (1989); Simpson and Bode (1980); Uebelacker and Johnson (1984); Williams, A. (1984) and Williams, W. (1976).

Names and abundances of species collected were entered into Microsoft Excel™ spreadsheets for calculation of population statistics. Population statistics employed for the benthic biology survey included the indices of community diversity, species evenness and species richness.

These population statistics provide numerical indices which, in conjunction with information on the types and numbers of species collected and water quality data, allow for determination of the health of aquatic environments (Shannon and Weaver, 1963; Lloyd, *et al.*, 1968; Margelef, 1958 and 1968; Pielou, 1975; Wilhm and Dorris, 1968).

Community diversity was calculated using the Shannon-Wiener information measure or the Shannon index of general diversity (H') (Shannon and Weaver, 1963; Margelef, 1968 and Pielou, 1975). The Shannon index was utilized because it incorporates both richness and evenness. The index is calculated by the equation:

$$H' = -\Sigma p_i \log p_i$$

H' = the symbol for diversity in a community

p_i = the proportion of the community made up by a particular species (*i*)

$\log p_i$ = the logarithm of p_i; it may be base 2, *e* or 10, in this study base 2 is utilized.

Species evenness was determined by Pielou's evenness index (J') (Pielou, 1966) as calculated from:

$$J' = H'/\log s$$

where s = the number of species per site

H' = the Shannon-Wiener index.

Margelef's richness index (d) (Margelef 1958) was utilized as another measure of health of the benthic community. This is determined by the formula:

$$d = s-1/\log N$$

where s = the number of species

N = the number of individuals per site.

Results:

A total of 40 species representing 7 taxonomic classes were collected from the seven stations. The more abundant organisms at the freshwater sites were caddisflies (Order Trichoptera), stoneflies (Order Plecoptera), larval midge flies (Order Diptera-Family Chironomidae) and freshwater prawns (Order Decapoda-Family Palemoniidae). The estuarine stations were dominated by polychaete worms (Families Ampharetidae, Nereidae and Spionidae) but also were inhabiated by amphipod crustaceans (Family Gammaridae) and bivalve mollusks (Family Dreissenidae). A summary of benthic community statistics is listed in Table 9, a complete listing of species collected may be found in Table 10 and site specific information may be found in Tables 11a-11f.

The high proportion of caddisflies, mayflies and stoneflies relative to the total number of organisims collected indicates the flowing freshwater streams possess fairly good water quality relative to dissolved oxygen, conductivity and other dissolved substances. However the density of organisms at these stations is low compared to that observed in other streams of the coastal plains (Mettee etal, 1983). The presence of numerous specimens of pollution sensitive species such as *Brachycentrus* and good overall diversity combined with low total numbers of organisms is considered by aquatic biologists to be an indication of a disturbance, such as siltation, with broad effects to the entire infaunal community (Hynes, 1971 and Pennak, 1989).

The benthic invertebrate communities at the estuarine stations contained a high proportion of spionid polychaetes and chironomids, organisms well adapted to tolerating environmental stresses. These families excel at colonizing and populating benthic habitats recently disturbed by siltation, dredging, toxic materials and hypoxia (Hudson et al., 1990; Hynes, 1971; Dauer, 1984; Pennak, 1989 and Uebelacker and Johnson, 1984). The low diversity and high proportion of stress tolerant species of these communities is likely to persist for years to come given the high sediment oxygen demand, a wide range of salinity values and a stratified water column (Barry A. Vittor personal communication).

Table 9

SUMMARY STATISTICS FOR BENTHIC MACROINVERTEBRATE COMMUNITIES
CHICKASAW CREEK WATERSHED

STATION	NUMBER OF SPECIMENS COLLECTED	NUMBER OF SPECIES COLLECTED	DENSITY PER SQUARE METER	SHANNON-WEINER DIVERSITY INDEX	MARGELEF'S RICHNESS INDEX	PIELOU'S EVENNESS INDEX
LC	101	15	304.0	3.59	6.98	0.92
CC-4	139	10	418.1	2.89	4.20	0.87
CC-2	167	14	500.3	3.44	5.85	0.90
CS-1	116	12	773.7	3.00	1.00	0.84
CC-S	51	4	340.2	1.01	1.76	0.50
CC-G	229	7	1527.4	1.63	2.54	0.58
CS-2	390	6	2601.3	1.37	1.93	0.53

Table 10
Benthic invertebrate species collected from streams of the Chickasaw Creek Watershed

NEMERTEA
- *Tubulanus sp* (LPIL)

OLIGOCHAETA
- Tubificidae (LPIL)
  - *Brachyura sowerby*
  - *Limnidrilus claparedianus*

POLYCHAETA
- Ampharetidae
  - *Hobsonia florida*
- Cossuridae
  - *Cossura delta*
- Goniadidae
  - *Glycinde solitaria*
- Nereidae
  - *Stenonereis martini*
- Spionidae
  - *Streblospio benedicti*
  - *Paraprinospio pinnata*

CRUSTACEA
- Amphipoda
  - Gammaridae
    - *Gammarus lacustris*
    - *Gammarus mucronatus*
  - Corophiidae
    - *Corophium louisianum*
- Decapoda
  - Palaemonidae
    - *Palaemonetes sp.*
  - Pinnotheridae
    - *Pinixia sp.*

INSECTA
- Coleoptera
  - Elmidae
    - *Stenelmis sp.*
  - Gyrinidae
    - *Gyrinus sp.*
- Diptera
  - Ceratopogonodae
    - *Bezzia sp.*
  - Chironomidae
    - *Chironomus stageri*
    - *Cryptochironomus fulvus*
    - *Coleotanypus scapularis*
    - *Dicrotendipes neomodestus*
    - *Procladius bellus*
  - Tabanidae
    - *Haematopota sp.*
  - Tipulidae
    - *Hexatoma sp*

Table 10 cont.
Invertebrate Species Collected from the Chickasaw Creek Watershed

Ephemeroptera
 Heptigeniidae
  Stenonema sp.
 Oligoneuriidae
  Isonychia sp
 Polymitarcydae
  Tortopus sp.
Lepidoptera
 Noctuidae
  Archanara sp.
Megaloptera
 Corydalidae
  Corydalus sp.
Odonata
 Aeshnidae
  Boyeria sp.
 Libellulidae
  Libellula sp.
Plecoptera
 Perlidae
  Acroneuria sp.
  Perlesta sp.
Trichoptera
 Brachycentridae
  Brachycentrus sp.
 Hydropsychidae
  Hydropsyche sp.
 Hydroptilidae
  Hydroptila sp.
 Philopotomidae
  Chimarra sp.

MOLLUSCA
 PELECYPODA
  Dressenidae
   Mytilopsis leucophaeta
  Sphareiidae
   Sphaerium sp.

BRYOZOA
 PHYLACTOLAEMATA
  Plumatellidae
   Plumatella sp.

Table 11a Table 11f
Benthic invertebrate species collected listed by station

Table 11a

BENTHIC INVERTEBRATE DATA - STATION LC LOG CREEK @ CHUNCHULA					
PHYLUM	CLASS	ORDER	FAMILY	SPECIES - TAXON(LPIL)	NUMBER
ANNELIDA	OLIGOCHAETA		TUBIFICIDAE	*Brachyura sowerby*	5
ANNELIDA	OLIGOCHAETA		TUBIFICIDAE	*Limnodrilus sp*	8
ARTHROPODA	INSECTA	COLEOPTERA	ELMIDAE	*Stenelmis sp.*	5
ARTHROPODA	INSECTA	COLEOPTERA	GYRINIDAE	*Gyrinus sp.*	16
ARTHROPODA	INSECTA	DIPTERA	CHIRONOMIDAE	*Chironomus stageri*	14
ARTHROPODA	INSECTA	DIPTERA	CHIRONOMIDAE	*Procladius bellus*	5
ARTHROPODA	INSECTA	DIPTERA	TABANIDAE	*Haematopota sp.*	3
ARTHROPODA	INSECTA	DIPTERA	TIPULIDAE	*Hexatoma sp.*	13
ARTHROPODA	INSECTA	EPHEMEROPTERA	OLIGONEURIIDAE	*Isonychia sp.*	5
ARTHROPODA	INSECTA	EPHEMEROPTERA	HEPTAGENIIDAE	*Stenonema sp.*	3
ARTHROPODA	INSECTA	PLECOPTERA	PERLIDAE	*Acroneuria sp.*	3
ARTHROPODA	INSECTA	PLECOPTERA	PERLIDAE	*Perlesta sp.*	12
ARTHROPODA	INSECTA	TRICHOPTERA	BRACHYCENTRIDAE	*Brachycentrus sp.*	3
ARTHROPODA	INSECTA	TRICHOPTERA	HYDROPTILIDAE	*Hydroptila sp.*	3
ARTHROPODA	INSECTA	LEPIDOPTERA	NOCTUIDAE	*Archanara sp.*	3
				NUMBER OF INDIVIDUALS	101
				DENSITY PER SQUARE METER	304
				NUMBER OF SPECIES	15
				SHANNON-WEINER INDEX	3.59
				MARGELEF'S RICHNESS INDEX	6.98
				PIELOU'S EVENNESS INDEX	0.92

Table 11b

BENTHIC INVERTEBRATE DATA - STATION CC-4 CHICKASAW CREEK @ GULF CREST					
PHYLUM	CLASS	ORDER	FAMILY	SPECIES - TAXON(LPIL)	NUMBER
ARTHROPODA	INSECTA	EPHEMEROPTERA	OLIGONEURIIDAE	*Isonychia sp*	5
ARTHROPODA	INSECTA	TRICHOPTERA	BRACHYCENTRIDAE	*Brachycentrus sp.*	32
ARTHROPODA	INSECTA	TRICHOPTERA	POLYCENTROPODIDAE	*Neureclipsis sp.*	27
ARTHROPODA	INSECTA	ODONATA	AESHNIDAE	*Boyeria sp.*	12
ARTHROPODA	INSECTA	ODONATA	LIBELLULIDAE	*Libellula sp.*	8
ARTHROPODA	INSECTA	COLEOPTERA	ELMIDAE	*Stenelmis sp.*	9
ARTHROPODA	INSECTA	DIPTERA	TIPULIDAE	*Hexatoma sp.*	5
ARTHROPODA	CRUSTACEA	AMPHIPODA	GAMMARIDAE	*Gammarus lacustris*	5
ARTHROPODA	CRUSTACEA	DECAPODA	PALAEMONIDAE	*Palemonetes sp.*	32
MOLLUSCA	PELECYPODA		SPHAREIIDAE	*Sphaerium sp.*	3
				NUMBER OF INDIVIDUALS	139
				DENSITY PER SQUARE METER	418
				NUMBER OF SPECIES	10
				SHANNON-WEINER INDEX	2.65
				MARGELEF'S RICHNESS INDEX	4.20
				PIELOU'S EVENNESS INDEX	0.80

Table 11c

BENTHIC INVERTEBRATE DATA - STATION CC-2 CHICKASAW CREEK @ KUSHLA					
PHYLUM	CLASS	ORDER	FAMILY	SPECIES - TAXON(LPIL)	NUMBER
ARTHROPODA	INSECTA	COLEOPTERA	ELMIDAE	*Stenelmis sp.*	19
ARTHROPODA	INSECTA	EPHEMEROPTERA	OLIGONEURIIDAE	*Isonychia sp.*	13
ARTHROPODA	INSECTA	EPHEMEROPTERA	POLYMITARCYIDAE	*Tortopus sp*	3
ARTHROPODA	INSECTA	PLECOPTERA	PERLIDAE	*Acroneuria sp.*	24
ARTHROPODA	INSECTA	PLECOPTERA	PERLIDAE	*Perlesa sp.*	8
ARTHROPODA	INSECTA	TRICHOPTERA	BRACHYCENTRIDAE	*Brachycentrus sp.*	11
ARTHROPODA	INSECTA	TRICHOPTERA	HYDROPSYCHIDAE	*Hydropsyche sp.*	30
ARTHROPODA	INSECTA	TRICHOPTERA	PHILOPOTOMIDAE	*Chimarra sp.*	5
ARTHROPODA	INSECTA	ODONATA	AESHIDAE	*Boyeria sp.*	3
ARTHROPODA	INSECTA	MEGALOPTERA	CORYDALIDAE	*Corydalus sp.*	16
ARTHROPODA	INSECTA	DIPTERA	TABANIDAE	*Haematopota sp.*	3
ARTHROPODA	INSECTA	DIPTERA	TIPULIDAE	*Hexatoma sp.*	3
ARTHROPODA	INSECTA	DIPTERA	CHIRONOMIDAE	*Chironomus stageri*	19
ARTHROPODA	INSECTA	DIPTERA	CHIRONOMIDAE	*Procladius bellus*	11
				NUMBER OF INDIVIDUALS	167
				DENSITY PER SQUARE METER	500
				NUMBER OF SPECIES	14
				SHANNON-WEINER INDEX	3.44
				MARGELEF'S RICHNESS INDEX	5.85
				PIELOU'S EVENNESS INDEX	0.90

Table 11d

BENTHIC INVERTEBRATE DATA - STATION CS-1 CHICKASAW CREEK				
PHYLUM	CLASS	FAMILY	SPECIES - TAXON(LPIL)	NUMBER
NEMERTEA			NEMERTEA(LPIL)	5
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*Limnodrilus claparedianus*	39
ANNELIDA	POLYCHAETA	AMPHARETIDAE	*Hobsonia florida*	9
ANNELIDA	POLYCHAETA	NEREIDAE	*Stenoneris martini*	2
ARTHROPODA	INSECTA	CHIRONOMIDAE	*Chironomus stageri*	18
ARTHROPODA	INSECTA	CHIRONOMIDAE	*Procladius bellus*	15
ARTHROPODA	INSECTA	CHIRONOMIDAE	*Cryptochironomus fulvus*	4
ARTHROPODA	INSECTA	CHIRONOMIDAE	*Dicrotendipes neomodestus*	6
ARTHROPODA	INSECTA	CHIRONOMIDAE	*Coelotanypus scapularis*	3
ARTHROPODA	INSECTA	CERATOPOGONIDAE	*Bezzia/ Probezzia sp*	2
ARTHROPODA	CRUSTACEA (AMPHIPODA)	GAMMARIDAE	*Gammarus mucronatus*	6
MOLLUSCA	PELYCEPODA	DRESSENIDAE	*Mytilopsis leucophaeta*	7
			NUMBER OF INDIVIDUALS	116
			DENSITY PER SQUARE METER	774
			NUMBER OF SPECIES	12
			SHANNON-WEINER INDEX	3.00
			MARGELEF'S RICHNESS INDEX	1.00
			PIELOU'S EVENNESS INDEX	0.84

Table 11e

BENTHIC INVERTEBRATE DATA -STATION CCS CHICKASAW CREEK				
PHYLUM	**CLASS**	**FAMILY**	**SPECIES - TAXON(LPIL)**	**NUMBER**
ANNELIDA	POLYCHAETA	NEREIDAE	*Stenoneris martini*	5
ANNELIDA	POLYCHAETA	SPIONIDAE	*Paraprinospio pinnata*	41
ARTHROPODA	CRUSTACEA (AMPHIPODA)	COROPHIIDAE	*Corophium louisianum*	2
MOLLUSCA	PELYCEPODA	DRESSENIDAE	*Mytilopsis leucophaeta*	3
			NUMBER OF INDIVIDUALS	51
			DENSITY PER SQUARE METER	340
			NUMBER OF SPECIES	4
			SHANNON-WEINER INDEX	1.01
			MARGELEF'S RICHNESS INDEX	1.76
			PIELOU'S EVENNESS INDEX	0.50

Table 11f

BENTHIC INVERTEBRATE DATA - STATION CCG CHICKASAW CREEK				
PHYLUM	**CLASS**	**FAMILY**	**SPECIES - TAXON(LPIL)**	**NUMBER**
ANNELIDA	POLYCHAETA	COSSURIDAE	*Cossura delta*	11
ANNELIDA	POLYCHAETA	GONIADIDAE	*Glycinde solitaria*	4
ANNELIDA	POLYCHAETA	NEREIDAE	*Stenonereis martini*	9
ANNELIDA	POLYCHAETA	SPIONIDAE	*Paraprinospio pinnata*	108
ANNELIDA	POLYCHAETA	SPIONIDAE	*Streblospio benedicti*	94
ARTHROPODA	CRUSTACEA (AMPHIPODA)	COROPHIIDAE	*Corophium louisianum*	2
ARTHROPODA	CRUSTACEA (DECAPODA)	PINNOTHERIDAE	*Pinnixa sp.*	1
			NUMBER OF INDIVIDUALS	229
			DENSITY PER SQUARE METER	1527
			NUMBER OF SPECIES	7
			SHANNON-WEINER INDEX	1.63
			MARGELEF'S RICHNESS INDEX	2.54
			PIELOU'S EVENNESS INDEX	0.58

Table 11g

BENTHIC INVERTEBRATE DATA - STATION CS-2 CHICKASAW CREEK				
PHYLUM	**CLASS**	**FAMILY**	**SPECIES - TAXON(LPIL)**	**NUMBER**
ANNELIDA	POLYCHAETA	COSSURIDAE	*Cossura delta*	24
ANNELIDA	POLYCHAETA	GONIADIDAE	*Glycinde solitaria*	3
ANNELIDA	POLYCHAETA	NEREIDAE	*Stenonereis martini*	1
ANNELIDA	POLYCHAETA	SPIONIDAE	*Paraprinospio pinnata*	172
ANNELIDA	POLYCHAETA	SPIONIDAE	*Streblospio benedicti*	189
ARTHROPODA	CRUSTACEA (DECAPODA)	PINNOTHERIDAE	*Pinnixa sp.* (LPIL)	1
			NUMBER OF INDIVIDUALS	390
			DENSITY PER SQUARE METER	2601
			NUMBER OF SPECIES	6
			SHANNON-WEINER INDEX	1.37
			MARGELEF'S RICHNESS INDEX	1.93
			PIELOU'S EVENNESS INDEX	0.53

CONCLUSIONS

The results of this survey indicate that the primary problems affecting the waters of the Chickasaw Creek Watershed are trash and litter carried by stormwater runoff from urban areas and stream siltation caused by erosion from cleared land in suburban and rural areas. Trash and litter in streams such as Gum Tree Branch and the lower reaches of Eight Mile Creek has become an obvious problem. Along the middle and upper reaches of Eight Mile Creek, throughout Seabury Creek, in the upper reaches of Chickasaw Creek and many of the small tributaries siltation has become a severe detriment to water quality and aquatic habitats.

Secondarily there are minor occasional increases of enteric bacteria which, at the time of the survey, appear not to present a significant threat to the recreational suitability of those waters classified for swimming. The middle and upper reaches of Chickasaw Creek are classified as suitable for swimming and other whole body water-contact sports. The state standard of 200 colonies per 100 milliliters of water (geometric mean) was met for the stations at Kushla, Chunchula and Gulf Crest. Considering the rural and woodlands nature of much of the basin it is likely in some cases that cattle and wildlife make significant contributions of fecal coliforms to the area's streams. However, given the increasing rural residential population, especially those residences along streams, it is likely that septic tanks and other on site disposal systems are responsible for a portion of the enteric waste load going to the streams of the watershed.

Also worthy of consideration is the investigation conducted by the ADEM and the U.S. Justice Department of individuals discharging sanitary wastes to waters of the basin (Red Creek). Given the increasing population of residents on septic tanks and the isolated, sparsely settled areas of the northern and western parts of the watershed it is possible that such actions on the part of others might occur again in the future.

Within the portion of the watershed downstream of U.S. Highway 43 low concentrations of dissolved oxygen continue to be the primary problem affecting water quality and aquatic habitats. The estuarine part of Chickasaw Creek experiences chronic hypoxia throughout the summer and early fall; even though the majority of the wastewater discharges historically responsible for the water quality problems in lower Chickasaw Creek have been diverted to the Mobile River. The bottom accumulations of organic carbon and particulate nutrients along the lower reaches of Chickasaw Creek are the result of decades of discharging untreated wastewater and contaminated stormwater to the creek. It will likely require years for the natural flow and tidal forces to flush the deposits of oxygen demanding materials out of the creek (South Alabama Regional Planning Commission, 1979; Barry A. Vittor, personal communication).

The problems affecting the majority of the watershed however are ongoing and for the most part non-point sources resulting from everyday activities. Fortunately these problems lend themselves to fairly straightforward solutions. The residents, businesses and land developers of the watershed and their elected government officials are faced with the challenge and opportunity of improving conditions in the CCW.

Much has been accomplished by industry towards improving the quality of surface waters and abating the harm to aquatic habitats. Reducing the harmful impacts to the Chickasaw Creek Watershed now necessitates investigating means for reducing the input of trash and litter from stormwater runoff in urban areas, reducing erosion and siltation caused by borrow pits and land clearing operations, explore options for paving rural roads and eliminate all improper disposal of household sanitary wastes.

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APPENDICES

APPENDIX A: STATE OF ALABAMA WATER QUALITY CRITERIA APPLICABLE TO STREAMS OF THE CHICKASAW CREEK WATERSHED

APPENDIX B: NPDES PERMITTED FACILITIES IN THE WATERSHED

APPENDIX A

STATE OF ALABAMA

SPECIFIC WATER QUALITY CRITERIA APPLICABLE TO THE WATER USE CLASSIFICATIONS OF THE CHICKASAW CREEK WATERSHED

Classification: Swimming and other whole body water contact sports..

Best usage of waters: Swimming and other whole body water contact sports

Conditions related to best usage: The waters under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water contact sports. The quality of waters will also be suitable for the propagation of fish, wildlife and aquatic life. The quality of salt waters and estuarine waters to which this classification is assinged will be suitable for the propagation and harvesting of shrimps and crabs.

Specific criteria:

Sewage, industrial wastes, or other wastes:
None which are not effectively treated or controlled in accordance with ADEM Administrative Rule 335-6-10-.08

pH:
Sewage, industrial wastes or other wastes shall not cause the pH to deviate more than one unit from the normal or natural pH, nor be less than 6.0, nor greater than 8.5. For estuarine waters and salt waters to which this classification is assinged, wastes as described herein shall not cause the pH to deviate more than one unit from the normal or natural pH, nor be less than 6.5, nor more than 8.5.

Temperature:
The maximum temperature in streams, lakes and reservoirs shall not exceed 90 degrees Fahrenheit.

The maximum in-stream temperature rise above ambient water temperature due to the addition of artifical heat by a discharger shall not exceed 4 degrees F in coastal or estuarine waters waters during the period October through May, nor shall the rise exceed 1.5 degrees F during the period June through September.

In lakes and reservoirs there shall be no withdrawal from, nor discharge of heated waters to, the hypolimnion unless it can be shown that such discharge or withdrawal will be beneficial to water quality.

In all waters the normal daily and seasonal temperature variations that were present before the addition of artificial heat shall be maintained, and there shall be no thermal block to the migration of aquatic organisms.

Thermal permit limitations in NPDES permits may be less stringent than those required above when a showing by the discharger has been made pursuant to Section 316 of the Federal Water Pollution Control Act (FWPCA), 33 U.S.C. Section 1251 et seq. or pursuant to a study of an equal or more stringent nature required by the State of Alabama authorized by Title 22, Section 22-22-9(c), Code of Alabama 1975, that such limitations will assure the protection and propogation of a balanced, indigenous population of shellfish, fish and wildlife, in and on the body of water to which the discharge is made. Any such demonstration shall take into account the interaction of the thermal discharge component with other pollutants discharged.

Dissolved Oxygen:

For a diversified warm water biota, including game fish, daily dissolved oxygen values shall not be less than 5 mg/l at all times; except under extreme conditions due to natural causes, it may range between 5 mg/l and 4 mg/l, provided that the water quality is favorable in all other parameters. The normal seasonal and daily fluctuations shall be maintained above these levels. In no event shall the dissolved oxygen level be less than 4 mg/l due to discharges from existing hydroelectric generation impoundments. All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, shall be designed so that the discharge will contain at least 5 mg/l dissolved oxygen where practicable and technologically possible.

In coastal waters, surface dissolved oxygen concentrations shall not be less than 5 mg/l, except where natural phenomena cause the value to be depressed.

In estuaries and tidal tributaries, dissolved oxygen concentrations shall not be less than 5 mg/l, except in dystrophic waters or where natural conditions cause the value to be depressed.

In the application of dissolved oxygen criteria referred to above, dissolved oxygen oxygen shall be measured at a depth of 5 feet in waters 10 feet or greater in depth; and for those waters less than 10 feet in depth, dissolved oxygen criteria will be applied at mid-depth.

Toxic substances; color producing substances; odor producing substances; or other deleterious substances attributable to sewage, industrial wastes, or other wastes:

Only such amounts, whether alone or in combination with other substances, and only such temperatures as will not render the waters unsafe or unsuitable as a source of water supply for drinking and food-processing purposes, or exhibit acute toxicity or chronic toxicity, as demonstrated by effluent toxicity testing or by application of numeric criteria given in ADEM Administrative Rule 335-6-10-.07, to fish,wildlife and aquatic life, or where applicable, shrimp and crabs; impair the waters for any other usage established for this classification or unreasonably affect the aesthetic value of waters for any use under this classification.

Bacteria:

Waters in the immediate vicinity of discharges of sewage or other wastes likely to contain bacteria harmful to humans, regardless of the degree of treatment afforded these wastes, are not acceptable for swimming or other whole body water-contact sports.

In all other areas, the bacterial quality of water is acceptable when a sanitary survey by the controlling health authorities reveals no source of dangerous pollution and when the geometric mean fecal coliform organism density does not exceed 100/100 ml in coastal waters and 200/100 ml in other waters. When the geometric mean fecal coliform organism density exceeds these levels, the bacterial water quality shall be considered acceptable only if a second detailed sanitary survey and evaluation discloses no significant public health risk in the use of the waters

The policy of nondegredation of high quality waters shall be stringently applied to bacterial quality of recreational waters.

Radioactivity:

The concentrations of radioactive materials present shall not exceed the requirements of the State Department of Public Health.

Turbidity:

There shall be no turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of waters or interfere with any beneficial uses which they serve. Furthermore, in no case shall turbidity exceed 50 Nephelometric units above backround. Backround will be interpreted as the natural condition of the receiving waters, without the influence of man-made or man-induced causes. Turbidity levels caused by natural runoff will be included in establishing backround levels.

Classification: Fish and Wildlife.

Best usage of waters: Fishing, propogation of fish, aquatic life and wildlife, and any other usage except for swimming and water-contact sports or as a source of water supply for drinking or food-processing purposes.

Conditions related to best usage: The waters will be suitable for fish, aquatic life and wildlife propogation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propogation of shrimp and crabs.

Other usage of waters: It is recognized that the waters may be used for incidental water contact and recreation during June through September, except that water contact is strongly discouraged in the vicinity of discharges or other conditions beyond the control of the Department or the Alabama Department of Public Health.

Conditions related to other usage: The waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports.

Specific Criteria:

Sewage, industrial wastes, or other wastes:

None which are not effectively treated or controlled in accordance with ADEM Administrative Rule 335-6-10-.08

pH:

Sewage, industrial wastes or other wastes shall not cause the pH to deviate more than one unit from the normal or natural pH, nor be less than 6.0, nor greater than 8.5. For estuarine waters and salt waters to which this classification is assinged, wastes as described herein shall not cause the pH to deviate more than one unit from the normal or natural pH, nor be less than 6.5, nor more than 8.5.

Temperature:

The maximum temperature in streams, lakes and reservoirs shall not exceed 90 degrees Fahrenheit.

The maximum in-stream temperature rise above ambient water temperature due to the addition of artifical heat by a discharger shall not exceed 4 degrees F in coastal or estuarine waters waters during the period October through May, nor shall the rise exceed 1.5 degrees F during the period June through September.

In lakes and reservoirs there shall be no withdrawal from, nor discharge of heated waters to, the hypolimnion unless it can be shown that such discharge or withdrawal will be beneficial to water quality.

In all waters the normal daily and seasonal temperature variations that were present before the addition of artificial heat shall be maintained, and there shall be no thermal block to the migration of aquatic organisms.

Thermal permit limitations in NPDES permits may be less stringent than those required above when a showing by the discharger has been made pursuant to Section 316 of the Federal Water Pollution Control Act (FWPCA), 33 U.S.C. Section 1251 et seq. or pursuant to a study of an equal or more stringent nature required by the State of Alabama authorized by Title 22, Section 22-22-9(c), Code of Alabama 1975, that such limitations will assure the protection and propogation of a balanced, indigenous population of shellfish, fish and wildlife, in and on the body of water to which the discharge is made. Any such demonstration shall take into account the interaction of the thermal discharge component with other pollutants discharged.

Dissolved Oxygen:

For a diversified warm water biota, including game fish, daily dissolved oxygen values shall not be less than 5 mg/l at all times; except under extreme conditions due to natural causes, it may range between 5 mg/l and 4 mg/l, provided that the water quality is favorable in all other parameters. The normal seasonal and daily fluctuations shall be maintained above these levels. In no event shall the dissolved oxygen level be less than 4 mg/l due to discharges from existing hydroelectric generation impoundments. All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, shall be designed so that the discharge will contain at least 5 mg/l dissolved oxygen where practicable and technologically possible.

In coastal waters, surface dissolved oxygen concentrations shall not be less than 5 mg/l, except where natural phenomena cause the value to be depressed.

In estuaries and tidal tributaries, dissolved oxygen concentrations shall not be less than 5 mg/l, except in dystrophic waters or where natural conditions cause the value to be depressed.

In the application of dissolved oxygen criteria referred to above, dissolved oxygen oxygen shall be measured at a depth of 5 feet in waters 10 feet or greater in depth; and for those waters less than 10 feet in depth, dissolved oxygen criteria will be applied at mid-depth.

Toxic substances attributable to sewage, industrial wastes, or other wastes:

Only such amounts, whether alone or in combination with other substances, and only such temperatures as will not render the waters unsafe or unsuitable as a source of water supply for drinking and food-processing purposes, or exhibit acute toxicity or chronic toxicity, as demonstrated by effluent toxicity testing or by application of numeric criteria given in ADEM Administrative Rule 335-6-10-.07, to fish and aquatic life, including shrimp and crabs in estuarine and salt waters or the propogation thereof.

Taste, odor and color-producing substances attributable to sewage, industrial wastes, or other wastes:

Only such amounts, whether alone or in combination with other substances, and only such temperatures as will not render the waters unsafe or unsuitable as a source of water supply for drinking and food-processing purposes, or exhibit acute toxicity or chronic toxicity, as demonstrated by effluent toxicity testing or by application of numeric criteria given in ADEM Administrative Rule 335-6-10-.07, to fish and aquatic life, including shrimp and crabs in estuarine and salt waters or adversely affect the propagation thereof; impair the palatability or marketability of fish and wildlife or shrimp and crabs in estuarine and salt waters; or unreasonably affect the aesthetic value of waters for any use under this classification.

Bacteria:

Bacteria of the fecal coliform group shall not exceed a geometric mean of 1,000/100 ml on a monthly average value; nor exceed a maximum of 2,000/100 ml in any sample.

For incidential water contact and recreation during June through September, the bacterial quality of water is acceptable when a sanitary survey by the controlling health authorities reveals no source of dangerous pollution and when the geometric mean fecal coliform organism density does not exceed 100/100 ml in coastal waters and 200/100 ml in other waters. When the geometric mean fecal coliform density exceeds these levels, the bacterial water quality shall be considered acceptable only if a second detailed sanitary survey and evaluation discloses no significant public health risk in the use of the waters. Waters in the immediate vicinity of discharges of sewage or other wastes likely to contain bacteria harmful to humans, regardless of the degree of the treatment afforded these wastes, are not acceptable for swimming or other whole body water-contact sports.

Radioactivity:

The concentrations of radioactive materials present shall not exceed the requirements of the State Department of Public Health.

Turbidity:

There shall be no turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of waters or interfere with any beneficial uses which they serve. Furthermore, in no case shall turbidity exceed 50 Nephelometric units above backround. Backround will be interpreted as the natural condition of the receiving waters without the influence of man-made or man-induced causes. Turbidity levels caused by natural runoff will be included in establishing backround levels.

Classification: Agricultural and Industrial.

Best usage of waters: Agricultural irrigation, livestock watering, industrial cooling and process water supplies, and any other usage, except fishing, bathing, recreational activities, including water contact sports, or as a source of water supply for drinking or food-processing purposes.

Conditions related to best usage: The waters, except for natural impurities which may be present therein, will be suitable for agricultural irrigation, livestock watering, industrial cooling waters and fish survival. The waters will be usable after special treatment, as may be needed under each particular circumstance, for industrial process water supplies. The waters will also be suitable for other uses for which waters of lower quality will be satisfactory.

This category includes watercourses in which natural flow is intermittant and non-existent during droughts and which may, of necessity, receive treated waters from municipalities and industries, both now and in the future. In such instances, recognition must be given to the lack of opportunity for mixture of the treated wastes with the receiving stream for purposes of compliance. It is also understood in considering waters for this classification that urban runoff or natural conditions may impact any waters so classified.

Specific Criteria:

Sewage, industrial wastes, or other wastes:

None which are not effectively treated or controlled in accordance with ADEM Administrative Rule 335-6-10-.08

pH:

Sewage, industrial wastes or other wastes shall not cause the pH to deviate more than one unit from the normal or natural pH, nor be less than 6.0, nor greater than 8.5. For estuarine waters and salt waters to which this classification is assinged, wastes as described herein shall not cause the pH to deviate more than one unit from the normal or natural pH, nor be less than 6.5, nor more than 8.5.

Temperature:

The maximum temperature rise above natural temperature before the addition of artificial heat shall not exceed 5 degrees Fahrenheit in streams, lakes and reservoirs, nor shall the maximum water temperature exceed 90 degrees Fahrenheit.

Dissolved Oxygen: Sewage, industrial wastes, or other wastes shall not cause the dissolved oxygen to be less than 3.0 parts per million. In the application of dissolved oxygen criteria referred to above, dissolved oxygen shall be measured at a depth of 5 feet in waters 10 feet or greater in depth; and for those waters less than 10 feet in depth, dissolved oxygen criteria will be applied at mid-depth.

Taste, odor and color-producing substances attributable to sewage, industrial wastes, or other wastes:

Only in amounts as will not render the waters unsuitable for agricultural irrigation, livestock watering, industrial cooling, industrial process water supply purposes and fish survival, nor interfere with downstream water uses.

Radioactivity:

The concentrations of radioactive materials present shall not exceed the requirements of the State Department of Public Health.

Turbidity:

There shall be no turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of waters or interfere with any beneficial uses which they serve. Furthermore, in no case shall turbidity exceed 50 Nephelometric units above backround. Backround will be interpreted as the natural condition of the receiving waters without the influence of man-made or man-induced causes. Turbidity levels caused by natural runoff will be included in establishing backround levels.

APPENDIX B

Businesses within the Chickasaw Creek Watershed operating under the conditions of an NPDES permit

Facility:	Kimberly Clark Tissue.
Location:	Bay Bridge Rd. Mobile, Al
NPDES Permit No.	AL 0002801
Receiving waters:	Chickasaw Creek
Nature of wastewater:	Non-contact cooling water and stormwater runoff from vehicle parking areas, access roads, roof drains, railroad spurs, equipment maintenance areas and other non-process areas of the mill.
Monitored parameters:	Flow, temperature, pH, TSS, oil & grease, total residual chlorine and COD.

Facility:	S.D. Warren Co.
Location:	Bay Bridge Rd. Mobile, AL
NPDES Permit No.	AL 0068730
Receiving waters:	Chickasaw Creek
Nature of wastewater:	Non-contact cooling water and stormwater runoff from access roads, railroad spurs, roof drains, equipment storage yard and other non-process areas.
Monitored parameters:	Flow, temperature,pH, TSS, oil & grease, COD and total residual chlorine.

Facility:	International Paper Co.-Mobile Mill
Location:	Paper Mill Rd. Mobile, AL
NPDES Permit No.	AL 0002780
Receiving waters:	Chickasaw Creek and Hog Bayou.
Nature of wastewater:	Non-contact cooling water, cooling tower blowdown, steam condensate, fire water and stormwater runoff from access roads, vehicle parking areas, railroad spurs, roof drains, equipment storage yard, woodyard, wood loading/unloading areas, coal storage piles, boiler ash storage and other non-process areas.
Monitored parameters:	Flow, temperature,pH, BOD-5, TSS, TDS, oil & grease, COD, manganese, iron and total residual chlorine.

Facility:	CYTEC Industries, Inc.
Location:	Cyanimid Rd. Mobile, AL
NPDES Permit No.	AL 0002747
Receiving waters:	Hog Bayou
Nature of wastewater:	Non-contact cooling water and stormwater runoff from access roads and other non-process areas.
Monitored parameters:	Flow, temperature,pH, TSS, TDS, oil & grease, COD, aluminum and sulfates.

Facility: Occidential Chemical Corporation.-Mobile Plant
Location: 1300 Jarvis Rd.
Mobile, AL
NPDES Permit No. AL 0003514
Receiving waters: Hog Bayou
Nature of wastewater: Treated process wastewater resulting from chlor-alkali production, cooling tower blowdown, treated groundwater, non-contact cooling water and stormwater runoff from access roads, railroad spurs, roof drains and other non-process areas.
Monitored parameters: Flow, temperature,pH, TSS, TDS, COD, total residual chlorine, 24-hr acute toxicity, total chlorides, copper, mercury and nickel.

Facility: Jones Chemical
Location: Jarvis Rd.
Mobile, AL
NPDES Permit No. AL 0043605
Receiving waters: Chickasaw Creek
Nature of wastewater: Stormwater runoff associated with chemical manufacturing, boiler blowdown, non-contact cooling water, hydrostatic test waters and wastewaters from cleaning chlorine cylinders and testing raw materials and products.
Monitored parameters: Flow, temperature, pH, COD, TSS, TDS, oil & grease, total chlorides, total nitrogen and total residual chlorine.

Facility: Eagle Chemical Co., Inc.
Location: 1500 Telegraph Rd.
Mobile, AL
NPDES Permit No. AL 0025283
Receiving waters: Chickasaw Creek
Nature of wastewater: Stormwater runoff associated with silica gel manufacturing and packing activities.
Monitored parameters: Flow, pH, TSS, COD, oil & grease, total sulfates, total chlorides total cobalt and total iron.

Facility: UOP-Molecular Sieves
Location: Linde Dr.
Chickasaw, AL
NPDES Permit No. AL 0002666
Receiving waters: Chickasaw Creek
Nature of wastewater:Treated process wastewater, cooling tower blowdown and boiler blowdown.
Monitored parameters: Flow, pH, TSS, TDS, ammonia, total nitrogen, total phosphorous sulfates, bromides, total chlorides, barium, cobalt, chromium, copper, manganese, molybdenum, nickel, palladium, platinum, tungsten, vanadium, zinc and 24-hr acute toxicity.

Facility: Alabama Power Co.-Chickasaw Steam Plant
Location: Shipyard Rd.
Chickasaw, AL
NPDES Permit No. AL 0002666
Receiving waters: Chickasaw Creek
Nature of wastewater: Condenser cooling water.
Monitored parameters: Flow, temperture and total residual chlorine..

Facility: Coastal Mobile Refining Co..
Location: Warrior Gulf Rd.
Chickasaw, AL
NPDES Permit No. AL 0031071
Receiving waters: Chickasaw Creek
Nature of wastewater: Stormwater runoff from diked storage areas, access roads and other non-process areas.
Monitored parameters: Flow, pH, oil & grease, total organic carbon, BETX and naphthalene.

Facility: Shell Oil & Refining (formerly LL&E)
Location: Industrial Parkway.
Saraland, AL
NPDES Permit No. AL 0055859
Receiving waters: Chickasaw Creek
Nature of wastewater: Process wastewaters, contaminated storm water, boiler and cooling tower blowdown, sanitary wastewater, tank bottoms, non-contact cooling water and stormwater runoff from diked storage areas. Stormwater runoff from access roads, vehicle parking areas and other non-process areas.
Monitored parameters: Flow, pH, dissolved oxygen, BOD-5, TSS, TDS, oil & grease, COD, total chlorides, ammonia, total sulphides, total chromium, hexavalent chromium, total phenols, BETX, napthalene 24-hr toxicity and 2,3,7,8-Tetrachloro-dibenzo-P-dioxin.

Facility: City of Chickasaw, Utilities Board-Chickasaw Lagoon
Location: North of Viaduct St.
Chickasaw, AL
NPDES Permit No. AL 0020885
Receiving waters: Chickasaw Creek
Nature of wastewater: Treated municipal wastewater.
Monitored parameters: Flow, pH, TSS, CBOD and acute toxicity.

Facility: City of Prichard, Water Works and Sewer Board
Stanley Brooks Wastewater Treatment Plant.
Location: Aldock Rd.
Prichard, AL
NPDES Permit No. AL 0055204
Receiving waters: Chickasaw Creek
Nature of wastewater: Treated municipal wastewater.
Monitored parameters: Flow, pH, BOD-5, TSS, TKN, total residual chlorine, fecal coliforms and chronic toxicity.

Facility: Mobile County-Chunchula Sanitary Landfill
Location: US Hwy. 43.
Chunchula, AL
NPDES Permit No. AL 0062791
Receiving waters: Sweetwater Branch
Nature of wastewater: Landfill leachate and stormwater runoff.
Monitored parameters: Flow, pH, BOD-5, TSS, TDS, ammonia and chronic toxicity.